

PUBLIC ACCEPTANCE OF CARBON CAPTURE, UTILIZATION AND STORAGE (CCUS) PROJECT UNDER THE BACKGROUND OF CARBON NEUTRALIZATION

Chaoyan Deng

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
Program in Management
Rattanakosin International College of Creative Entrepreneurship
Rajamangala University of Technology Rattanakosin
Academic Year 2026
Copyright of Rajamangala University of Technology Rattanakosin

PUBLIC ACCEPTANCE OF CARBON CAPTURE, UTILIZATION AND STORAGE (CCUS) PROJECT UNDER THE BACKGROUND OF CARBON NEUTRALIZATION

Chaoyan Deng

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
Program in Management
Rattanakosin International College of Creative Entrepreneurship
Rajamangala University of Technology Rattanakosin
Academic Year 2026
Copyright of Rajamangala University of Technology Rattanakosin

PUBLIC ACCEPTANCE OF CARBON CAPTURE, UTILIZATION AND STORAGE (CCUS) PROJECT UNDER THE BACKGROUND OF CARBON NEUTRALIZATION

Chaoyan Deng

2026



Copyright Consent Letter of Thesis/Independent Study between the Student and Rajamangala University of Technology Rattanakosin

At Rajamangala University of Technology Rattanakosin
96 Moo 3, Phutthamonthon Sai 5 Road, Salaya
Subdistrict Phutthamonthon District,
Nakhon Pathom Province 73170

Date 29 May 2026

I, ~~Mr.~~/~~Mrs.~~/Miss Chaoyan Deng Student ID 1631110381107, am a student of the Faculty/College of Rattanakosin International College of Creative Entrepreneurship in the Program of Doctor of Philosophy Major: Management Plan Thesis

agree to grant the copyright and other related information in the approved thesis/ independent study under the following topic

Title of Thesis/Independent Study

Thai .....

English Public Acceptance of Carbon Capture, Utilization, and Storage (CCUS) Projects under the Background of Carbon Neutralization

I agree to grant such rights to Rajamangala University of Technology Rattanakosin for the full term of protection as provided under relevant intellectual property laws.

Signature ..... Student
(Miss Chaoyan Deng)

Signature ..... Advisor
(Professor Dr. Chunyan Dai)

Signature ..... Director
(Dr. Nuttapong Jotikasthira)



Thesis Certificate
Rattanakosin International College of Creative Entrepreneurship
Rajamangala University of Technology Rattanakosin

Thesis of Title	Public Acceptance of Carbon Capture, Utilization, and Storage (CCUS) Projects under the Background of Carbon Neutralization
Researcher	Miss Chaoyan Deng
Degree Sought	Doctor of Philosophy Program in Management (International Program)
Thesis Advisor	Professor Chunyan Dai, Ph.D.

Rattanakosin International College of Creative Entrepreneurship, Rajamangala University of Technology Rattanakosin Approved this Thesis in Partial fulfillment of the Requirements for the Degree of Doctor of Philosophy

..... Director
(Dr. Nuttapong Jotikasthira)

Thesis Committee

..... Chairperson
(Professor Dr. Kornchai Phornlaphatrachakorn)

..... Member
(Associate Professor Dr. Chalermkiat Wongwanichtawee)

..... Member
(Dr. Kessara Kanchanapoom)

..... Member
(Assistant Professor Dr. Jirawan Deeprasert)

..... Member and Advisor
(Professor Dr. Chunyan Dai)

Title of Thesis Public Acceptance of Carbon Capture, Utilization, and Storage (CCUS) Projects under the Background of Carbon Neutralization
Researcher: Miss Chaoyan Deng, (M.Sc.); **Degree:** Doctor of Philosophy (Management);
Advisor: Chunyan Dai, (Ph.D.), Professor; **Academic Year:** 2026

ABSTRACT

The objectives of this study were (1) to identify and empirically validate the key factors influencing the public acceptance of carbon capture, utilization and storage (CCUS) projects in Guizhou Province, China, (2) to identify and empirically validate the influencing paths of public cognition affecting perceived benefits and perceived risk for the public to accept CCUS projects in Guizhou Province, China, (3) to identify and empirically validate the influencing paths of legal protection and fairness affecting trust for the public to accept CCUS projects in Guizhou Province, China, and (4) to assess the impact of environmentalism on public acceptance of CCUS projects in Guizhou, China.

This study adopted a quantitative research approach. Structured questionnaires were distributed to teachers and students in colleges and universities, staff members of relevant enterprises and public institutions, as well as government officials in Guizhou Province, resulting in 415 valid quantitative data questionnaires. Statistical analyses included descriptive statistics, exploratory factor analysis, confirmatory factor analysis, and structural equation modeling.

Major findings: (1) On the issue of public cognition, perceived interests, perceived risk, trust, legal protection, fairness and environmentalism, it is clear that all are key core factors that affect the public acceptance of CCUS projects in Guizhou Province, and all the factors work together to influence the public acceptance willingness through different paths; (2) On the issue of public cognition, this factor indirectly affects the acceptance of the project by positively enhancing the public's perceived interest in the project and negatively weakening the perceived risk, and the intermediary effect of perceived interest is more prominent than perceived risk; (3) On the issue of legal protection and fairness in decision-making and distribution, these factors enhance the public's trust in CCUS projects and related subjects, and indirectly enhance the acceptance of projects with trust as the key intermediary; and (4) On the issue of environmentalism, this factor has a direct and positive driving effect on public acceptance, which can further strengthen the positive influence of perceived interests, weaken the negative constraints of perceived risk, and enhance the public's willingness to accept CCUS projects comprehensively, providing an empirical basis for the promotion of regional CCUS projects.

Keywords: Carbon capture utilization and storage (CCUS), Public acceptance, Public cognition, Fair, Trust

Advisor's Signature .....

Acknowledgments

In the summer of Thailand, the sun is warm and inviting, and the marine climate is both cozy and comfortable. Time seems to linger on. Looking back on the years of my academic pursuit and doctoral studies, a flood of emotions, both sweet and bitter, come to mind. But above all, I am deeply grateful for this learning experience.

First and foremost, I would like to express my sincere gratitude to Professor Chunyan Dai for her years of dedicated guidance. Her rigorous academic style, optimistic attitude toward life, patient teaching methods, and bold spirit of innovation have always inspired me to persevere in this academic field and have had a positive impact on my work and life. It was under her guidance and encouragement that I was fortunate enough to delve into the cutting-edge field of carbon neutrality, which is of great significance to our times. She also trusted me to participate in some national-level research projects, and her guidance enabled me to accumulate rich practical experience and improve my overall quality.

I am also deeply grateful to the faculty members of the Rattanakosin International College of Creative Entrepreneurship, Rajamangala University of Technology Rattanakosin for laying a solid theoretical foundation for me. I would like to thank Asst. Prof. Jirawan Deeprasert for providing valuable academic feedback during the review of my research plan and final thesis. I am also grateful to the members of the review panel for their constructive suggestions.

I am very grateful to Dr Jiang Songyu for his tireless guidance in my academic pursuits. It was him who helped me overcome various difficulties in my doctoral thesis. His clear and concise course explanations, profound academic attainments, and approachable thesis guidance have had a profound impact on the completion of my studies. I am especially grateful to Dr. Tang Changjiang, Ms. Wen Li and Dr. Li Lina, as well as all the staff who have silently supported my academic pursuits, for their selfless support in both my life and studies. Their help with accommodation and daily affairs has allowed me to fully focus on my studies. I am also grateful to classmates like Qin Peng and Yang Zhongya for their academic exchanges and guidance. Their generous sharing of doctoral thesis writing experiences has helped me stay on the right track amid confusion.

I am deeply grateful to my parents for their all-round support during my doctoral studies. They have provided me with endless help both spiritually and materially. I am also grateful to my spouse for his spiritual encouragement during my doctoral studies and for the birth of our child during this period, allowing me to achieve success in both love and studies. Thank my child for growing up with my doctoral thesis. His support has given me more time and energy to concentrate on my study. During this period, his transformation from fetus to baby has made me realize the power of life!

I am grateful to everyone who has been an indispensable part of my doctoral journey. Thank you for your consistent encouragement and support.

Chaoyan Deng

December 2025

Table of Contents

	Page
Abstract	(1)
Acknowledgments	(2)
Table of Contents	(4)
List of Tables	(8)
List of Figures	(10)
List of Abbreviation and Glossary	(11)
Chapter 1 Introduction.....	1
1.1 Background of the Study	1
1.1.1 Research Problem Statement	1
1.1.2 Research Gap Identified	4
1.2 Significance of this Study	6
1.2.1 Theoretical Significance	6
1.2.2 Practical Significance	7
1.3 Statement of Research Questions	8
1.4 Statement of Research Objectives	9
1.5 Methodology	9
1.6 Definition of Terms	10
1.6.1 Perceived Risk Influencing Public Acceptance of CCUS Projects	10
1.6.2 Perceived Benefits Influencing Public Acceptance of CCUS Projects	10
1.6.3 Environmentalism Affecting Public Acceptance of CCUS Projects	10
1.6.4 Public Cognition Influencing the Public Acceptance of CCUS Projects	10
1.6.5 Trust Influencing Public Acceptance of CCUS Projects ..	10
1.6.6 Fairness Influencing Public Acceptance of CCUS Projects	10
1.6.7 Legal Protection Affecting Public Acceptance of CCUS Projects	10
1.6.8 Public Acceptance of CCUS Projects	11
1.7 Delimitation of the Thesis	11
1.8 Outline of the Thesis	13

Table of Contents (continued)

		Page
	1.9 Conclusion	14
Chapter 2	Literature Review	15
	2.1 Research Contexts	15
	2.1.1 Carbon Neutrality	15
	2.1.2 CCUS (Carbon Capture, Utilization and Storage)	17
	2.1.3 Problems in the Development of CCUS Project	20
	2.1.4 Public Acceptance	21
	2.1.5 The typicality of public acceptance research on CCUS projects in Guizhou	32
	2.2 Parent Disciplines	34
	2.2.1 ABC (Affect, Behavior and Cognition) Attitude Theory	34
	2.2.2 Social License to Operate (SLO)	37
	2.2.3 Institutional Trust Theory	39
	2.2.4 Stakeholder Theory	40
	2.3 Immediate Disciplines	43
	2.3.1 Public Cognition	43
	2.3.2 Perceived Risk	44
	2.3.3 Perceived Benefits	46
	2.3.4 Environmentalism	48
	2.3.5 Trust	50
	2.3.6 Fairness	51
	2.3.7 Legal Protection	52
	2.3.8 Public Acceptance	52
	2.3.9 Social Statistical Characteristics	53
	2.4 Theoretical Model and Hypotheses Statement	53
	2.4.1 Theoretical Model	53
	2.4.2 Hypothesis Development	55
	2.5 Conclusion	62
Chapter 3	Methodology	63
	3.1 Overview and Justification of Research Paradigm	63
	3.1.1 Positivism	63
	3.2 Quantitative Research	64
	3.2.1 Research Tool	65

Table of Contents (continued)

		Page
	3.2.2 Data Collection Administration	75
	3.2.3 Data Analysis	77
	3.3 Ethical Considerations	83
	3.4 Conclusion	84
Chapter 4	Results	86
	4.1 Sample Data Collection and Processing	86
	4.1.1 The Implementation Situation of the Questionnaire Survey	86
	4.1.2 Sample Data Cleaning	86
	4.1.3 Descriptive Statistical Analysis of Sample Distribution	87
	4.2 Reliability and Validity Analysis of the Questionnaire	89
	4.2.1 Reliability Analysis of Questionnaire Data	89
	4.2.2 Validity Analysis of the Questionnaire	91
	4.2.3 Common Method Variance (CMV)	97
	4.3 Assessment of the Measurement Model's Reliability and Validity	97
	4.3.1 Development of a Confirmatory Factor Analysis (CFA) Model	97
	4.3.2 Assessment of Reliability and Validity	98
	4.4 Assessment of Demographic Factor Heterogeneity	103
	4.5 Structural Equation Modeling (SEM) Analysis	106
	4.5.1 The Development and Specification of the Structural Equation Model (SEM)	106
	4.5.2 Goodness-of-Fit Assessment in Structural Equation Modeling (SEM)	107
	4.5.3 Analysis of Structural Equation Modeling (SEM) Results	108
	4.6 Results of Mediation Analysis	109
	4.7 Conclusion	115
Chapter 5	Discussion and Conclusion	116
	5.1 Discussion	116
	5.2 Implication to Theories	119
	5.2.1 Implication to ABC (Affect, Behavior and Cognition) Attitude Theory	120

Table of Contents (continued)

	Page
5.2.2 Implications to Social License to Operate (SLO)	122
5.2.3 Implications to Institutional Trust Theory	124
5.3 Implication to Practitioners …	127
5.3.1 Implication to Government Departments	127
5.3.2 Implication to CCUS Project Investment and Operating Enterprises	129
5.3.3 Implication to Third-Party Professional Service Provider in CCUS Projects	131
5.4 Limitations and Future Research	132
5.5 Conclusion	133
Bibliography ……..	135
Appendix ……	157
Appendix A Questionnaire (English Version) ……	158
Appendix B Publication of Journal during Ph.D. Study …….	166
Vitae ……..	188

List of Tables

Table		Page
2.1	CCUS Acceptance Research High Frequency Keyword Clustering	29
2.2	Table of Research Variables	54
2.3	Summary of Research Hypotheses	61
3.1	Operational Definition of Variable	65
3.2	Items used to Measure Perceived Risk	67
3.3	Items used to Measure Perceived Benefits	68
3.4	Items used to Measure Environmentalism	69
3.5	Items used to Measure Public Cognition	69
3.6	Items used to Measure Trust	70
3.7	Items used to Measure Fairness	71
3.8	Items used to Measure Legal Protection	73
3.9	Items used to Measure Public Acceptance	74
3.10	Pilot-test Reliability Statistics	78
3.11	Pilot-investigation KMO and Bartlett's test	79
3.12	Cronbach's (reliability criterial)	80
3.13	Fit Indices of Structural Equation Models	83
4.1	Descriptive Statistical Analysis of Sample	88
4.2	Reliability Test of the Questionnaire	89
4.3	KMO and Bartlett's Test of Sphericity for the Public Acceptance Questionnaire of CCUS Projects	91
4.4	Rotating Component Matrix of the Scale	92
4.5	Summary of Total Variance Explained	94
4.6	Criteria for Assessing the Validity and Reliability of the Measurement Model	99
4.7	Descriptive Statistics, Factor Loadings, Internal Consistency (Cronbach's α), Composite Reliability (CR), and Average Variance Extracted (AVE) of the Measurement Model	100
4.8	Result of Discriminate Validity Tests	102
4.9	Independent Samples T-Test Results for Gender-Based Differences in Public Acceptance of CCUS Projects	103
4.10	One-way ANOVA Results Evaluating the Influence of Age on Public Acceptance Levels of CCUS Projects	104

List of Tables (continued)

Table		**Page**
4.11	Results of One-way ANOVA Test on the Relationship between Education Level and Public Acceptance of CCUS Projects	105
4.12	Results of One-way ANOVA Test on the Relationship between Income and Public Acceptance of CCUS Projects	106
4.13	Fit Test Results for the Structural Equation Model (SEM)	108
4.14	Model Path Analysis Results	109
4.15	Summary of Mediation Analysis for Each Mediating Path in the Model	111
4.16	Result of Testing the Structure Equation Model	111

List of Figures

Figures **Page**

2.1 Schematic Diagram of CCUS (Carbon Capture, Utilization and Storage) (Source: IEA, 2017) 17
2.2 Trend chart of the numbers of articles about public on CCUS-acceptability published annually(2007-2023) 24
2.3 Keyword Time Line Diagram of CCUS Project Public Acceptance Research 24
2.4 CCUS Acceptance Research High Frequency Keyword Clustering Diagram 29
2.5 Key words pop-up diagram of CCUS project public acceptance research 31
2.6 The standard learning levels of the ABC Attitude Model (Source: Mario, 2007) 34
2.7 ABC attitude theory model (Source: Liu, B. S. et al., 2021) 36
2.8 Overview of relationships between concepts. (Source: Nina Hall et al., 2015) 38
2.9 The nomological network of influences of institutional forces on the supplier's trust in manufacturing supply chains both directly and indirectly through buyer firm practices (Source: Hemmert, M., Kim, D., Kim, J., & Cho, B, 2016) 39
2.10 Evaluation model of the relationship between stakeholders(Source: Wang et al., 2022) 42
2.11 Conceptual Framework 55
4.1 Confirmatory Factor Analysis (CFA) Results 98
4.2 Structural Equation Model (SEM) of Public Acceptance Toward CCUS Projects 107
4.3 Fitting Results of Structural Equation Model 108

List of Abbreviation and Glossary

Abbreviation / Glossary	Explanation
AGFI	Adjusted Goodness of Fit Index
AVE	Average Variance Extracted
CB-SEM	Covariance-based SEM
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CITC	Common Item Total Correlation
EFA	Exploratory Factor Analysis
GFI	The Goodness of Fit Index
KMO	Kaiser-Meyer-Olkin
RMSEA	The Root Mean Square Error of Approximation
SEM	Structural Equation Modeling
TLI	Tucker-Lewis Index
CCUS	Carbon Capture, Utilization and Storage
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilization
CCTS	Carbon Capture, Transportation and Storage
IEA	International Energy Agency
PC	Public Cognition
PB	Perceived Benefits
PR	Perceived Risk
FR	Fairness
LP	Legal Protection
TR	Trust
EN	Environmentalism
PA	Public Acceptance
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
NEA	National Environmental Protection Agency

CHAPTER 1
INTRODUCTION

The purpose of this study is to explore the public's acceptance of Carbon Capture, Utilization and Storage (CCUS) in Guizhou Province, China, and then put forward opinions and suggestions on the development of CCUS from the social level (establishing multi-channel communication mechanism) and the government level (formulating and improving relevant legal protection of CCUS), so as to provide guidance for the implementation and sustainable development of CCUS project in Guizhou, China. This chapter mainly introduces background of the study, significance of the study, statement of research questions, statement of research objectives, methodology, definition of terms, delimitation of the thesis and outline of the thesis.

1.1 Background of the Study

1.1.1 Research Problem Statement

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(Zhai et al., 2018).

To mitigate the escalating threat of the greenhouse effect, the international community has reached a consensus on reducing greenhouse gas emissions. In response, in 2016, more than 170 national leaders gathered at the United Nations Headquarters to jointly sign the Paris Agreement. At present, more than 140 countries and regions around the world have put forward the climate goal of “zero carbon” or “carbon neutrality”. China, as a responsible country, Chairman Xi Jin Ping solemnly promised at the 75th UN General Assembly in September, 2020 that China's carbon dioxide emissions would peak before

2030 and strive to achieve carbon neutrality before 2060 (Zangerolame Taroco & Sabbá Colares, 2019).

Climate change is having a lasting and profound impact on the world. The 27th Conference of the Parties to the United Nations Framework Convention on Climate Change, held in 2022, adopted the Sharm el-Sheikh Implementation Plan, which reaffirmed the long-term goal of the Paris Agreement to "control the global average temperature increase within 2℃ compared with the pre-industrial period" and once again urged countries to gradually reduce coal-fired power without adopting capture and storage measures. According to the Third Group Report of the Sixth Climate Change Assessment of the United Nations Intergovernmental Panel on Climate Change (IPCC), in order to achieve the goal of 2℃, the current global CO2 emission budget is only about 1.15 trillion tons, and the global CO2 emission accounts for about one third of this budget from 2010 to 2019. Under the condition that it is impossible to completely abandon fossil energy, carbon capture, utilization and storage (CCUS) technology, as an indispensable part of carbon neutral technology combination, is the key technical means and underpinning technology to achieve the temperature control goal of the Paris Agreement (IPCC6, 2023).

With the gradual clarification of the carbon-neutral goal and the acceleration of carbon emission reduction in China and other countries, a technology referred to as carbon capture, utilization and storage (CCUS) came into being. CCUS is a series of technologies (IPCC, 2014) 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).

Carbon Capture, Utilization and Storage (CCUS) technology separates CO2 from emission sources, and then converts it into utilization or directly stores it to realize CO2 emission reduction. CCUS is an effective way for coal-fired power plants, steel plants and

cement plants to control greenhouse gas emissions. Guizhou hosts all three carbon-intensive industries, yet few CCUS project has been implemented to date. Because CCUS includes CS (CO2 storage), CT (CO2 transportation) and CU (CO2 utilization), these processes have potential risks and benefits for local residents. Therefore, it is of great significance to carry out CCUS acceptance research for the public under the background that China has issued a series of support policies to Guizhou Province.

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. This makes CCU (Carbon Capture and Utilization) or CCS (Carbon Capture and Storage) 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.

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 risk, 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 knowledge about relevant technologies (Storrs et al., 2023).

Why is public acceptance so important to CCUS project?

Public acceptance is crucial for CCUS projects. The core reason is that the siting, construction and operation of such projects require the occupation of land resources, the design of pipeline laying and other engineering works, and there are potential environmental risk (such as leakage of stored CO2). Lack of public support will directly lead to project approval delays, extended construction periods or even project abandonment. At the same time, CCUS projects often need government policy support and social capital investment. A positive public attitude can promote policy implementation and attract capital participation, while the opposite will trigger public controversy and increase the cost and resistance of project advancement. Moreover, public awareness and participation can also promote the improvement of project technology optimization, risk management and control, and enhance the long-term sustainability of the project (Fleishman et al., 2010). In view of 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 (NEA, 2017).

1.1.2 Research Gap Identified

1.1.2.1 Geographical Gap

The global CCUS public acceptance research shows obvious regional imbalance characteristics, and the localized and refined regional research is seriously insufficient to adapt to the social culture and project layout reality in different regions. From a global perspective, the existing research is highly concentrated in developed countries and regions such as North America, Europe and Australia. With the layout of early CCUS demonstration projects, these regions have formed a relatively complete public acceptance research system, focusing on the correlation mechanism between local public risk perception, community attitude and project promotion (del Rio et al., 2026). However, the special empirical research on emerging economies and developing regions such as China, India and Africa is extremely scarce, and most comprehensive studies clearly point out that the research on CCUS public acceptance in developing economies that meet academic norms is almost blank. As the core region of global carbon emissions

and the key market of CCUS technology, this kind of region is essentially different from the western developed countries in social and cultural background, energy policy system and public environmental literacy. The conclusion of direct application of European and American research lacks regional adaptability and cannot explain the public acceptance behavior in the local scene (Lu et al., 2021).

Domestic research also has the limitations of regional research, mostly focusing on national macro-generalization research, lacking the heterogeneity research of key regions. CCUS projects in China are mainly located in coal-producing areas and heavy industry bases in the central and western regions. The local public's cognitive level, risk perception and interest demands are obviously different from those in the eastern developed regions, but there is little targeted empirical analysis. At the same time, there is a lack of research at the micro-community level, and the acceptance of the affected groups around the project is insufficient, so it is difficult to deal with practical problems such as neighborhood effect and community communication (Tardin-Coelho et al., 2025). Excessive macro research, insufficient micro-precision research, more research in developed areas and less research in core layout areas make it difficult for research results to support regional projects.

By studying the public acceptance of CCUS project in Guizhou, China Province, this paper fills some research gaps in regional coverage in this field.

1.1.2.2 Theoretical Gap

In the theoretical dimension, there are some problems in the current research, such as single theoretical application, insufficient localization and weak mechanism research. First of all, the homogenization of theoretical application is outstanding, and the framework of multi-theory integration has not yet formed. The existing research mostly relies on single classical theory such as planned behavior theory and technology acceptance model, which can only explain some influencing factors and cannot cover multiple variables such as policy, social trust and regional culture. Although some studies have introduced theories such as social permission and institutional trust, the systematic analysis framework of multi-theory cross-integration has not yet been established, which cannot fully explain the formation mechanism of public acceptance (Li et al., 2014).

Secondly, there are gaps in the study of core mechanism and dynamic evolution. The existing research mostly stays in the identification and simple verification

of influencing factors, and the core issues such as the interaction between factors, the mediation mechanism and the mechanism of regional differences are not deeply studied (Li et al., 2017). In addition, the research is mainly based on static analysis, lacking the research on the dynamic evolution of public acceptance with project advancement, policy iteration and information dissemination, which is difficult to support the formulation of dynamic public communication strategies. On the whole, the integrity and practical explanatory power of the existing theoretical system are insufficient, and it can not provide comprehensive theoretical guidance for CCUS public communication.

In this paper, ABC attitude theory and institutional trust theory are integrated and applied to carbon capture, utilization and storage (CCUS), which fills this gap. By integrating these models, the factors affecting the public acceptance of CCUS are analyzed. In addition, by taking trust as an intermediary factor between legal protection and public acceptance, and taking trust as an intermediary factor between fairness and public acceptance, it fills the gap in understanding how public trust in all aspects of CCUS projects affects their acceptance.

From the perspective of cross-dimensional mechanisms, previous studies have mainly focused on the path of "perception-trust-acceptance". This study enriches the model of public acceptance of CCUS by incorporating legal protection and environmentalism. By analyzing the stakeholder theory, it emphasizes the importance of multi-subject collaboration, including the government, enterprises, communities, and environmental protection organizations.

1.2 Significance of this Study

1.2.1 Theoretical Significance

Firstly, enrich the theoretical research on the deployment and implementation of CCUS projects. In previous studies on the development of CCUS projects, most have conducted research on technological improvements, economic costs and benefits, and analyzed the feasibility of CCUS project deployment from a technical or economic perspective. However, research on CCUS projects from a humanities or social science perspective is scarce. According to the Kaniyin Law, the deficiencies are often the key to determining whether a project can be sustained and operated.

Secondly, this study integrates constructs such as perceived risk, perceived benefit, environmentalism, public cognition, trust, fairness, legal protection, and public acceptance, enriching the research on public acceptance of CCUS project deployment and development. Previous studies mainly focused on the acceptance of other clean energy sources, with relatively few studies on the public acceptance of CCUS projects. At the same time, most previous studies were based on single-factor analysis and lacked multi-factor analysis that comprehensively applied multiple theories. By integrating relevant theoretical models and adding the regional background of Guizhou Province, which covers three major carbon emission source industries, this study can more comprehensively and objectively understand the public's acceptance of CCUS projects.

Thirdly, the empirical analysis of this study is helpful to explain the public acceptance of CCUS projects by the acceptance model and enrich the theoretical research of the acceptance model. Traditional neighbor-avoidance theory, PBC (Perceptual Behavior Control), TRA (Rational Action Theory) and TPB (Planned Behavior Theory) can only explain one aspect of CCU (Carbon Capture and Utilization) acceptance or CCS (Carbon Capture and Storage) acceptance. By establishing an extended acceptance model, it is helpful to explain the acceptance of CCUS (carbon capture, utilization and storage) more comprehensively and expand the theoretical research of the acceptance model.

1.2.2 Practical Significance

First, from the perspective of CCUS operators, it is helpful for operators to scientifically implement the plan and deployment, protect the legitimate rights and interests of the public, and then improve and upgrade the products, which is conducive to the sustainable development of CCUS projects. The sustainable development of CCUS requires not only a process of continuous improvement of technology, but also a process of continuous improvement of government's encouragement and support policies and related normative policies, and more importantly, a process of continuous acceptance by the public, which includes not only the deviation of public interests brought about by it, but also the change of lifestyle brought about by it.

Secondly, from the perspective of the development of CCUS technology itself, by investigating the public acceptance of CCUS, we can expand the public awareness of CCUS. Based on its great significance, we can effectively encourage more professional and technical personnel to work in its field, lay a foundation for building local CCUS

projects and provide more continuous talent protection, which is conducive to providing more jobs in the transformation of regional industries to low carbon, and ultimately promote the development of CCUS technology. The development of technology is rooted in innovation, innovation comes from high-level talents, and the gathering of talents is attributed to development opportunities. Through the deployment planning and publicity of CCUS project, more citizens are encouraged to actively participate in the study, research and employment in this field.

Thirdly, from the government's point of view, through public participation in major projects, the public can feel a higher sense of ownership, which will help improve the government's credibility, improve the relevant legal system, and help macro-planning and deployment of various industries to jointly do a good job in this project with historical significance and benefit the global climate environment. As a system and procedure, public participation in the impact assessment of large-scale projects such as CCUS can not only ensure the public's environmental rights and interests and promote the harmonious development of democracy in China, but also effectively monitor the abuse of rights in government construction projects through public participation in environmental impact assessment, effectively mobilize the public's enthusiasm and awareness of environmental protection, and expand and supplement the current corresponding environmental impact assessment system and public participation theory, as well as public decision-making and management-related research.

1.3 Statement of Research Questions

RQ1: What are the key factors that influence the public acceptance of carbon capture, utilization and storage (CCUS) projects in Guizhou Province, China?

RQ2: How dose public cognition influence perceived benefits and perceived risk for public to accept CCUS projects in Guizhou Province, China?

RQ3: How dose legal protection and fairness influence trust for public to accept CCUS projects in Guizhou Province, China?

RQ4: How does environmentalism affect the public acceptance of CCUS projects in Guizhou, China?

1.4 Statement of Research Objectives

RO1: To analyze and empirically validate the key factors influencing the public acceptance of carbon capture, utilization and storage (CCUS) projects in Guizhou Province, China.

RO2: To identify and empirically validate the influence paths of public cognition affecting perceived benefits and perceived risk for public to accept CCUS projects in Guizhou Province, China.

RO3: To identify and empirically validate the influence paths of legal protection and fairness affecting trust for public to accept CCUS projects in Guizhou Province, China.
RO4: To assess the impact of environmentalism on public acceptance of CCUS projects in Guizhou, China.

1.5 Methodology

This study employed a quantitative approach to explore the factors influencing public acceptance of CCUS projects. An empirical method was used to validate the proposed conceptual model and test the hypothesized influence paths among key variables. A quantitative research design was adopted, and data were collected through a structured questionnaire survey. A total of 415 valid responses were obtained from the public in Guizhou Province, China. Convenient sampling was used to ensure coverage of various types of public in Guizhou Province. The measurement items were adapted from validated scales in existing literature and refined through pre-testing. The constructs involved included public awareness, fairness, legal protection, environmentalism, perceived benefits, perceived risks, trust, and public acceptance. Structural equation modeling (SEM) was used to analyze the data to evaluate the measurement model and structural model. Confirmatory factor analysis (CFA) was conducted to verify reliability and validity, including convergent validity and discriminant validity. Path analysis examined the direct, indirect, and total effects among the constructs, while the mediating effect was tested using the bootstrap method.

1.6 Definition of Terms

1.6.1 Perceived Risk Influencing Public Acceptance of CCUS Projects

Perceived risk refers to the public's subjective belief that CCUS projects may lead to negative outcomes. (Xiao et al., 2026).

1.6.2 Perceived Benefits Influencing Public Acceptance of CCUS Projects

Perceived benefits refer to the value of related gains that the public can perceive from CCUS projects, such as job opportunities and economic compensation (Xiao et al., 2026).

1.6.3 Environmentalism Affecting Public Acceptance of CCUS Projects

Environmentalism refers to public support for environmental technologies and activities related to carbon reduction. People with environmental awareness are more likely to care about global climate change and the attitude of CCUS projects in mitigating global warming (Hurlimann et al., 2008).

1.6.4 Public Cognition Influencing the Public Acceptance of CCUS Projects

Public cognition refers to the extent to which the public is informed about the knowledge related to CCUS projects. The objective understanding of CCUS projects by the public affects their acceptance of it (Liu, B. S. et al., 2021).

1.6.5 Trust Influencing Public Acceptance of CCUS Projects

Trust is generally the public's belief in others' promises based on the principle of honesty or their recognition of others' ability to fulfill their promises based on the principle of competence. In the implementation process of CCUS projects, both aspects that can earn the public’s trust are indispensable (Liu, B. S. et al., 2021).

1.6.6 Fairness Influencing Public Acceptance of CCUS Projects

Fairness refers to the degree of transparency in the distribution of public interests during the implementation of CCUS projects. Research results show that the higher the fairness, the higher the public acceptance of it (Liu, B. S. et al., 2021).

1.6.7 Legal Protection Affecting Public Acceptance of CCUS Projects

Legal protection refers to whether the legal and policy framework for CCUS projects is complete, whether the benefits people receive are guaranteed at the legal level, and whether the risks they face are avoided at the legal level (Hemmert et al., 2016).

1.6.8 Public Acceptance of CCUS Projects

Public acceptance refers to the psychological perception of the public towards CCUS projects based on their own moral and value systems, which is manifested in different degrees of recognition and acceptance from aspects such as attitude, emotion and rationality (Liu, B. S. et al., 2021).

1.7 Delimitation of the Thesis

The research subjects of this study are the public in Guizhou Province who are planning to carry out CCUS projects. The participants come from various prefectures and cities in Guizhou and are engaged in industries such as government, enterprises, communities, and scientific research. CCUS projects include CCS (carbon capture and storage), CCT (carbon capture and transport), and CCU (carbon capture and utilization). To enhance the effectiveness of the questionnaire, a brief and concise summary of CCUS was provided at the beginning of the questionnaire to help the public form a basic understanding of CCUS, facilitating their effective completion of the questionnaire.

The main reasons for choosing the public in Guizhou Province as the research object are as follows:

Firstly, looking at the current status of CCUS project implementation, by the end of 2024, China has nearly 120 carbon capture, utilization and storage (CCUS) demonstration projects in operation or under planning, distributed across most provinces. Among them, Guizhou Province is also emerging as a leader in large-scale CCUS projects. In December 2025, the world's first commercial supercritical carbon dioxide power generation unit, "Supercarbon One", was successfully put into operation at the Shougang Shuicheng Steel Plant in Liupanshui, Guizhou. Guizhou is a province with a relatively high number of high-carbon emission enterprises, such as coal-fired power plants and steel mills. Despite the goal of carbon neutrality, the implementation of CCUS zero-carbon projects in Guizhou is imperative. Therefore, conducting acceptance surveys among the local public is conducive to the comprehensive development of CCUS projects.

Secondly, in terms of policy support and educational background, both China and Guizhou Province have issued special policies for the implementation of CCUS demonstration projects in Guizhou and policies on green and low-carbon technological innovation. These policies require active participation and support from the public to be

better implemented. Although information technology has developed rapidly in recent years and Guizhou has achieved the goal of "highways reaching every county", the internet has not yet fully covered some mountainous areas in Guizhou. Moreover, as CCUS is a rather specialized term, many people cannot keep up with the latest innovative technologies. Conducting acceptance surveys on CCUS projects in Guizhou can help understand the acceptance dynamics and then carry out targeted publicity work.

Thirdly, from the perspective of ethnic demography and geographical location, Guizhou is a multi-ethnic province. The overall cognitive level, general educational background, customs, and values of different ethnic groups may vary, which could lead to different levels of public acceptance of certain specific technologies and special public projects. Additionally, the unique karst topography in Guizhou poses potential risks for carbon dioxide storage, and the diversified storage paths such as saline aquifers and coalbed methane displacement add complexity to the research on public acceptance of CCUS projects. Therefore, conducting research on public acceptance of carbon capture, utilization and storage (CCUS) in this province enriches its existing research system.

Regarding the variables, this study focuses on a set of constructs selected from the ABC (affect, behavior, and cognition) attitude theory, social license theory, institutional trust theory, and stakeholder theory. These constructs include public perception, perceived benefits, perceived risk, fairness, legal protection, trust, and public acceptance. More fundamental background variables such as environmentalism were not directly included, which might limit the interpretation of causal mechanisms in a more comprehensive context.

Furthermore, this study employed a cross-sectional design, with the data collected within a single time frame. As such, it was unable to capture the longitudinal changes in public acceptance of CCUS projects over time. These limitations were deliberately set to maintain the feasibility and depth of analysis of the study, while acknowledging that future research might expand the scope to a broader population, institutional types, or longitudinal dimensions.

1.8 Outline of the Thesis

This thesis is divided into five core chapters, each of which aims to systematically advance the research on public acceptance of CCUS projects.

Chapter One: Introduction provides the foundational background for the research. It presents the research context, highlights the research questions and identified gaps, clarifies the significance, objectives and guiding questions of the study. It also outlines the adopted mixed methods, defines key terms, and concludes with a summary of the research scope.

Chapter Two: Literature Review provides a comprehensive review of the existing literature and theoretical frameworks related to this study. This chapter explores the background of CCUS, the concept of CCUS acceptance, and the current research status of CCUS and its acceptance. In addition, the application of public acceptance-related theories in CCUS projects was reviewed, and a critical discussion was conducted on the ABC (affect, behavior, and cognition) attitude theory, social license theory, institutional trust theory, and stakeholder theory. These theories provided a basis for the research model. Finally, this chapter proposes a conceptual framework and forms hypotheses.

Chapter Three: Research Methods elaborates on the research paradigm, research design, data collection methods, and analysis procedures. It describes the structured survey and structural equation model (SEM) of quantitative research. This chapter also discusses sampling strategies, measurement scales, exploratory factor analysis, validation methods, and ethical considerations.

Chapter Four: Results present the empirical research findings of the quantitative analysis. It elaborates on the descriptive statistics, exploratory factor analysis results, confirmatory factor analysis, and structural path model results. The relationships among key constructs are analyzed, including direct, indirect, and mediating effects.

Chapter Five: The discussion and conclusion section correlates the research findings with the theoretical framework and previous literature. It explores the implications for theoretical development, practical applications for CCUS researchers, CCUS project developers, and government officials, and critically assesses the limitations of the study. Finally, it proposes directions for future research.

1.9 Conclusion

This chapter mainly introduces the research background, research significance, research problems, research objectives, research scope and research limitations. This chapter is the basis of the whole study, and the next chapter introduces the content of literature review.

CHAPTER 2
LITERATURE REVIEW

This chapter lays the theoretical foundation for the research on the public acceptance of CCUS (Carbon Capture, Utilization and Storage) projects in Guizhou, China, under the background of carbon neutrality. It systematically reviews the recent relevant research and theories to clarify the background of this study and construct a conceptual framework. Firstly, this chapter will introduce the background of this study and examine the key factors influencing the public acceptance of CCUS projects in Guizhou. It will explore the challenges posed by climate change due to increased greenhouse gas emissions and emphasize the potential of CCUS in addressing this gap. It will analyze existing acceptance theory models, such as the ABC (Affect, Behavior, and Cognition) attitude theory, social license theory, institutional trust theory, and stakeholder theory, and summarize the variables that may affect the public acceptance of CCUS projects in Guizhou. It will also explore the stakeholders of CCUS projects. Secondly, based on existing theories (ABC (Affect, Behavior, and Cognition) attitude theory, social license theory, and institutional trust theory), this study will discuss the path relationships in the empirical model. Finally, this study will propose hypotheses regarding the variables - perceived risk, perceived benefit, environmentalism, public cognition, trust, fairness, legal protection, and public acceptance - to explore their impact on the public acceptance of CCUS projects in Guizhou.

2.1 Research Contexts

2.1.1 Carbon Neutrality

Carbon neutrality refers to the balance between anthropogenic emission sources and anthropogenic absorption sinks such as afforestation and carbon capture and storage (CCS) technology. Carbon neutrality targets can be set at different levels, including global, national, city, and enterprise activities. In a narrow sense, it refers to carbon dioxide emissions, while in a broad sense, it can also refer to all greenhouse gas emissions. For carbon dioxide, the concepts of carbon neutrality and net zero emissions are basically

interchangeable. However, for non-carbon dioxide greenhouse gases, the situation is more complex. Since methane is a short-lived greenhouse gas, as long as emissions are stable, zero emissions are not necessary, and it will not have an impact on the climate system in the long term (Huovila et al., 2022; Selivanov et al., 2023).

The absorption sinks for the carbon neutrality target only include the increased carbon sinks from human activities such as afforestation and forest management, rather than natural carbon sinks or the existing stock of carbon sinks. The absorption of carbon dioxide by the ocean leads to continuous acidification of the ocean, which has adverse effects on marine ecosystems. The natural absorption of carbon dioxide by terrestrial ecosystems is carbon neutral and not a permanent carbon sink. Therefore, the carbon dioxide emitted by human activities into the atmosphere must be removed through increased human-induced carbon absorption sinks to achieve carbon neutrality (Sun et al., 2022).

Although carbon neutrality is of great significance and time is pressing, achieving this goal requires the joint efforts of all industries and sectors across society, as well as persistent advancement. Especially from the perspective of key industries and fields, China's energy structure is dominated by coal. For the energy system to rapidly phase out 85% of fossil fuels and achieve zero carbon emissions within just 30 years is not a simple transformation through energy conservation and emission reduction, but a true energy revolution. To achieve carbon neutrality, the energy system must take the lead in achieving carbon neutrality. Additionally, the industrial sector, the building sector, the transportation sector, and demand-side management also need to make their own corresponding arrangements and take practical actions to reach the carbon neutrality target (Guo et al., 2022).

The task of carbon neutrality is significant and wide-ranging. Among them, the coverage of new clean energy and the post-absorption or utilization of CO2 emitted by traditional energy through CCUS projects are two important aspects for the comprehensive realization of carbon neutrality. For some fossil fuel power generation, heating, and some large boilers, the application of carbon capture and storage technology (CCS), as well as the coupling of biomass energy power generation with CCS technology (BECCS), can achieve net zero CO2 emissions from energy activities by 2050 (Guo et al., 2022).

China's CCUS was basically in the study and demonstration stage before 2020, and the cost of carbon reduction was high. However, its development will play an important role in future carbon neutrality efforts, especially after 2030, when its contribution will gradually become apparent. According to a relatively optimistic scenario prediction, CCUS could contribute 30% of carbon reduction by 2050 (Davoodi et al., 2023).

2.1.2 CCUS (Carbon Capture, Utilization and Storage)

CCUS stands for carbon dioxide capture, utilization and storage. Its characteristic is to reduce the carbon dioxide content in the air and promote the early neutralization of carbon dioxide. Carbon capture refers to the gasification of fuel before combustion to obtain combustible gas and combustible solid, thereby separating carbon from fuel and reducing carbon emissions. Or selectively enriching low-concentration carbon dioxide in coal-fired flue gas through chemical or physical methods. Or capturing carbon by the principle that oxygen and carbon generate carbon dioxide. Carbon dioxide utilization refers to the process of recycling captured carbon dioxide through engineering and technological means. Carbon dioxide storage refers to the injection of captured carbon dioxide into deep geological reservoirs through engineering and technological means to achieve long-term isolation of carbon dioxide from the atmosphere (Figure 2.1) (IEA, 2017).

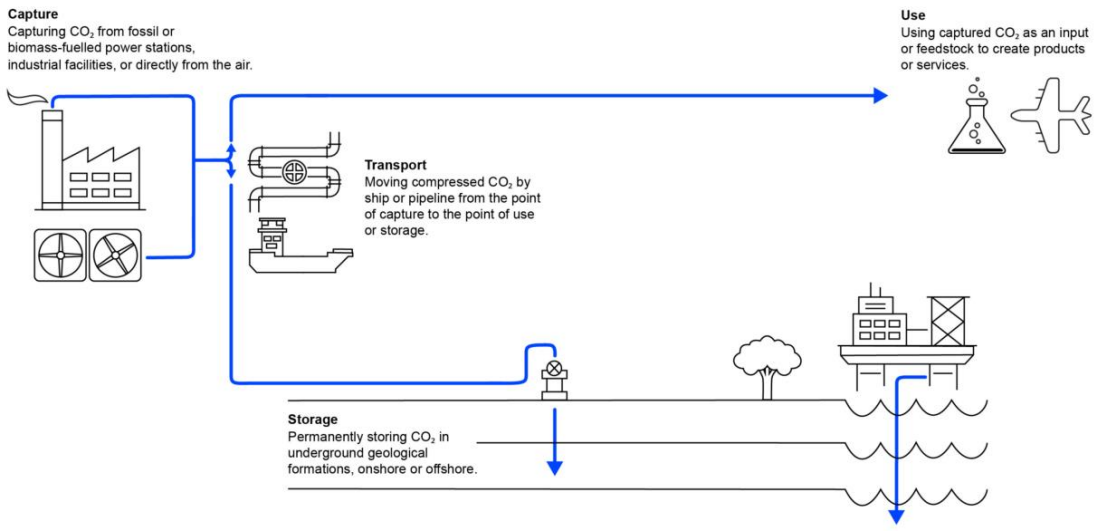


Figure 2.1 Schematic Diagram of CCUS (Carbon Capture, Utilization and Storage) (Source: IEA, 2017)

In 2018, Intergovernmental Panel on Climate Change (IPCC) released Special Report on Global Warming of 1.5℃, highlighting the need to accelerate global climate action to achieve the 1.5℃ temperature control target. Over the past decade, carbon capture and storage (CCS) has received extensive attention as an important option for reducing carbon dioxide emissions. However, globally, the development of CCS has been poor due to high costs and the lack of project profit sources, falling far short of the scale proposed by the International Energy Agency (IEA). To improve this situation, the economic value of carbon dioxide has been widely discussed. The Carbon Sequestration Leadership Forum (CSLF) changed "CCS" to "CCUS" (Shen, 2022; Sun et al., 2022). From carbon capture and storage (CCS) to carbon capture, utilization and storage (CCUS), an additional "U" is added, which stands for utilization. "U" is defined as the resource utilization of carbon dioxide, including geological resource utilization, chemical utilization, and biological utilization, etc. This is the current direction and frontier topic of CCUS technology development.

According to the data from the Global Carbon Capture and Storage Institute's "Global Carbon Capture and Storage", there are currently 65 commercial carbon capture and storage facilities worldwide, which can capture and permanently store 40 million tons of carbon dioxide annually. Carbon capture and storage technology has made significant contributions to reducing emissions in industries such as steel, cement, chemicals, and power generation, with reduction rates ranging from 16% to 90%. Large-scale carbon dioxide capture and storage is mainly concentrated in North America and Europe, accounting for 62%; followed by Australia and China. In terms of the types and scales of carbon dioxide emission sources, global large-scale integrated projects involve emission sources such as power plants, natural gas processing, syngas, fertilizers, hydrogen production, oil refining, and the chemical industry. Among them, power plants have the largest capture volume, accounting for 52%; followed by natural gas processing, accounting for 20%; and syngas, accounting for 14% (Keams, 2022).

According to the International Energy Agency (IEA), by 2030, investment in carbon capture, utilization and storage (CCUS) must increase by 160 billion US dollars; it is estimated that an additional 2.5 to 3 trillion US dollars will be needed by 2050. Over the next 40 years, the CCUS industry has huge room for expansion. Therefore, the demand for emission reduction has driven the expansion of the CCUS market (IEA, 2023).

Carbon capture, utilization and storage (CCUS) technology is of great significance for China to achieve its carbon neutrality goal, which is specifically reflected in the following five aspects: (1) CCUS is the only technical approach to achieve low-carbon utilization of fossil energy; (2) CCUS can make up for the negative impacts brought by some traditional carbon reduction measures, such as helping the power industry maintain flexibility; (3) Under the current technological conditions, CCUS technology is an indispensable means for achieving net-zero emissions in industries such as steel and cement; (4) Negative carbon technologies are important carbon reduction approaches for some industrial processes and industries that are difficult to reduce emissions; (5) CCUS is an effective way to produce low-carbon hydrogen (IEA, 2022).

China introduced carbon capture, utilization and storage (CCUS) technology at the end of the last century and subsequently issued a series of relevant policies (Song et al., 2022). The 12th Five-Year Plan established the development of CCUS technology as a national strategy, set out the goals and requirements for CCUS, and encouraged the establishment of demonstration projects across the country. This commitment reflects China's responsibility as a major country in the world. In the 14th Five-Year Plan released in the same year, in addition to proposing the "3060" goal, it also explicitly proposed to build large-scale CCUS demonstration projects. This indicates that the government is increasingly attaching importance to addressing climate change and recognizes the importance of achieving carbon reduction targets through CCUS technology.

On January 26, 2022, the State Council of China issued the "Opinions on Supporting Guizhou in Blazing a New Trail in the New Era of Western Development" (State Council of the People's Republic of China, 2022), which proposed: to explore the implementation of carbon capture, utilization and storage (CCUS) demonstration projects, and orderly carry out underground coal gasification, large-scale carbon capture and utilization, and karst geological carbon capture and storage pilot projects. Promote the construction of industrial resource comprehensive utilization bases, and promote the large-scale and high-value utilization of industrial solid waste and renewable resources. Steadily advance the construction of "waste-free cities". This document undoubtedly points out the direction for Guizhou, which has many high-emission enterprises, to carry out CCUS projects. However, for various reasons, there are very few CCUS projects in Guizhou.

2.1.3 Problems in the Development of CCUS Project

Although there are some examples of CCUS technology in industrial environment, in order to achieve the goal of net zero, it needs more extensive deployment and still faces many challenges.

Technical cost is high.

The emission reduction cost of CCUS technology is relatively high, and its competitive advantage with other technologies is not obvious. The economy and society are not ready for commodity prices to rise, which restricts the popularization and application of CCUS technology. The cost of installing and operating CCUS has put great pressure on power, steel, cement and other industries. Taking the coal-fired power industry as an example, the power generation efficiency of coal-fired power plants with CCUS facilities will be reduced by 20-30%, and the power generation cost will be increased by about 60% (Liu et al., 2017).

Technical demand is urgent.

The development of CCUS technology faces the risk of technology lock-in in time. The equipment in high-emission industries, such as coal-fired power plants, cement plants and steel plants, has a short service time, and forced retirement will cause a large number of assets to run aground, amounting to 3.1-7.2 trillion yuan. In order to avoid huge assets stranded and ensure sufficient capital recovery time, the demand for CCUS technical transformation of a large number of electric power and industrial infrastructure will increase rapidly after 2030. In order to avoid technology lock-in, it is necessary to speed up technology research and development and iterative upgrade, and ensure that the new generation of CO2 capture technology with low cost and energy consumption can be widely deployed and applied in the window period, so as to give play to emission reduction benefits (Che et al., 2022; Liu et al., 2017).

Lack of business model.

Compared with countries and regions with rich CCUS application experience in the world, China's relevant policies need to be improved and its business model needs to be developed. International experience shows that the government supports CCUS through financial subsidies, special fiscal and taxation, mandatory constraints, carbon pricing mechanism and other means, which can improve the enthusiasm of enterprises and promote the commercialization of technology. At the same time, the corresponding

regulatory measures issued by the state can clarify the division of rights, responsibilities and benefits in the development process of CCUS projects, improve the enthusiasm of enterprises for long-term operation, and raise public concerns about the safety and environmental impact of CCUS projects (Song et al., 2022).

Source and sink are not well matched.

Large-scale emission sources in China are mainly located in the eastern coastal areas, and fossil energy resources are mainly distributed in the central and western regions, while basins suitable for storage are mainly distributed in the northeast and northwest regions. Without the support of national pipe network system, the source-sink mismatch caused by this spatial difference greatly limits the practical utilization of potential CO2 storage capacity in China. However, the construction of national pipe network system faces many constraints, such as policy, management and economy, so it will be beneficial to solve the problem of poor matching of source and sink from the national level (Jiang et al., 2020).

Public acceptance of CCUS is unclear.

As these technologies go beyond the relatively immature development stage, public recognition and acceptance may become more and more important for successfully achieving the net zero commitment (Tardin-Coelho et al., 2025). This is not a unique challenge for CCUS; The successful implementation of technology is often influenced by public opinions, because people need to be convinced of the advantages of new technologies. Public boycotts and protests have led to the cancellation of some well-planned CCUS projects many times, such as in Barendrecht (Netherlands) and jnschwalde (DE) (Brunsting et al., 2011) .

In view of the successful deployment of these CCUS technologies and the efforts to achieve net zero commitment, depending on the public acceptance, the question becomes: how to improve the public acceptance of CCUS?

2.1.4 Public Acceptance

2.1.4.1 Connotation of Public Acceptance

Public acceptance of CCUS refers to the varying degrees of recognition and acceptance by the public based on their own moral and value systems, as well as their psychological perception of CCUS (Tardin-Coelho et al., 2025).

The subjects of public participation include four types of groups. The first is the groups affected or potentially affected by the project. The second is the organizations that are vulnerable to the project, mainly composed of the People's Congress, trade unions, and women's federations. The third is the media and news institutions at the social level. The fourth is the technical team mainly composed of experts in environmental science, social economics, and related disciplines (NEA, 2017).

Wüstenhagen et al. (2007) divided public acceptance into social-political acceptance, community acceptance and market acceptance. Social-political acceptance refers to the attitudes of the public, key stakeholders and policy decision-makers towards new technologies and risky projects. Community acceptance refers to the specific acceptance of location decisions and risky projects by local stakeholders. Market acceptance explains the acceptance attitudes of investors, producers and consumers towards goods (Wüstenhagen et al., 2007).

By combing the technical connotation, project characteristics and core theory of public acceptance of CCUS, it is clear that public acceptance is the key soft factor that restricts the promotion and industrialization development of CCUS projects. At present, academic circles at home and abroad have accumulated some research results around the public acceptance of CCUS project. In order to accurately grasp the overall picture of research development in the field of CCUS public acceptance, clarify the evolution of research at home and abroad, identify core research hotspots and research gaps, and predict future research trends, at the same time, lay a solid literature foundation and clarify the research breakthrough point for the subsequent research hypothesis, model construction and empirical analysis of this paper. In 2.1.4.2, using bibliometrics analysis method, taking the related literatures in core databases at home and abroad as research samples, through visual analysis and statistical combing, this paper systematically shows the annual publishing trend, Keywords time line diagram analysis, research topic clustering and Analysis of keyword burst of the literatures in this field, objectively summarizes the achievements and shortcomings of the existing research, accurately locates the innovation space and research value of this research, and ensures the scientificity, cutting-edge and rationality of the full-text research.

2.1.4.2 Bibliometric Analysis of CCUS Project Public Acceptance

Taking the core collection of Web of Science as the data source, this part of study analyzes the academic research on CCUS acceptance so far by using CiteSpace visualization software.

CiteSpace is an information visualization software developed by Dr. Chen Chaomei and others using Java language, which is based on co-citation analysis theory and path-finding network algorithm. It measures the documents (collections) in a specific field, and explores the key path of the evolution of the subject field and its knowledge inflection point through drawing, generating and interpreting the knowledge map (Zhao et al., 2023). CiteSpace 6.2.4 is adopted to analyze the articles on CCUS acceptance collected in the core collection database of Web of Science since 1900, and to explore its research progress from the aspects of the number of articles, keyword clustering analysis, author's contribution and keyword emergence. Search conditions: “Subject = (‘CCUS’ or ‘CCS’ or ‘CCU’ or ‘carbon capture, utilization, and storage’ or ‘carbon capture and storage’ or ‘carbon capture and utilization’) and theme = (‘acceptance’ or ‘acceptability’)”, Select “article” “proceeding paper”, “review article” as the literature type and “English” as the language, in order to manually remove irrelevant documents without affecting the authority, standardization and accuracy of the contents of the documents, 236 documents were retrieved in the Web of Science core collection database on July 23rd, 2023.

① Statistical Analysis of the Amount of Articles Published

In the core collection of Web of Science, this part of study makes a statistical analysis of the articles related to CCUS public acceptance. The results are shown in Figure 2.2. From the earliest two articles in 2007 to 2023 (July 24th, 2023), there were 236 articles. Generally speaking, there are few related studies. Judging from the number of articles published each year, except for more than 20 articles in 2009, 2014 and 2021, it is generally maintained at around 10 articles, indicating that there is still a lot of room for research in this field.

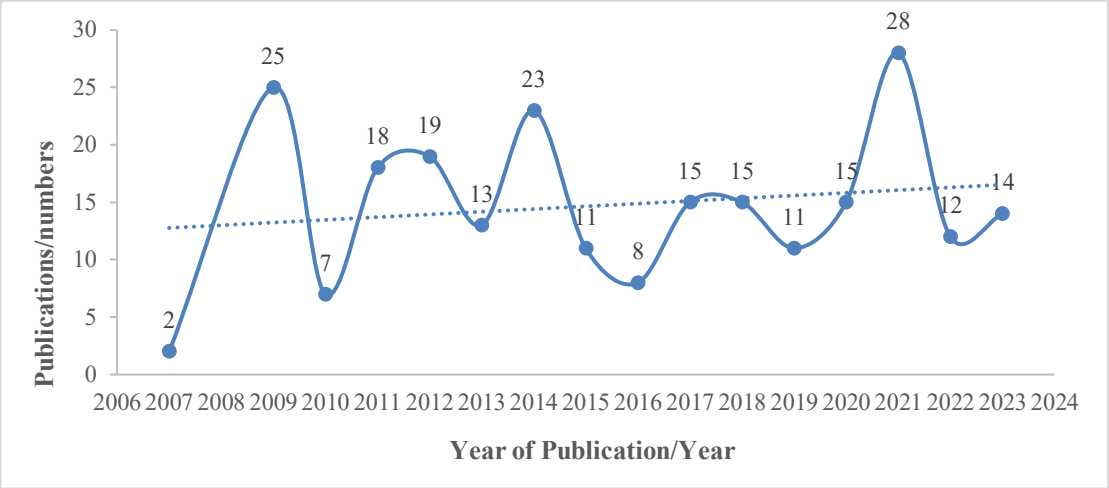


Figure 2.2 Trend chart of the numbers of articles about public on CCUS-acceptability published annually(2007-2023)

② Keywords Time Line Diagram Analysis

Through the literature retrieval in the core collection of Web of Science from 2006 to 2023, the time chart of CCUS project public acceptance research is obtained. As shown in Figure 2.3, interest perception, public cognition, environmental impact, user diversity and community participation are important research contents.

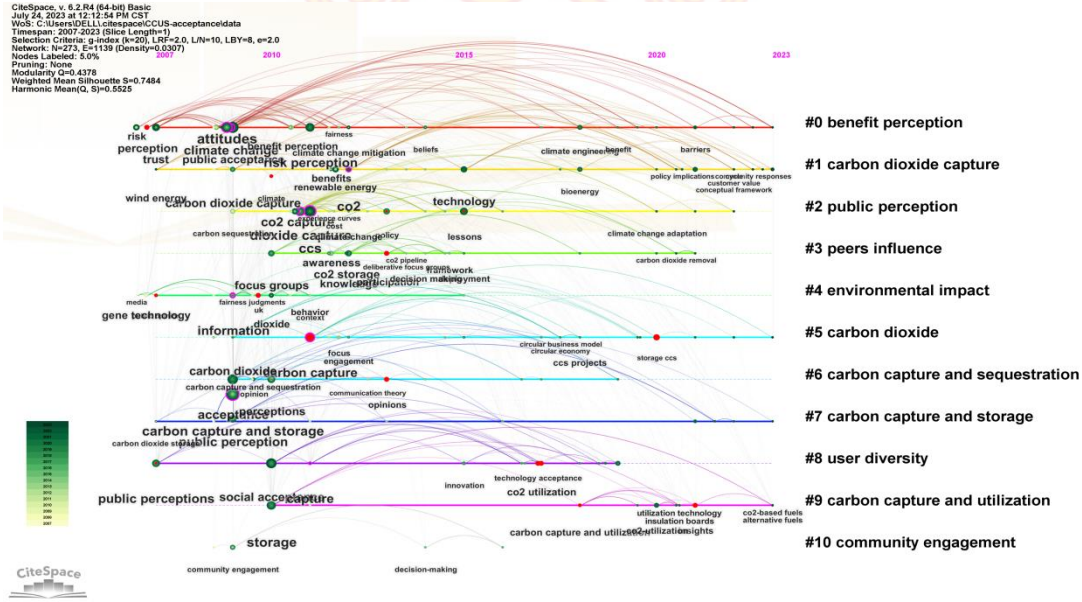


Figure 2.3 Keyword Time Line Diagram of CCUS Project Public Acceptance Research

③ Keyword Cluster Analysis

Through keyword clustering and LLR algorithm (log-likelihood ratio), this part of visually analyzes the keywords of CCUS public acceptance research, which can show the hot topics concerned by experts and scholars. Twelve hotspot clusters such as Benefit Perception, Public Acceptance, Social Acceptance, Carbon Dioxide Capture, Carbon Capture and Sequestration, Climate Change Mitigation and Carbon Dioxide were obtained. The modularity q = 0.7113 > 0.3, which shows that there are significant differences among CCUS acceptance research topics, and the reliability is high. The clustering average contour value (Sihouette) S=0.8802, and s is greater than the standard value of 0.5, which indicates that the divided clustering structure is reasonable and effective. As shown in Table 2.1 and Figure 2.4, the largest cluster #0 benefit perception, the cluster size is 24, and the contour value is 0.958>0.5, which indicates that the clustering result is consistent with the research topic of this article. The second largest cluster is #1 public acceptance, which shows that public acceptance is an important factor in CCUS implementation. Combined with literature review, this part of study divides the above clustering into four aspects, namely, the study on the basic connotation of acceptance (#1, #2), the study on coping with climate change (#7, #9, #10), the study on carbon dioxide capture, utilization and storage (#3, #5, #8), and the study on the influencing factors of CCUS acceptance (#0, #4).

i. Research on the Basic Connotation of Acceptance (#1, #2)

Many scholars have put forward their own opinions on the study of the basic connotation and concept of 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. Under the policy background of CCUS and other renewable energy technologies, acceptance is generally regarded as a top-down process, in which energy infrastructure projects are “donated” to local communities, and local communities are expected to passively accept and tolerate them. However, with the deepening of research, the concept of acceptance should not be limited to this. In a broad sense, acceptance includes the integration of social

politics, market and community acceptance. Socio-political acceptance refers to the acceptance or rejection of technologies and policies by social actors such as policy makers and the general public. 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 outcome of CCUS project (Jones et al., 2017).

ii. Study on the Strategies to Deal with Climate Change (#7, #9, #10)

In recent years, climate change has been concerned by all walks of life, so as to explore a series of ways to alleviate climate change. Although countries have promised and formulated strategies to reduce carbon dioxide emissions, in fact, global carbon dioxide has not decreased significantly (Gills & Morgan, 2020). Mainly because the carbon emissions of developing countries continue to increase, making 1.5℃. Among many options for reducing emissions and mitigating climate change, one of the most ideal options is to replace fossil energy with renewable energy (Adams & Nsiah, 2019). However, under the current situation that most countries in the world are dominated by fossil fuels, if fossil fuels are stopped across the board, there will undoubtedly be huge obstacles in the implementation process (Knutti, 2019). According to the principle of suboptimal theory, which was first put forward in the field of economics and later extended to the field of social and political decision-making, that is, when all the conditions of Pareto optimality cannot be met, there exists suboptimal problem (Kaliszewski et al., 2016). In this case, realizing as many Pareto optimal conditions as possible is not necessarily the best choice in real situations.

In the existing countries with fossil energy as the dominant energy source, although the proportion of coal has decreased, the non-sustainable growth of natural gas and oil consumption has led to an upward trend in carbon emissions, while the increase of renewable energy is not obvious under the existing conditions. The labor force related to fossil energy exploitation is a huge group, and energy transformation is a challenge to the employment transformation of the existing labor force (Muttitt & Kartha, 2020). The incumbent monopoly enterprises in the energy market resist the development of the new renewable energy industry by controlling key resources such as finance, trade unions and relations with policy makers (Pahle et al., 2018). In addition, the environmental cost of

fossil energy is not passed on to consumers, so it has a significant cost advantage. Although renewable energy can enjoy government subsidies, it is not a long-term solution. Moreover, carbon tax and carbon emissions trading can prevent the use of fossil energy to some extent from the outside, but it is still in its infancy (Guo et al., 2019).

CCUS (carbon capture, utilization and storage) is the second choice to achieve carbon neutrality in today's social environment, because it can not only reduce carbon emissions from existing sources, but also avoid the immediate stranding of fossil fuel assets (Fuhrman et al., 2020).

iii. Study on Acceptance Classification of Carbon Dioxide Capture, Utilization and Storage (#3, #5, #8)

In the related literature, the acceptance of carbon dioxide capture, utilization and storage refers to the acceptance of carbon dioxide utilization (CCU) or carbon dioxide storage (CCS). Arning, K. and others have investigated the cognition and acceptance of potential customers on carbon capture and utilization products (foam mattresses), and concluded that the public's overall view on carbon capture and utilization technology and carbon-derived mattresses as product examples is positive (Arning et al., 2019). Lutzke, L. and others conducted an online survey of American adults. This study measured the influence of product types (carbonated drinks, plastic food storage containers, foam or plastic furniture and shatterproof glass) and carbon capture methods (direct air capture or point source capture) on consumers' willingness to consume or use CCU-based products. Compared with other products, participants are less likely to accept carbonated drinks, especially those containing carbon captured from point sources. At the same time, most participants (about 69%) expressed at least some openness to consuming or using CCU-based products. Several other variables affecting consumer acceptance (which may affect the future communication strategy of CCU-based products) are also identified (Lutzke & Arvai, 2021). Linzenich, A. and others studied the acceptance of energy technology in the environment, and compared the risk perception of eight infrastructure technologies in Germany by laymen, and reached the conclusion that CCU’s risk perception is higher than that of renewable energy but lower than that of traditional energy technologies (Linzenich et al., 2019). Akerboom, S. and others take three unsuccessful CCS (carbon dioxide capture and storage) projects in the Netherlands as examples, and point out that social acceptance has proved to be a major obstacle to the implementation of CCS in the

Netherlands and other places, but it is still too early to think that the introduction of new financial instruments, the increase of government support and the improvement of social participation seem to enhance the prospects of CCS in the Netherlands (Akerboom et al., 2021).

From the perspective of the target audience, there are media reports, the general public, the community, the government and so on. Jiang, K. and others have studied the CCUS reports of China News, showing that 71.3% of the newsletters have a positive attitude towards CCUS, and the relevant policies of CCUS are closely promoting media reports every year. And put forward a scientific communication strategy involving policy guidance, journalist training, student education and public participation (Jiang et al., 2022). Studies by Mulyasari, F. and others show that a positive framework that emphasizes the interests of local residents is the basic principle for future communication on CCUS pilot project in Bulora County, Java Province, Indonesia (Mulyasari et al., 2021).

iv. Study on Influencing Factors of CCUS Acceptance (#0, #4, #6, #11)

In the literature on the influencing factors of CCUS acceptance, scholars tend to study it with structural equation model. Liu, B. S. and others developed a behavior model based on ABC (Affect, Behavior and Cognition) attitude theory to predict the public's acceptance of CCUS. The results show that public cognition has a significant impact on public acceptance, and perceived benefits have a higher indirect impact than perceived risks. Trust regulates the relationship between public cognition and perceived risks/benefits. When fairness is high, the relationship between perceived benefits and acceptance is strengthened, and the relationship between public cognition and public acceptance is explored (Liu, B. S. et al., 2021). Arning, K. and others discussed the relationship between risk and benefit perception and perceived technological uncontrollable based on structural equation model, in order to predict the general and local acceptance of CCU. The research results emphasize the importance of understanding the interaction among perceived uncontrollable, perceived risk and perceived benefit, and the resulting CCU's social acceptance (Arning et al., 2020). Xiao (2026) and others try to analyze and evaluate what kind of information will affect the public's acceptance of CCUS, and how. A questionnaire survey on the acceptance of CO2 geological storage was conducted among Japanese college students. The results of confirmatory factor analysis show that five factors, such as risk perception, interest perception, trust and two

perceptions related to human interference with the environment (one for carbon dioxide geological storage and one for global warming), well explain the acceptance (> 83%). Interest perception is the main factor that determines public acceptance, and information about natural analogues greatly reduces risk perception (Xiao et al., 2026). Seigo, S. L. and others compared three provinces with different CCS deployment levels in Canada, and concluded that although the familiarity with technology in different regions is very different, the predictors of risk perception are stable and have nothing to do with familiarity. The revenue concept of CCS may be influenced by the national deployment environment (Seigo et al., 2014).

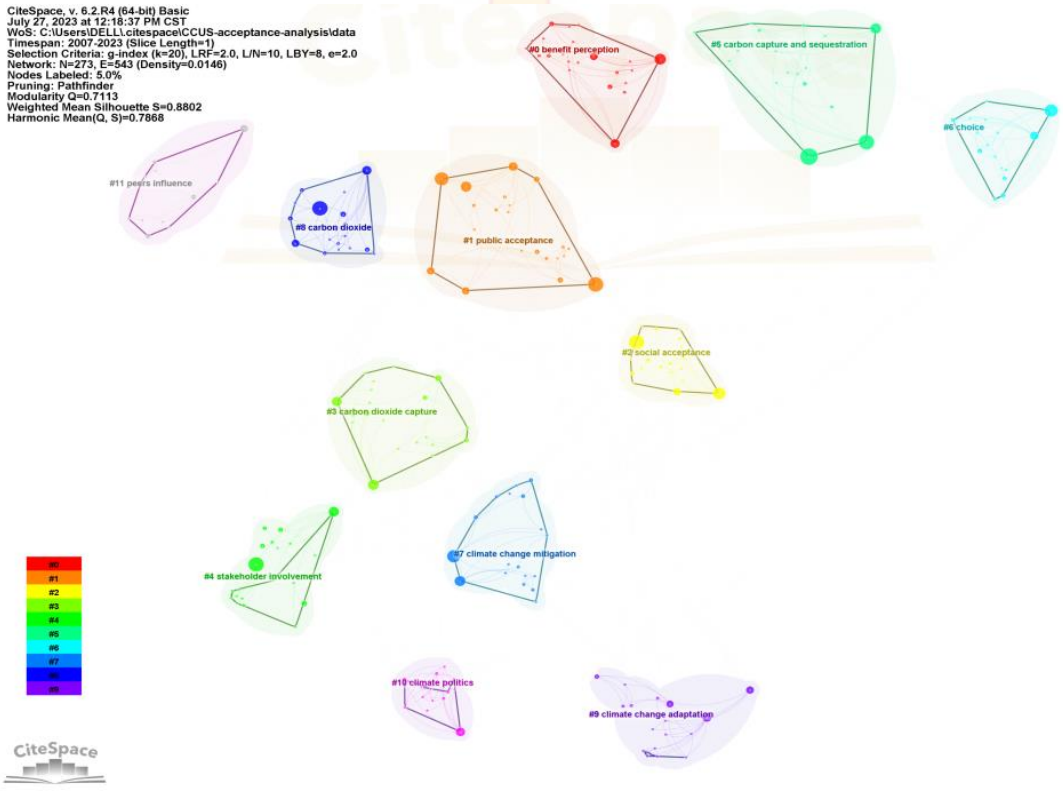


Figure 2.4 CCUS Acceptance Research High Frequency Keyword Clustering Diagram

Table 2.1 CCUS Acceptance Research High Frequency Keyword Clustering

S/N	Cluster size	Silhouette value	Generation year	Clustering tag
0	24	0.958	2016	#0 benefit perception
1	21	0.836	2013	#1 public acceptance
2	21	0.862	2016	#2 social acceptance

Table 2.1 (continued)

S/N	Cluster size	Silhouette value	Generation year	Clustering tag
3	20	0.824	2015	#3 carbon dioxide capture
4	20	0.801	2015	#4 stakeholder involvement
5	19	0.903	2015	#5 carbon capture and sequestration
6	19	0.925	2010	#6 choice
7	18	0.754	2016	#7 climate change mitigation
8	18	0.909	2013	#8 carbon dioxide
9	17	0.876	2013	#9 climate change adaption
10	15	0.968	2015	#10 climate politics
11	12	0.849	2014	#11 peers influence

④ Analysis of keyword burst

The approach utilized in this study involved exploring the evolving trends in the selected literature through keyword burst analysis. Keyword burst refers to a sudden increase in the frequency of a specific keyword within a certain timeframe. If, during a specific period, a particular keyword had a high burstness in a given field, it indicated a sudden surge in research on a specific topic within that field. This could be employed to reflect the research hotspots of public acceptance of CCUS in different years. By employing CiteSpace for keyword burst analysis, a keyword burst graph was generated for the period spanning from January 2007 to July 2023. The threshold for the Burstness control panel was set at 0.8, leading to the identification of the top 16 keywords with the highest citation counts, which allowed for the examination of their trend transitions, as depicted in Figure 2.5. The Keywords column indicates the keywords, while the Strength column represents the intensity of burstness. The Begin and End columns correspond to the starting and ending years, respectively. Furthermore, the red progress bar signifies the period of keyword burst. The graph revealed that in the early stage, the burst keywords included “public opinion”, “public acceptance”, and “perception”. In the middle stage, the burst keywords were “participation” and “social acceptance”. In the later stage, the burst keywords encompassed “CO2 utilization”, “carbon capture”, “technology acceptance”,

and “insights”, with a focus on the research of CCU and CCS. Additionally, it is worth noting that the acceptance of technology and insights are likely to emerge as pivotal topics in future research. Notably, the strongest burstness was observed in “public acceptance” with a Strength value of 5.44. Therefore, future research trends pertaining to CCUS acceptance should center around the key theme of public acceptance, fostering a multidimensional and interdisciplinary development.

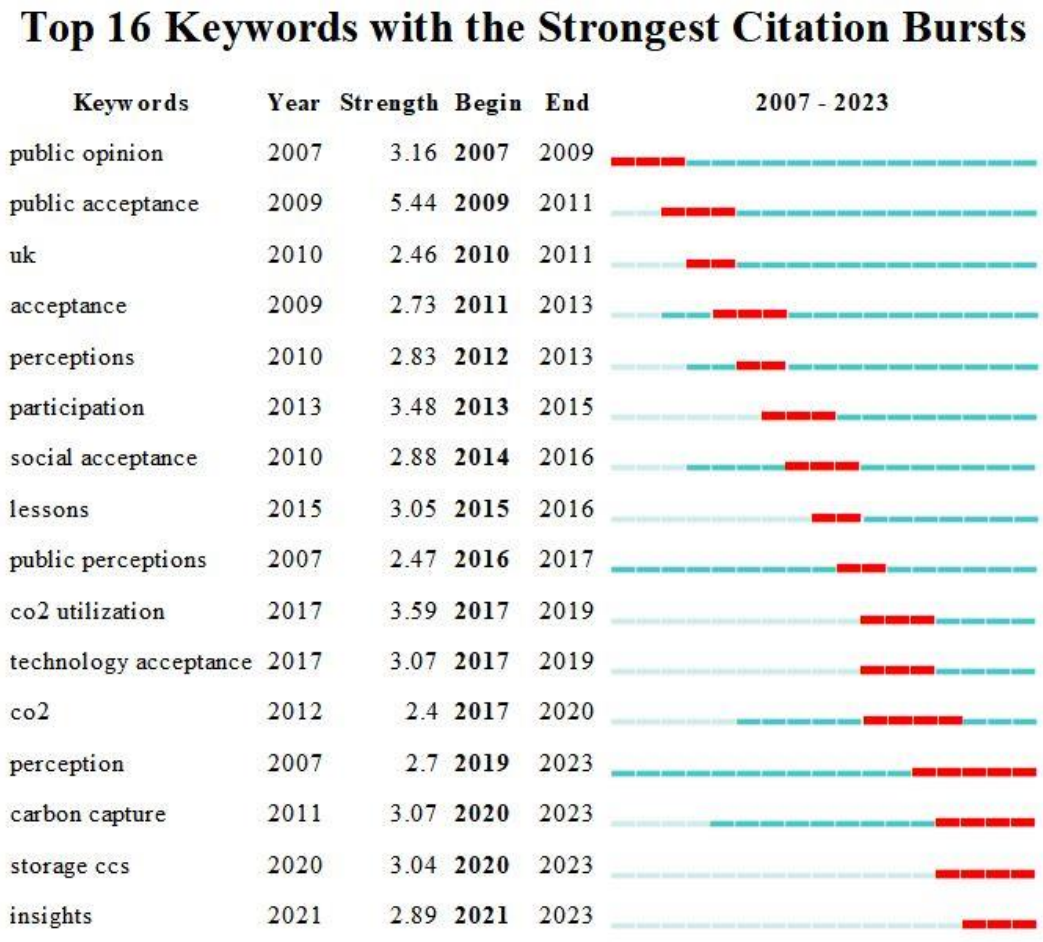


Figure 2.5 Key words pop-up diagram of CCUS project public acceptance research

Although the technology of carbon capture, utilization and storage (CCUS) is very important, so far, there are few effective research plans aiming at the actual situation in Guizhou, and the public's acceptance research on the landing of CCUS projects in Guizhou is almost zero. The lack of public awareness and the guidance of environmentalism will hinder the advancement of CCUS project. Previous research mainly focused on CCUS project itself, and the detailed research on public acceptance was limited.

2.1.5 The typicality of public acceptance research on CCUS projects in Guizhou

The study on the public acceptance of the CCUS project in Guizhou can be generalized from five dimensions: scenarios, risks, benefits, policies, and methods, and it has universal reference value for similar regions and projects across the country.

2.1.5.1 The typicality of scenarios in resource-based high-carbon provinces

(1) High concentration of carbon-intensive industries: There is a dense presence of stable emission sources such as thermal power, coal chemical industry, steel, and cement. The public coexists deeply with carbon-intensive industries. Research on acceptance can be directly extended to the CCUS implementation scenarios in energy bases such as Shanxi, Inner Mongolia, and Shaanxi.

(2) Ecological sensitivity superposition: Guizhou is a national ecological civilization pilot zone, with karst ecology being fragile. The contradiction between the "urgent need for carbon reduction and concerns over ecological risks" is prominent. Its communication and risk mitigation model can be replicated to the CCUS site selection areas within the ecological protection red line.

(3) The pain of energy transition: Coal power remains a pillar, and during the transition, it faces the trade-offs between "ensuring supply and reducing carbon emissions" and "employment and environmental protection". Research on public attitudes towards this can provide a reference for the social stability path of energy transition in resource-based regions.

2.1.5.2 The typicality of risk communication in complex geological storage

(1) The uniqueness of karst storage: The development of caves and fissures brings challenges to storage safety and monitoring. The public is more sensitive to leakage risks. The risk perception-trust building-information disclosure model formed can be extended to regions with complex underground spaces (such as the karst areas in Southwest China, the coal seam areas in North China, and various countries in Southeast Asia).

(2) Diversified storage pathways: Involving saline aquifers, coalbed methane displacement, etc., research on the differences in public acceptance of various storage methods can provide detailed strategies for site selection and public education under different geological conditions.

2.1.5.3 Typicality of the Mechanism for Benefit Distribution and Community Participation

(1) The NIMBY effect is significant: The projects are mostly located near industrial communities, which easily triggers the "NIMBY" phenomenon. The community benefit-sharing, compensation mechanism, and public participation process formed can be promoted to CCUS projects in industrial-intensive areas, thus resolving the site selection dilemma.

(2) Synergistic utilization scenarios: On-site conversion of CO2 from coal chemical industry into urea, coalbed methane displacement, etc. The bundled benefit model of "emission reduction + income increase" can be used to design economic incentive schemes that enhance public acceptance.

2.1.5.4 Demonstrative Typicality of Policy Pilot Programs and Institutional Innovation

(1) Policy synergy dividends: As a national ecological civilization pilot zone, its explorations in CCUS-specific policies, carbon sink accounting, and carbon trading integration can provide experience for the country to improve the subsidy-accounting-trading policy system.

(2) Grassroots governance adaptation: The communication mechanism of tripartite collaboration among local governments, enterprises and communities can be promoted to the implementation of CCUS projects in areas with relatively weak grassroots governance capabilities in central and western provinces.

2.1.5.5 Universality and Typicality of Research Methods and Evaluation Tools

(1) Localized measurement scale: Acceptance questionnaire and influencing factor model (such as cognition, trust, risk/benefit perception, social norms) adapted to the cognitive characteristics of the public in the southwest region, which can be directly applied to quantitative research in other regions of the country.

(2) Multi-stakeholder Participation Approach: Establish a joint science popularization and decision-making participation model of "government + enterprises + communities + research institutions", and the participatory governance toolkit formed can be promoted to the social communication stage of CCUS projects across the country.

(3) Interdisciplinary integration: By combining mixed research methods from environmental psychology, sociology, and public administration, a reusable methodological framework is provided for the study of social acceptance of CCUS.

Therefore, this study can put forward the following new research ideas:

(1) Integrating the ABC (affect, behavior and cognition) attitude theory, social license theory, institutional trust theory and stakeholder theory enriches the theoretical system of the acceptance model.

(2) At the same time, explore the influencing factors of the public's acceptance of carbon capture, utilization and storage (CCUS), and put forward hypotheses to verify the path relationship of the empirical model of this study.

(3) When exploring the variables that affect public acceptance, the potential variable of environmentalism is added, which fills the relevant research gaps.

2.2 Parent Disciplines

2.2.1 ABC (Affect, Behavior and Cognition) Attitude Theory

The ABC attitude theory holds that attitude is composed of three components: cognition, affect, and behavior. Among them, cognition is the perception of the object of attitude, affect is the feeling toward the object of attitude, and behavior is the behavioral intention or actual behavior toward the object of attitude. Thus, the three-dimensional ABC attitude theory is constructed (Rosenberg, 1960).

In the ABC attitude theory, the three dimensions of cognition, affect and behavior are interrelated, essentially belonging to a hierarchical effect. This theory takes emotion as the mediating variable between cognition and behavior, that is, the "cognition-affect-behavior" attitude model (As shown in figure 2.6). From the analysis of the qualitative materials formed, the influence mechanism where cognition affects emotion and then further influences behavior is clearly demonstrated(Mario, 2007).

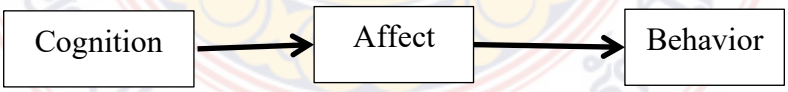


Figure 2.6 The standard learning levels of the ABC Attitude Model (Source: Mario, 2007)

The ABC attitude theory clarifies the formation path of acceptance, based on the concept of hierarchical effects, analyzing the importance of components and their interactions. At the standard learning level, consumers form emotional preferences for products based on existing cognition, which in turn influences behavior(de Salvi, 2008). Cognitive components refer to the perception and attention that an individual forms towards the object of an attitude after receiving external stimuli. Affect components refer to the subjective feelings an individual has towards the object of an attitude after cognition, which can influence one's behavior. Behavioral components refer to the possibility of an individual actively demonstrating certain behaviors or performances after obtaining cognition and generating emotions. Therefore, the ABC attitude theory, which consists of three components and a unified cycle, is formed.

After Baron et al. (1989) proposed the ABC attitude theory, different scholars have verified it through empirical research in various fields. And according to the different motivation levels of the attitude subject towards the attitude object, the formation process of attitude is divided into three levels: the standard learning level based on cognitive information processing (cognition → affect → behavioral intention), the low-level intervention based on the behavioral learning process (cognition → behavioral intention → affect), and the hegemonic experience level (affect → behavioral intention → cognition) (Hu, X. P. et al., 2021; Madichie, 2009).

Research on the ABC attitude theory comes from multiple fields. It originated in the field of psychology and has been relatively mature. Later, it expanded to industries such as consumer goods, tourism, and e-commerce, and covered multiple disciplines. Research on the ABC attitude theory increasingly shows a trend of interdisciplinary integration and constantly fuses with new theories (Yingqing et al., 2024).

Perceived benefits, perceived risk and cognition are crucial for the public’s acceptance of CCUS (Xiao et al., 2026). Public acceptance of CCUS is facilitated by the benefits that the public perceives CCUS products or CCUS projects to bring to them. Additionally, the risks perceived by the public regarding CCUS technology also influence their acceptance of CCUS. Therefore, the outcome of the trade-off between perceived benefits and perceived risks ultimately constitutes the main emotional module in the ABC attitude theory and affects acceptance. Trust also plays a crucial role, expanding the applicability of the ABC attitude theory in the context of CCUS technology (Liu, B. S. et

al., 2021). The interaction and communication between CCUS project developers and the government and the public have enhanced public awareness and trust in CCUS. In general, these studies demonstrate the significant role of the ABC attitude theory in aspects such as public acceptance of CCUS products and projects.

The ABC attitude theory has been widely applied to consumers' acceptance of products, emphasizing factors such as perceived benefits and perceived risk. Consumers' attitudes towards related products in the brand or e-commerce field reflect the key factors (Mathew, 2016). The applicability of the ABC attitude theory to tourists or local residents in the tourism industry has also been demonstrated (Hu, X. et al., 2021). However, in the field of environmental protection or in the area of energy technology, especially in the aspect of carbon capture, utilization and storage (CCUS), the ABC attitude theory is rarely adopted. To date, only one study has developed a behavioral model through the ABC attitude theory to predict public acceptance of carbon capture, utilization and storage (CCUS) (Liu, B. S. et al., 2021). However, the profound influence of the ABC attitude theory on the development of CCUS has yet to be fully expounded.

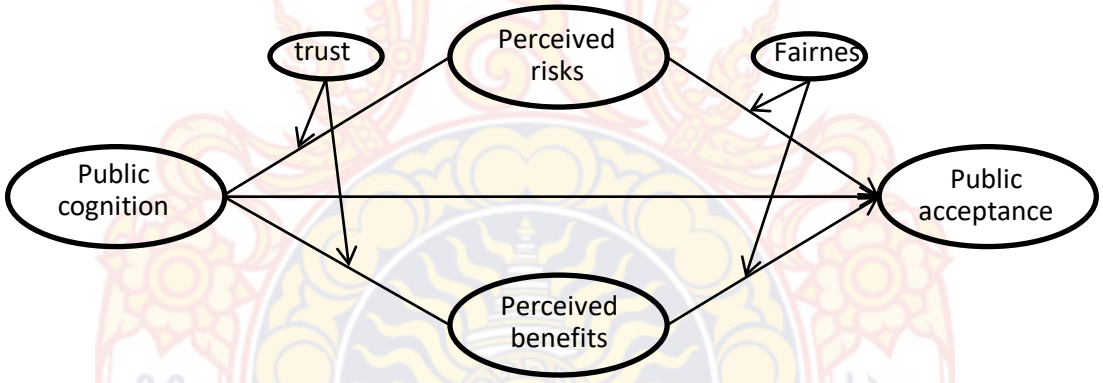


Figure 2.7 ABC attitude theory model (Source: Liu, B. S. et al., 2021)

This study will explore how the public perceives the advantages and disadvantages of CCUS development, and how their perceived benefits and perceived risks influence their acceptance. By introducing the ABC attitude theory framework for empirical analysis, it will help governments or relevant environmental protection organizations to implement effective intervention measures, thereby facilitating the CCUS technology to be more beneficial to society and human development. Against this backdrop, public awareness, perceived benefits, perceived risk, trust, and fairness are taken as research

variables to confirm their influence on the public acceptance of CCUS projects in Guizhou Province.

2.2.2 Social License to Operate (SLO)

The concept of "Social License to Operate" (SLO) describes the informal approval of a business or industry activity by relevant stakeholders (Gehman et al., 2017; Gough et al., 2018; Gunningham et al., 2004). Social license is achieved when an activity is highly accepted, recognized, and identified with by those involved or affected. Establishing and maintaining social license requires establishing the legitimacy of operations, the credibility of the operator, and trust in the operator's behavior and intentions. If any of these aspects decline, social license may weaken or be revoked (Gehman et al., 2017).

The term "Social License to Operate" originated in the mining industry in the mid-1990s as a response to social risk (Boutilier & Thomson, 2011). Taking mining as an example, social operation license refers to the continuous acceptance and approval of mining development by local community members and other stakeholders, which may affect their profitability (Boutilier & Thomson, 2011; Jason Prno & D Scott Slocombe, 2012). Since then, the term has been adopted by many actors in the resource sector, including mining companies, civil society and non-governmental organizations, research institutions, government and consultant. A series of other industries have also adopted social business licenses, including pulp and paper manufacturing, alternative energy power generation and agriculture (Moffat & Zhang, 2014).

The concept of social license is important for those engaged in impact assessment for two main reasons. First, the extent to which an activity is perceived as socially acceptable will influence how it is experienced (Williams & Schirmer, 2012) . Second, considerations of social license are crucial for community and public participation processes in social impact assessment (SIA); thinking about when and how social license is generated can effectively guide participation practices around new development projects (Baines et al., 2013; Vanclay et al., 2013).

Moffat, K. et al. measured and modeled the key elements of social licensing by referring to the social psychology research in intergroup relations, and believed that the trust of the community in mining companies would be the core of this social licensing model, and it would also be a powerful predictor of the community's acceptance of its operations. The degree to which mining companies manage and mitigate the operational

impact (for example, the impact on social infrastructure) would affect the trust in the company. The way a company contacts with the community (i.e. the quantity and quality of contact) and the way it treats community members (i.e. the procedural fairness in this relationship) will shape the trust of community members in mining companies, thus affecting their acceptance of mining companies (Moffat & Zhang, 2014). Figure 2.8 summarizes the main elements of the model and their relationships.

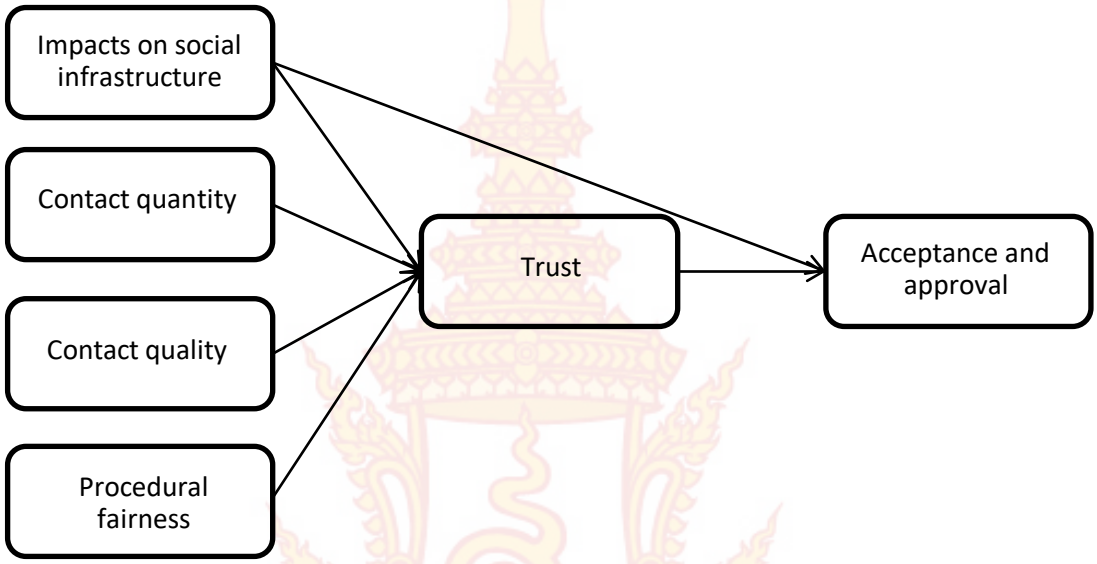


Figure 2.8 Overview of relationships between concepts. (Source: Nina Hall et al., 2015)

The concept of Operating Social License (SLO) has been applied to CCS, which can support a more detailed understanding of the relationship, background and narrative formed during technology deployment. In the carbon capture and storage (CCS) industry, participants define social operating licenses in four related ways, covering the community's acceptance of the industry, the community's expectations of the industry, and the mutually beneficial relationship between the community and the industry (Gough et al., 2018; Hall et al., 2015). Cough, C. et al. (2022) used the conceptual framework of SLO to explore the activities of CCS industrial clusters in the UK to understand the role of clusters and the extent to which the activities of stakeholders of different scales support SLO (Gough & Mander, 2022).

This study applies Social License to Operate (SLO) to CCUS. By investigating the trust or approval of various levels of the public in Guizhou Province, including researchers, educators, and local residents, regarding CCUS projects, it aims to provide broader and more sustained participation in the planning stage, thereby enhancing the feasibility of

implementing CCUS projects in Guizhou. Therefore, this paper takes fairness and trust in the Social License to Operate (SLO) as research variables to study their direct or indirect influence on public acceptance of CCUS projects.

2.2.3 Institutional Trust Theory

The theory of institutional trust holds that the public's trust in CCUS projects is not only derived from direct judgments on the project entities but also from trust in the institutional environment, including regulatory systems, laws and regulations, and industry standards. If a country has a complete CCUS regulatory system, strict enforcement, and a transparent information disclosure mechanism, the public will indirectly form trust in the project; conversely, the absence of institutions or ineffective enforcement will lead to the collapse of trust, and even if the project itself is technologically reliable, it will be difficult to gain public recognition (Krishna et al., 2023).

With regard to institutional strength, some scholars have previously proposed a research model to investigate the legal network of institutional strength's influence on supplier trust in the manufacturer’s supply chain, including direct and indirect influence through the buyer's enterprise practice, and studied three types of relationships: (1) institutional strength and supplier’s trust, (2) institutional strength and buyer’s enterprise practice, and (3) buyer’s enterprise practice and supplier's trust (Hemmert et al., 2016).

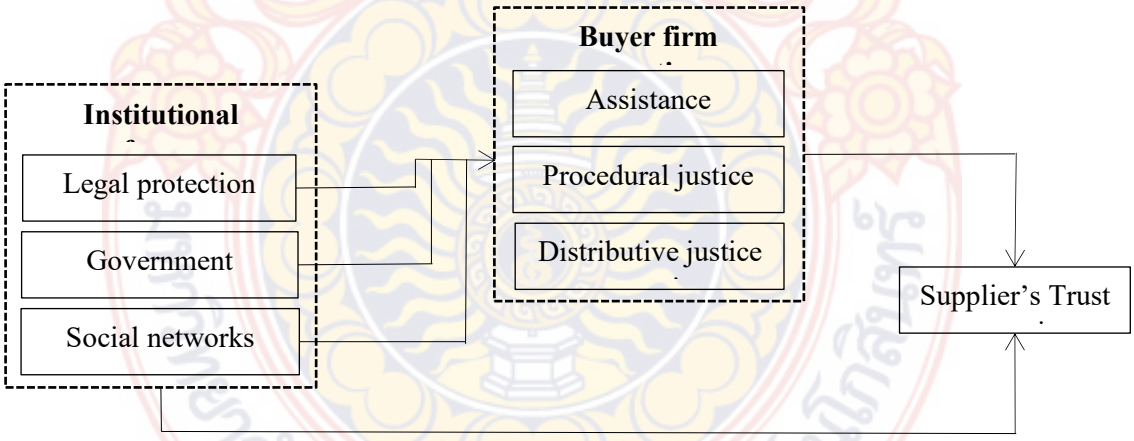


Figure 2.9 The nomological network of influences of institutional forces on the supplier's trust in manufacturing supply chains both directly and indirectly through buyer firm practices (Source: Hemmert, M., Kim, D., Kim, J., & Cho, B, 2016)

Legal protection plays a core role in the public acceptance of CCUS projects and serves as the “ballast stone” for public acceptance of CCUS. Its core value lies in institutionalizing risks, rights, responsibilities, and benefits, transforming the public from passive bearers into active participants and beneficiaries.

This study aims to incorporate early public participation, environmental impact assessment (EIA) public notification, and hearings into the approval process, achieving the integration of social and legal permits. Through the core logic of “legal clarification of responsibilities → reduction of risk perception → establishment of trust → enhancement of acceptance”, it seeks to actively gain the support of the public in Guizhou for the implementation of local CCUS projects.

Based on previous research, this paper holds that the legal protection system for CCUS projects positively influences the public's trust in the implementation of CCUS projects, and thereby affects their acceptance. Therefore, this paper takes legal protection and trust from the institutional trust theory as research variables to study their indirect or direct impact on public acceptance.

2.2.4 Stakeholder Theory

Ansoff proposed the concept of stakeholders in his theories on strategic management published in the early 20th century. On this basis, scholars from Stanford University in the United States further expanded their research in the field of management, gradually forming a relatively complete theoretical system of stakeholders (Mitchell et al., 1997). Stakeholder theory points out that competition within the same group must take into account the rights claims and demands of various stakeholders both inside and outside the group, understand the conflicts of interest. These subjects not only include the managers who formulate market rules, but also the workers who participate in production, the shareholders who invest, and all the roles in the production chain and supply chain.

The concept of stakeholders defined in Edward Freeman’s book “Strategic Management: A Stakeholder Approach” published in the 1990s is based on the subjects in economic activities, participants who have an impact and play a role in the realization of an enterprise’s organizational goals. It should also include groups whose interests may be affected in the enterprise’s production and operation, specifically including consumers, the community where the enterprise is located, and the government that manages the enterprise, etc. This laid the foundation for the research on the definition of stakeholders

in public management theory (Seidl & Wheeler, 2024). Clarkson (1995) classified stakeholders into primary stakeholders and secondary stakeholders based on the degree of their association with the core enterprise (Clarkson, 1995). Wheeler enriched the stakeholder theorem by introducing the “social dimension”. By combining it with the primary and secondary stakeholders proposed by Clarkson, stakeholders can be classified into four types based on two evaluation directions: primary social, primary non-social, secondary social, and secondary non-social (Goetze et al., 2024; Seidl & Wheeler, 2024).

With the continuous maturation and improvement of the definition and theory of stakeholders, the current research on stakeholders in the field of management is mainly used to solve the problem of considering the relevant subjects that contribute to the increase or decrease of the interests of an organization or enterprise in the process of organizational management and decision-making in the face of the external environment. Its characteristics lie in the fact that the subjects have participation, and the participation is subject to the constraints of the rules of interest distribution. Through a scientific and reasonable way of interest distribution, the stakeholders participating in the distribution can obtain the expected returns that satisfy them.

The essence of stakeholders is to organize stakeholder relations. Stakeholder theory requires managers to consider who has nothing to do with the organization. This theory is too comprehensive, thus damaging its usefulness. According to the framework of Mitchell et al. (1997), stakeholders are divided into six types (regulators, controllers, partners, passive, dependent and non-stakeholders) (Miles, 2017).

In the process of CCUS project implementation, the stakeholders are: government, CCUS project constructor, people and financial institutions. Among them, the government plays an administrative control and order-oriented role in environmental effects; People are interested in the noise pollution caused by CCUS project, the neighbor avoidance effect caused by earthquake, and the provision of jobs. In addition, the investment, income return and government support of CCUS enterprises; The investment and financing of financial institutions constitute the theoretical system of stakeholders.

Yuhao Wang et al. constructed an evaluation model of the relationship between stakeholders in carbon emission reduction. Government (F1), manufacturing enterprises (F2), R&D organizations (F3), energy industry (F4), financial institutions (F5) and carbon emission reduction intensity (F0) are regarded as potential variables, and 28 evaluation

indicators are regarded as observation variables, which together constitute an evaluation model of the relationship between stakeholders and carbon emission reduction intensity (Wang et al., 2022).

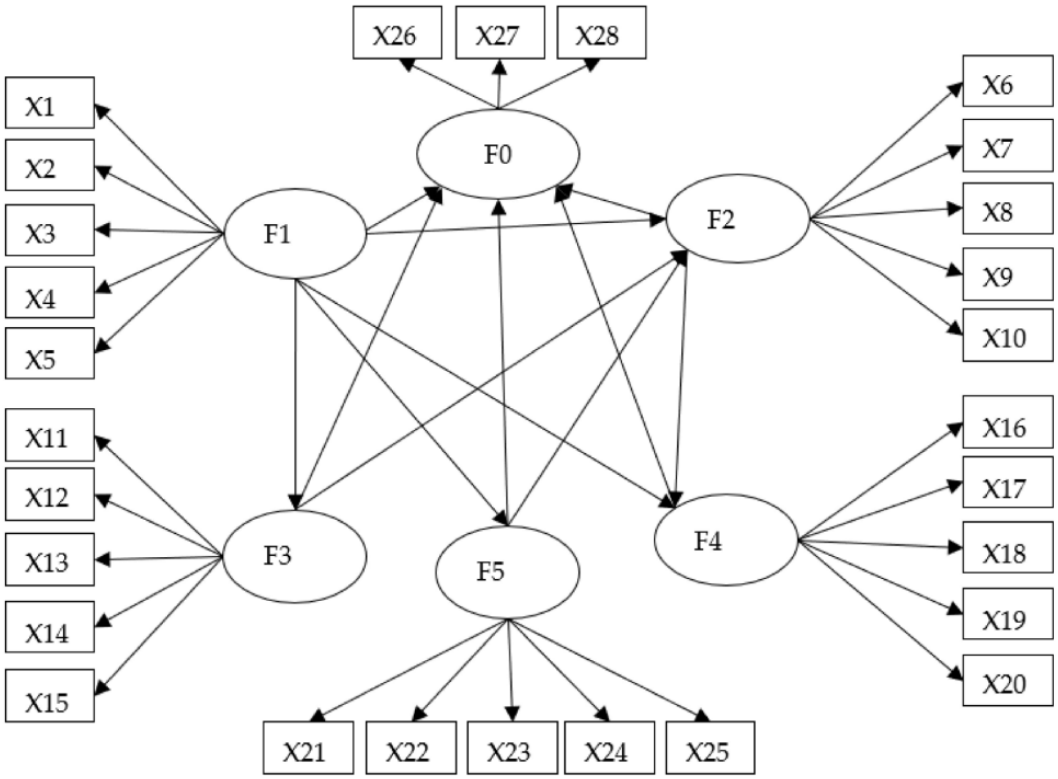


Figure 2.10 Evaluation model of the relationship between stakeholders(Source: Wang et al., 2022)

This study aims to sort out and coordinate the conflicts and demands of the public at all levels in Guizhou Province during the promotion of CCUS projects, explore the game issues among the stakeholders of CCUS projects, define the game subjects through theoretical analysis, and screen and analyze the elements of gains and losses they are concerned about through data analysis. It clarifies the demands and responsibility and rights systems of different stakeholders in the dynamic development process of the CCUS industry from the basic theoretical level, which is conducive to understanding the demands of multiple parties and guiding stakeholders to make decisions in line with the goal of win-win from a practical perspective.

2.3 Immediate Disciplines

2.3.1 Public Cognition

Public cognition initially originated from social cognitive theory. Social cognitive theory holds that public perception stems from the process of individuals perceiving, processing, and attributing social information. Individuals construct their cognitive systems through observational learning and self-regulation (Bandura & Cherry, 2020). On the other hand, the agenda-setting theory posits that mass media influence the public's judgment of the importance of specific issues by filtering and highlighting them, thereby shaping the public's cognitive framework (Rodríguez-Díaz & McCombs, 2023). Typical application scenarios of the agenda-setting theory include the dissemination of policy issues (such as the promotion and cognitive guidance of CCUS technology) and the guidance of public opinion on public events.

The degree of recognition of a technology and how it works greatly affect how a person evaluates any given technology choice. In most countries, the public is usually unfamiliar with CCUS technology. In many studies, when asked whether they know CCUS, only a few respondents can give meaningful answers, let alone make personal judgments on its advantages (Xiao et al., 2026). Laymen are found to have a general understanding of CO2, but lack knowledge of its scientific level. These misunderstandings are directly related to the misunderstanding of CCUS, but indirectly related to their views on the implementation of CCUS. As an effective climate change mitigation technology, compared with other mitigation technologies (such as wind energy option), most respondents are not very positive about CCUS (de Best-Waldhober et al., 2010). Some interviewees also expressed concern that there are still many uncertainties in the future development of CCUS, which may crowd out investment in other renewable energy technologies, which may eventually lead to changes in low-carbon lifestyles (Palmgren et al., 2004; Wassermann et al., 2010). Another condition of public awareness is that CCS can only be used temporarily as an unsustainable "end solution" and should not be used when more sustainable solutions become widely available (van Alphen et al., 2007). These results show that most people do not have a deep understanding of CCUS technology.

This study integrates social cognitive theory and agenda-setting theory to define public perception of CCUS projects as the subjective cognition, attitude tendency, and judgment system formed by the general public based on their own knowledge reserves,

life experiences, media exposure, and social interactions regarding the attribute characteristics, value utility, potential risks, and development prospects of carbon capture, utilization, and storage (CCUS) technologies and projects. The core of this definition encompasses three dimensions: the first is the cognitive level, which refers to the awareness of basic information such as technical principles, implementation processes, and policy backgrounds; the second is the attitude level, which is the support, neutrality, or opposition tendency formed based on cognition; the third is the behavioral intention level, which is the potential behavioral trend of participating in, cooperating with, or opposing the implementation and promotion of the project. This definition also incorporates the ABC attitude theory (cognition - affect - behavior), emphasizing that public perception is an organic unity of cognition, attitude, and behavioral intention, and is comprehensively influenced by multiple factors such as individuals, media, and social culture.

2.3.2 Perceived Risk

In addition to public cognition of carbon capture, utilization and storage (CCUS), perceived risk is also an important consideration for its large-scale implementation (Gough & Mander, 2022). Qualitative research found that respondents were worried about accidents and potential carbon dioxide leakage, which they thought would have a negative impact on the environment and human health (Shackley et al., 2005; Wallquist & L'Orange Seigo, et al., 2012). Some people even expressed concern about the earthquake caused by deep underground gas storage (Seigo et al., 2014). Wennersten and others (2015) believe that the impact of possible carbon leakage on public health may be the most relevant risk awareness issue. At the same time, from the environmental point of view, underground storage of carbon dioxide may pollute groundwater and surface water (Smith et al., 2011), and leakage may lead to exponential growth of carbon dioxide on the ground, thus causing potential harm to plants and animals (Polson et al., 2012; Terwel et al., 2011b).

The classic definition of perceived risk originated from Bauer's (1960) theory of perceived risk based on psychology and consumer behavior, which refers to an individual's subjective cognition and judgment of the uncertainty of the decision outcome and the possible negative consequences of such uncertainty during the decision-making process (Bauer, 1960). This concept has two core features: first, subjectivity, which distinguishes it from quantifiable objective risks, and its magnitude depends on an individual's

knowledge reserves, past experiences, value orientations, and information acquisition channels; second, dual-dimensionality, which includes “outcome uncertainty” (the probability judgment of whether the decision will produce negative effects) and “consequence severity” (the judgment of the degree of impact of negative effects on individuals or groups).

The perception risk theory is the core basis for defining “public perception risk”, providing a theoretical framework for analyzing the public's subjective judgment on risks such as leakage and cost shifting in CCUS projects. In addition, Psychometric Paradigm, Social Amplification of Risk Framework (SARF), and Theory of Planned Behavior (TPB) also respectively explain the perception risk.

Psychological Paradigm was refined by Slovic and others in the 1980s, suggesting that the public’s perception of risk is not based on technical probability calculations but is determined by two major dimensions: the “dreadfulness” of the risk (such as lethality and irreversibility) and its “unknownness” (such as new technologies and cognitive ambiguity) (Slovic, 1980). This theory can explain why the public is more sensitive to the unknown risks of long-term storage and the irreversible impacts of leakage in CCUS. Social Amplification of Risk Framework was proposed by Kasperson and others in 1988, arguing that risk events, after being disseminated through media reports and social interactions, can be amplified or weakened, thereby influencing public risk perception (Kasperson et al., 1988). This theory is applicable to analyzing the formation of the “not-in-my-backyard” effect in CCUS projects and the role of information transparency in public perception. Theory of Planned Behavior was proposed by Ajzen, although it focuses on behavioral decision-making, it can be extended to explain the mechanism of perceived risk - the public’s perceived risk of CCUS will affect their attitude towards the project, and then influence their intention to support or oppose, serving as a key theoretical bridge connecting perceived risk and the social acceptance of the project (Ajzen, 2011).

Based on the above theories, in the context of the CCUS project in this study, perceived risk extends to the public's subjective assessment of the potential negative consequences in terms of safety, environment, economy and society throughout the entire project process (capture, transportation, utilization and storage), and it is a key variable influencing the social acceptance of the project.

2.3.3 Perceived Benefits

Empirical research shows that the public's acceptance of CCS technology is related to their perceived financial benefits (van Alphen et al., 2007; Wennersten et al., 2015; Zhang et al., 2015). The research conducted by Curry (2004) shows that most people support investment in energy technology, but this support will decrease when the cost information of all climate mitigation technologies is provided. As a technical option, CCS is expensive compared with taking a stand of taking no action. Van Alphen et al. (2007) pointed out that carbon dioxide capture will reduce the energy efficiency of power plants, which will have an impact on electricity prices. Considering this, it is not surprising that CCS may not be an attractive option for many people. In addition, due to the massive infrastructure demand and the demand for extensive carbon dioxide pipeline system, this can hardly provide direct benefits, such as employment opportunities or economic compensation for nearby power plants, so it is not difficult to understand why some people may not support CCS projects near their local areas (Wallquist, L'Orange Seigo, et al., 2012). In addition, the combination of CCS technology and CO2 utilization technology, such as CCS EOR (enhanced oil recovery), can improve the recovery rate of energy or resources, thus ensuring national energy security and improving the economic benefits of oil fields (Liang & Wu, 2009).

Perceived benefit is an individual's subjective judgment and psychological expectation of the positive effects, value or utility that a certain thing or behavior can bring, based on their own cognition, needs and value orientation. Perceived benefit originates from consumer behavior and perceived value theory, with the core being the individual's subjective judgment of the positive value of the behavior or thing, and it, together with perceived risk, constitutes the core dimension of decision-making trade-offs. Classic theories include perceived value theory (Zeithaml, 1988), expectancy value theory (Fishbein, 1975), and theory of planned behavior (Ajzen, 1991), which provide a theoretical framework for the definition and measurement of perceived benefit.

Perceived Value Theory, centered on Zeithaml’s (1988) research, posits that perceived value is the result of a trade-off between perceived benefits and perceived costs (including risks). It clearly defines that perceived benefits encompass multiple dimensions of positive utility such as functionality, emotion, and social aspects, which serve as the core basis for delineating the connotation and dimension division of perceived benefits

(Zeithaml, 1988). The Perceived Value Theory has established an analysis framework of benefit-risk trade-offs for CCUS research, promoting the expansion of perceived benefits from a single dimension to a comprehensive understanding that includes ecological (emission reduction), economic (employment/industrial upgrading), and social (energy security) dimensions.

Expectancy-Value Theory (EVT), systematically expounded by Fishbein & Ajzen (1975), holds that an individual's attitude is jointly determined by the “expected probability of behavioral outcomes” and the “evaluation of the value of the outcomes”. Perceived benefits are the value judgments of positive outcomes of an action and are the core positive elements that constitute an attitude. This theory provides the fundamental logic for the quantitative measurement of perceived benefits (Fishbein, 1975). EVT offers a quantitative analysis logic for the perceived benefits of CCUS - the public’s attitude towards CCUS is jointly determined by their “expected probability of positive outcomes” (such as the probability of successful emission reduction) and “evaluation of the value of the outcomes” (such as the importance of climate improvement), among which the value judgment of positive outcomes is the core connotation of the perceived benefits of CCUS.

Theory of Planned Behavior (TPB), developed by Ajzen (1991), expands on the Theory of Reasoned Action by incorporating perceived benefits as a predictor of attitude formation. It posits that an individual’s positive perception of the benefits of a behavior directly influences their attitude, which in turn affects their behavioral intention, thus establishing a link between perceived benefits and actual decision-making (Ajzen, 1991). The TPB clarifies the role of perceived benefits in CCUS: the public's positive perception of the benefits of a project directly influences their supportive attitude, which then affects their intention to participate or support, serving as a key theoretical bridge connecting perceived benefits with actual decision-making.

Based on the above theories, in the context of the CCUS project in this study, the public's perceived benefits specifically refer to the subjective understanding of the positive values of CCUS technology in mitigating climate change, improving air quality, promoting regional industrial upgrading, creating job opportunities, and obtaining ecological compensation. Together with perceived risks, they constitute the core influencing dimensions of the public’s attitude towards the project. The balance between the two directly determines the public’s acceptance of the CCUS project.

2.3.4 Environmentalism

The improvement of environmental awareness affects the public's attitude towards CCUS project (Zhang et al., 2015). A person with high environmental awareness is more likely to support such environmental technologies and activities. Curry (2004) conducted a survey to better understand the public's attitude towards global climate change and mitigation technologies, such as CCUS, which may reduce the impact of power generation on the climate. Generally speaking, people are very confused about the environmental problems to be solved by this technology. When a person cares about the environment or thinks that immediate action must be taken to deal with climate change, the public's willingness to pay will increase. The research conducted by Wallquist et al. (2009) shows that there is a big gap in the public's understanding of carbon emissions, which in turn affects the public's acceptance of mitigation technologies such as CCUS. A study by de Best-Waldhober et al. (2012) also shows that a considerable part of the public still does not understand the relationship between current energy consumption and its impact on climate change. Therefore, the public's acceptance of CCUS depends largely on the public's broader understanding of the background of climate change, and CCUS is emphasized under this background (van Alphen et al., 2007).

Environmentalism, also known as environmental protectionism, is a philosophical concept, ideology and social movement centered on protecting, restoring and improving the natural environment. It advocates adjusting human activities, institutional designs and value concepts to reduce ecological damage and pollution and achieve sustainable coexistence between humans and nature. The core of environmentalism is to reflect on and reconstruct the relationship between humans and nature. The theoretical roots of environmentalism are centered on ecological ethics, environmental philosophy and social science theories, and a complete system is formed in combination with practical movements.

Land Ethics, proposed by Aldo Leopold in 1949, emphasizes the moral responsibility of humans towards the land community and is the foundational theory of ecocentrism, promoting the shift of environmentalism from resource conservation to the overall ecological protection. Its core lies in extending the ethical boundary to natural ecosystems (Leopold, 2007). In the application of CCUS, it can explain the public's

concern over ecological damage caused by leakage from storage and promote projects to balance ecological integrity and regional sustainable development (Yang et al., 2016).

Deep Ecology, proposed by Arne Naess in 1973, asserts that nature has intrinsic value, criticizes anthropocentrism, and emphasizes the integrity and self-realization of ecosystems, thus serving as the ideological foundation of radical environmental movements (Glasser, 2005). In the application of CCUS, public concerns over "the continuation of fossil fuel dependence" can be analyzed to promote the synergy between technology and renewable energy and enhance the ecological rationality of emission reduction (Kellou et al., 2025).

The Social Amplification of Risk Framework (SARF) proposed by Kasperson et al. in 1988 reveals the mechanisms by which risk events are amplified or weakened through social dissemination, and explains the formation of public perception on environmental issues (such as pollution and climate change) and the "Not-In-My-Backyard" (NIMBY) effect (Kasperson, 1988). In the application of CCUS, it can be used to analyze how the dissemination of information on environmental issues (such as storage risks) shapes public attitudes, providing a path for risk communication (Arning et al., 2024).

Based on the above theories, in the context of the CCUS project in this study, environmentalism is the subjective cognition and attitude tendency formed by the public based on the value orientation of ecological protection and climate change response towards the carbon reduction effect, ecological impact and sustainability of the entire process of CCUS technology (capture, transportation, utilization and storage). The core is to assess the pros and cons of the technology to the natural environment, and to judge whether it meets the environmental protection goals of "mitigating the climate crisis and protecting the integrity of the ecosystem", and thereby influencing the support or opposition behavior towards the project. On the positive support dimension, it recognizes the carbon reduction function of CCUS, regards it as an important technical means to address climate change, and forms a supportive attitude based on the "benefit of climate improvement". On the critical dimension, it questions issues such as "continuing the dependence on fossil fuels" and "ecological risks caused by leakage during storage" of CCUS, emphasizing that the technology needs to develop in coordination with renewable energy to meet environmental protection requirements.

2.3.5 Trust

Trust is a psychological state and social attitude in which one party (the trusting party) voluntarily gives up some control and relies on the actions of another party (the trusted party, including individuals, organizations, and systems) based on subjective judgments of their professional competence, integrity, good intentions, and reliability in fulfilling commitments, and is willing to bear the potential risk of loss in situations of uncertainty and risk. Its core is to reduce cognitive uncertainty, and it is a key mediating variable in social interaction, cooperation, and risk decision-making.

Social Trust Theory defines trust as a mechanism to reduce social complexity, which stems from cultural norms and social capital. Social trust is divided into generalized trust (towards strangers) and particularized trust (towards acquaintances), influencing the scale and efficiency of cooperation (Jasinski, 2011). In CCUS research, it is used to explain how the public's trust in project entities affects their assessment and acceptance of technological risk.

The Institutional Trust Theory defines trust as originating from institutional norms, regulatory mechanisms, and the fairness of processes; institutions build a stable foundation of trust by reducing transaction costs and ensuring fairness (Krishna et al., 2023). In CCUS research, it is used to analyze how project approval processes, risk supervision mechanisms, and information disclosure systems affect public trust.

In the Risk-Trust Interaction Theory, Siegrist & Cvetkovich (2000) hold that under information asymmetry, trust substitutes for personal knowledge and directly affects risk perception; high trust reduces risk perception, while low trust amplifies it, providing a framework for risk communication (Siegrist & Cvetkovich, 2000). The Risk-Trust Interaction Theory offers a core framework for understanding the mechanism of trust in CCUS risk communication (Terwel et al., 2009b).

Based on the above theories, in the research on public acceptance of CCUS projects, trust refers to the psychological state and social attitude of the public, who, in the face of the uncertainties and risks of CCUS technology, are willing to rely on the decisions and actions of the relevant project entities (government, enterprises, and research institutions) and accept the potential risks of the technology, based on their subjective judgment of the professional capabilities, integrity, sense of responsibility, and transparency of these entities. The core of trust is to reduce the public's cognitive

uncertainty about CCUS technology and project implementation, and it is a key mediating variable connecting risk perception and acceptance (Huijts et al., 2007).

2.3.6 Fairness

The technology acceptance framework shows that fairness may affect people's decision-making process, especially when decisions are made by citizens near the project site (Huijts et al., 2012). Liu, B. S. et al. (2021) took fairness as a situational variable, and tested its moderating effect on perceived risk/benefit and acceptance under the background of CCUS. The research shows that when fairness is high, the relationship between perceived benefit and acceptance is strengthened (Liu, B. S. et al., 2021).

Fairness refers to the principle of following unbiased, normative and reasonable standards in the allocation of resources, the enforcement of rules, the making of decisions and the evaluation of behaviors, treating all stakeholders equally without discrimination or favoritism based on their identities, statuses or interests. The core of fairness is to ensure that the outcomes, processes and rules conform to the generally accepted standards of equity and moral norms. It is a fundamental value criterion in social governance, organizational operation and interpersonal interaction(Rawls, 1971).

Sovacool, B. K., et al. (2016) empirically analyzed the impact of distributive fairness and procedural fairness in CCUS projects on public acceptance, proposing a transmission path of "perceived fairness→trust→acceptance" (Lilliestam & Hanger, 2016). Upham, P., et al. (2011) systematically reviewed the application of fairness in CCUS research, covering dimensions such as distribution, procedure, and environmental justice (Upham, 2011). O'Rourke, S., & Lacey, J. (2010) confirmed through a questionnaire survey that the perception of procedural fairness and distributive fairness significantly affects public support for CCUS projects (Upham, 2011).

Based on the definition of fairness and related research, in the study of public acceptance of CCUS projects, fairness is the subjective perception and evaluation of the public regarding the procedural fairness, distributive fairness, and interactional fairness throughout the entire process of CCUS projects (planning, site selection, construction, operation, benefit distribution, and risk sharing). It is a key antecedent variable that influences public trust, risk perception, and project acceptance. The core of justice lies in whether the project-related entities (government and enterprises) treat the community public equally, whether they guarantee the public's right to participate and be informed,

whether they achieve “shared benefits and shared risk”, and whether the decision-making process is transparent and the consultation is adequate.

2.3.7 Legal Protection

The legal network of the influence of institutional forces on supplier trust in manufacturing supply chain shows that legal protection will affect public acceptance, and the legal protection for CCUS projects includes two angles-the central government level and the local government level. Hemmert, M. et al. (2016) research shows that legal protection plays an important role in both the buyer's enterprise and the supplier, which is conducive to building mutual trust (Hemmert et al., 2016; Liu, B. S. et al., 2021).

In addition, Gunningham, N., & Sinclair, D. (2014) analyzed the legal regulatory framework design for CCUS projects, revealing the impact of the completeness of the legal system on public risk perception and project acceptance (Gunningham, 2014). Li, Y. F., & Zhang, Z. T. (2022) reviewed the current legal protection system for CCUS technology in China, proposing institutional suggestions to improve public environmental rights and damage compensation mechanisms, providing a local basis for studying public perception of legal protection. Brewer, T. L., et al. (2019) empirically confirmed that the certainty of law and regulation (a core manifestation of legal protection) significantly enhances public acceptance of CCUS projects and reduces risk perception.

In this study, legal protection refers to the public's subjective perception and expectation that their legitimate rights and interests (such as personal safety, property rights, environmental rights, and participation rights) and the ecological environment rights of the region during the entire process of CCUS projects can be clearly defined, effectively guaranteed, and promptly remedied by the current national legal system (including environmental law, administrative law, civil law, etc.). It is an important safeguarding variable that influences the public's risk perception, trust level, and acceptance of the project. Theories related to legal protection include the legal protection theory of environmental rights, the theory of legal liability, and the theory of balanced protection of stakeholders’ rights and interests.

2.3.8 Public Acceptance

Public Acceptance refers to the different levels of recognition and acceptance of the public based on their own moral and values, as well as their psychological cognition of the contact objects. The public acceptance of CCUS at home and abroad can be roughly

divided into three categories: attitude acceptance, emotional acceptance and rational acceptance (Liu, B. S. et al., 2021).

Attitude acceptance refers to the public's superficial judgment on the development of CCUS. Most scholars define public CCUS acceptance as the public's attitude of agreeing with CCUS construction and CCUS carbon emission reduction. Some scholars also define it as the public's acceptance of CCUS development, which involves many fields such as technology, society, psychology and public management. Some scholars believe that it is the public's acceptance of CCUS technology, CCUS site selection and CCUS development policy. Emotional acceptance is the public's level of psychological recognition of CCUS, which can also be understood as their willingness to accept, absorb and recognize the development of CCUS, or specifically refers to people's willingness to recognize CCUS technology or projects. Rational acceptance is a decision made on the basis of benefit-cost, which is a degree of self-tolerance of the public to the risks and harms that CCUS construction may bring, and reflects the result of people's weighing between the benefits and threats brought by CCUS. Whether the public accepts CCUS decision depends on their weighing of risks and benefits. At present, public acceptance is a key factor in national energy development and project planning, and it has also become a key factor in whether CCUS projects can land.

2.3.9 Social Statistical Characteristics

Different socio-demographic characteristics will have an impact on the public acceptance of CCUS research. Referring to the latest theoretical research, this research model takes users' gender, age, education level and income status as control variables to study their influence on CCUS indicators (Liu, B. S. et al., 2021).

2.4 Theoretical Model and Hypotheses Statement

2.4.1 Theoretical Model

Based on the ABC (Affect, Behavior, and Cognition) attitude theory, the Social License to Operate (SLO) theory, and the institutional trust theory, this study proposes internal and external factors that influence the public's acceptance of carbon capture, utilization, and storage (CCUS) projects. Through scholars' research on the ABC (affect, behavior, and cognition) attitude theory, we know that the ABC attitude theory can well explain how attitudes influence public acceptance of new technologies. It has been widely

applied in fields such as education and consumption, but rarely used in the energy sector. Among them, the five dimensions of perceived risk, perceived benefit, trust, fairness, and public cognition in the ABC attitude theory have been empirically verified by scholars and have become the main factors and indicators of public acceptance of CCUS in the ABC attitude theory. Therefore, in this study, the five core variables in the ABC attitude theory are taken as the influencing factors of public acceptance of CCUS.

Many studies show that legal protection affects the public's trust, and then affects the public's acceptance. Therefore, in this study, legal protection is regarded as a pre-variable of trust, and whether legal protection affects public acceptance through trust is explored. At the same time, in order to enhance the public's explanation of CCUS project acceptance, this study further explains the impact on public CCUS project acceptance under the background of carbon neutrality in peak carbon dioxide emissions. The model incorporates environmentalist indicators as potential variables. Finally, this study takes the user's gender, age, education background and income status as control variables to study its influence on CCUS project acceptance. The research model of this study is shown in Figure 2.10, and various variables are summarized in Table 2.2.

Table 2.2 Table of Research Variables

Category	Variable
Dependent variable	Public Acceptance
Independent variable	Public Cognition, Fairness, Legal protection, Environmentalism
Mediator variable	Perceived Risk, Perceived Benefits, Trust
Control variable	Gender, Age, Education Level, Income

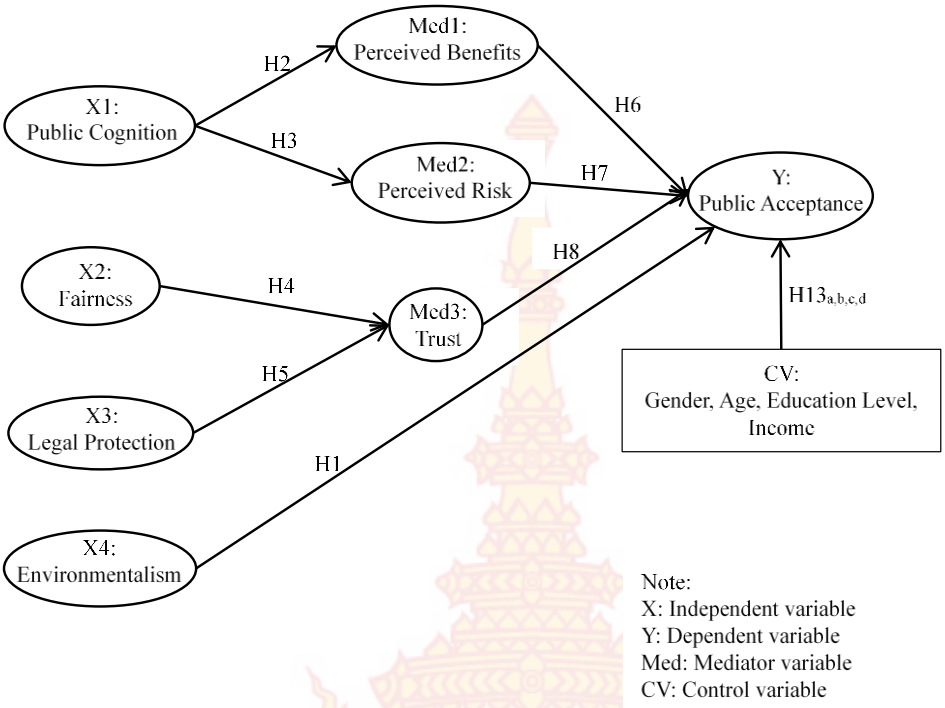


Figure 2.11 Conceptual Framework

2.4.2 Hypothesis Development

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. Previous studies 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 (Wallquist et al., 2009). Therefore, this study believes that environmentalism can positively affect the public's acceptance of CCUS projects in Guizhou.

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

The more the public is aware of the principles, emission reduction value, safety guarantees and comprehensive benefits of CCUS technology, the clearer they can identify its environmental, economic and social benefits, and reduce information bias and negative prejudice. CCUS is highly specialized and has a relatively low public awareness level. Enhancing public understanding can strengthen the perception of its climate benefits, industrial driving force and value in energy transition (Linzenich, 2019). Guizhou Province is promoting CCUS based on its energy industry and karst storage conditions.

An increase in public awareness will more easily highlight the positive value of the project. Therefore, it is proposed that public cognition has a significant positive effect on the public's perception of the benefits of CCUS projects in Guizhou Province.

Hypothesis 2: Public cognition positively affects Guizhou public’s perceived benefits in CCUS.

Public perception is a core pre-factor influencing risk perception. The more fully the public understands the principles, safety control and environmental benefits of CCUS technology, the lower the information asymmetry and unknown anxiety will be, and the more rationally they can judge and weaken perceived risks. CCUS is highly specialized and has a high threshold for public understanding. Insufficient understanding can easily amplify the perception of risks such as leakage, health and ecology. Guizhou Province has prominent karst geological features and a concentration of energy and chemical industry scenarios, and the public's familiarity with geological storage is relatively low. Therefore, enhancing public understanding has a more significant role in suppressing irrational risk perception. Thus, it is proposed that public understanding has a significant negative effect on the perceived risk of CCUS projects among the public in Guizhou Province (Xu et al., 2023).

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

The stronger the public’s perception of the environmental reduction, ecological safety, industrial drive and local development benefits of CCUS projects, the more likely they are to form a positive attitude and support willingness, thereby enhancing project acceptance (Xu et al., 2023). As a key low-carbon technology under the “dual carbon” goals, the social implementation of CCUS is highly dependent on public value recognition. Combining the energy transition needs of Guizhou Province and the advantages of karst geological storage, the clearer the public’s perception of the project's comprehensive benefits, the more it can weaken the NIMBY tendency and enhance participation and support willingness. Existing empirical evidence also shows that perceived benefits have a significant positive predictive effect on public acceptance of low-carbon technologies. Therefore, it is proposed that perceived benefits have a significant positive effect on the acceptance of CCUS projects by the public in Guizhou Province.

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

The stronger the public's perception of risks such as geological safety, CO2 leakage, ecological health, and socio-economic impacts of CCUS projects, the more likely they are to develop negative attitudes, resistance, and NIMBY behaviors, significantly reducing their willingness to accept the projects (Arning et al., 2020). The highly specialized nature of CCUS technology and insufficient information transparency can easily lead to risk amplification and irrational concerns. Given the sensitive karst geology and dense layout of energy and chemical industries in Guizhou, the public is more sensitive to the safety of storage and environmental risks, and the inhibitory effect of risk perception on acceptance is more pronounced. Empirical studies both at home and abroad have confirmed that perceived risk significantly and negatively predicts public acceptance of low-carbon technologies. Therefore, it is proposed that perceived risk has a significant negative effect on the acceptance of CCUS projects by the public in Guizhou.

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

The public’s perception of procedural justice, distributive justice and interactional justice in government regulation and enterprise operation is a core prerequisite for the formation of trust between the government and enterprises. Procedural justice is reflected in transparent decision-making, public participation and consistent rules; distributive justice concerns balanced risk and benefit, and reasonable compensation for ecology and livelihood; interactional justice points to adequate information disclosure and timely response to rights and interests (McLaren, 2012). In the context of Guizhou’s energy structure and low-carbon transformation, the perception of fairness in the entire process of CCUS project initiation, regulation, operation and compensation by the government and enterprises can reduce public risk concerns, strengthen the judgment of the legitimacy of the subjects and the credibility of their performance, and significantly enhance the trust level of the public in the government and project enterprises. Therefore, it is proposed that fairness has a significant positive impact on the trust of the public in Guizhou Province towards the government and enterprises conducting CCUS projects.

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

Legal protection, by clarifying rights and responsibilities, standardizing procedures, guaranteeing remedies, and stabilizing expectations, serves as the core institutional foundation for public trust (Beck et al., 2016). CCUS projects involve geological safety, ecological risks, property rights, and public participation. A complete legal framework can regulate the behaviors of government supervision and enterprise operation, reduce information asymmetry and NIMBY risk. Combining the low-carbon transformation and energy project governance practices in Guizhou Province, the higher the level of legal protection, the more the public is convinced that the government administers according to law, enterprises comply with regulations, rights can be remedied, and risks can be managed. Consequently, it significantly enhances the public's trust in the government and enterprises conducting CCUS projects. Therefore, it is proposed that legal protection has a significant positive impact on building trust between the public in Guizhou Province and the government and enterprises conducting CCUS projects.

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

Due to the highly technical nature of CCUS, information asymmetry, and the uncertainty of geological and ecological risk, the public finds it difficult to independently assess the value of the project. Trust in the capabilities, integrity, and good intentions of the government and enterprises becomes a core prerequisite for acceptance (Terwel et al., 2009a). As a region sensitive to both energy and ecology, the public in Guizhou is highly sensitive to risk distribution, information transparency, and rights protection. Trust can significantly reduce risk perception, strengthen recognition of benefits, and alleviate NIMBY resistance. At the same time, trust enhances decision-making participation and legitimacy expectations, promoting the transformation of cognitive attitudes into behavioral acceptance (Terwel et al., 2011a). In the context of Guizhou's "dual carbon" and energy transition scenarios, trust positively enhances acceptance by stabilizing expectations, bridging information gaps, and regulating risk-benefit judgments. Based on this, it is proposed that trust has a significant positive impact on the acceptance of local CCUS projects by the public in Guizhou.

Hypothesis 8: Trust positively affects the public acceptance that carry out CCUS projects in Guizhou.

Legal protection and fairness, as the core variables of institutional trust theory, have been confirmed by research to significantly influence public trust (Hemmert et al., 2016; Wang et al., 2014). Trust, as the core variable of social license theory, has been confirmed by research to significantly affect public acceptance (Hall et al., 2015). Trust plays a mediating role between legal protection, fairness and public acceptance (Hall et al., 2015; Hemmert et al., 2016). This paper will integrate institutional trust theory and social license theory from the perspective of local public who are involved in CCUS projects to assess the impact of CCUS project institutions on local public acceptance. This paper holds that legal protection and fairness directly affect public trust respectively, and influence public acceptance through trust as a mediating variable. Therefore, the following hypotheses are proposed:

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

Hypothesis 12: Trust mediates legal protection for the local public in the implementation of CCUS project and public acceptance in Guizhou.

The standard learning hierarchy of the ABC attitude theory (high-involvement level) follows the attitude formation path of (cognition→affect→behavioral intention), which is applicable to low-carbon technology issues like CCUS that are high-risk and have high cognitive loads (Maki, 2011). The public's technical, safety, and value cognition of CCUS constitute the cognitive starting point of attitudes, directly shaping their perception of risks in terms of leakage, health, environment, and economy (the core of the affect dimension); insufficient cognition and information bias tend to increase risk perception, while adequate and transparent cognition helps to rationally calibrate risk judgment (Xu et al., 2023). Perceived risk, as a key affective evaluation, significantly negatively predicts public acceptance (behavioral intention), constituting the core path for the transmission of cognition to acceptance (Wilson et al., 2019). Therefore, in the context of CCUS, public cognition does not directly affect acceptance but influences it through the mediating role of perceived risk, fully conforming to the standard learning hierarchy logic of cognition→perceived risk (affect)→acceptance (behavioral intention). Empirical research also confirms that perceived risk plays a significant mediating role between public cognition and acceptance of CCUS, serving as a key mechanism connecting cognitive

processing and behavioral intention (Liu, B. S. et al., 2021). Thus, this study proposes Hypothesis 10:

Hypothesis 10: Perceived risk plays an mediate role between public cognition of CCUS and public acceptance of CCUS.

Similarly, in the context of CCUS projects, the public's systematic understanding of the technical features, emission reduction effectiveness, economic value, and ecological benefits is the prerequisite for forming perceived benefits. An increase in the level of understanding can significantly enhance the public's positive perception of the environmental benefits, social value, and development dividends of CCUS (Xu et al., 2023). Perceived benefits, as a core positive evaluation variable, can directly drive the public's willingness to accept and support CCUS projects (Wilson et al., 2019). Therefore, public understanding does not directly affect the acceptance of CCUS but influences it through the mediating role of perceived benefits. Perceived benefits play a significant mediating role between public understanding and acceptance, a mechanism that is highly consistent with the theoretical logic of the standard learning hierarchy and has been verified in empirical studies on public acceptance of CCUS (Liu, B. S. et al., 2021). Therefore, this study proposes Hypothesis 9:

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

Finally, with the growth of age, experience is more abundant; Education level will also affect understanding and accepting new things; Different income conditions will also affect public concerns. Therefore, hypothesis 13 is put forward.

Hypothesis 13: Guizhou people with different gender, age, education level and income status have different acceptance of CCUS.

Hypothesis 13a: Guizhou people with different gender have different acceptance of CCUS.

Hypothesis 13b: Guizhou people with different age have different acceptance of CCUS.

Hypothesis 13c: Guizhou people with different education level have different acceptance of CCUS.

Hypothesis 13d: Guizhou people with income status have different acceptance of CCUS.

The research hypotheses are summarized in Table 2.3.

Table 2.3 Summary of Research Hypotheses

Number	Hypothetical content
H1	Environmentalism is positively affecting the public's acceptance of CCUS in Guizhou.
H2	Public cognition positively affects Guizhou public's perceived benefits in CCUS.
H3	Public cognition positively affects Guizhou public's perceived risk of CCUS.
H4	Fairness positively affects trust in the government and enterprises carrying out CCUS projects in Guizhou.
H5	Legal protection positively affects trust in the government and enterprises carrying out CCUS projects in Guizhou.
H6	Perceived benefits positively affect the public acceptance of CCUS in Guizhou.
H7	Perceived risk positively affects the public acceptance of CCUS in Guizhou.
H8	Trust positively affects the public acceptance that carry out CCUS projects in Guizhou.
H9	In the upcoming CCUS project, perceived benefits has an intermediary role between Guizhou public's cognition of CCUS and Guizhou public's acceptance of CCUS.
H10	Perceived risk plays an mediate role between public cognition of CCUS and public acceptance of CCUS.
H11	Trust mediates fairness of the government and CCUS project enterprises to the public in Guizhou and public acceptance of CCUS projects in Guizhou.
H12	Trust mediates legal protection for the local public in the implementation of CCUS project and public acceptance in Guizhou.
H13	Guizhou people with different gender, age, education level and income status have different acceptance of CCUS.
H13a	Guizhou people with different gender have different acceptance of CCUS.

Table 2.3 (continued)

Number	Hypothetical content
H13b	Guizhou people with different age have different acceptance of CCUS.
H13c	Guizhou people with different education level have different acceptance of CCUS.
H13d	Guizhou people with different income status have different acceptance of CCUS.

2.5 Conclusion

This chapter mainly introduces the concept, classification, process flow, significance, and research status at home and abroad of carbon capture, utilization and storage (CCUS), the ABC (affect, behavior and cognition) attitude theory, social license theory, institutional trust theory, stakeholder theory, the definition of variables that affect the public's acceptance of CCUS projects, research hypotheses and research models. This chapter provides a theoretical basis for Chapter Three, and the next chapter will introduce the research methods.

CHAPTER 3
METHODOLOGY

In this study, quantitative research methods are adopted. Through questionnaire survey, after finding out the general relevant information of Guizhou (where CCUS (Carbon Capture, Utilization and Storage) is to be carried out), the researchers conduct an online questionnaire survey on the selected respondents, and analyze the data through data processing tools such as SPSS and AMOS. This chapter mainly introduces the philosophical paradigm, research ideas, research methods, data collection methods, measurement methods, data analysis methods and ethical issues of social research.

3.1 Overview and Justification of Research Paradigm

3.1.1 Positivism

Positivism is a philosophical thought. In a narrow sense, positivism refers to the philosophy of the French philosopher AugusteComte. Broadly speaking, any kind of philosophical system is positivism as long as it is confined to empirical materials and refuses to exclude transcendental or metaphysical speculation.

The basic feature of positivism is that the task of philosophy is attributed to the study of phenomena, starting from the viewpoint of phenomenology, refusing to grasp the sensory materials through rationality, and thinking that scientific laws can be obtained through the induction of phenomena. It regards dealing with the relationship between philosophy and science as the central issue of its theory, and tries to dissolve philosophy into science.

Positivism assumes that people's behaviors have internal relations and are very clear about their own motives and significance; If rigorous methods (such as construction and measurement) are adopted, researchers can understand and understand the insider's behavior and meaning explanation (Huang et al., 2019). Positivism originates from the philosophical ontology of realism, that is, reality is real and can be understood, and things themselves have inherent fixed and repeatable laws. Positivism defines theory as a proposition linking abstract concepts, which is also a widely used definition; Positivism

theory focuses on seeking reasons and supporting the explanation of causality, emphasizing the generalization and universality of the theory.

Isidore A. Comte, the founder of early classical positivism, thinks that sociologists should adopt the empirical methods of natural science (such as observation, experiment, comparison, etc.) to study social phenomena. In epistemology, classical positivism advocates that social phenomena must be perceived by experience, and empirical theory must be tested by experience; There is no such thing as the real self or subject in the research process, just emphasize the objectivity of the research object. Researchers should adhere to the principle of "value neutrality" and avoid the interference of personal thoughts or preferences in the research process.

This philosophical stance aligns with our study's objective to identify causal relationships among objectively measured variables (e.g., trust, risk perception) influencing public acceptance.

3.2 Quantitative Research

This study adopts a quantitative research approach, collecting data through questionnaires and using SPSS 27 for descriptive statistics, reliability and validity analysis. At present, the questionnaire is designed based on existing literature. It should cover all dimensions of the research, such as public awareness, perceived benefits, perceived risks, fairness, legal protection, environmentalism, and trust. A pretest should be conducted before the formal distribution of the questionnaire, and the questionnaire should be improved based on the responses and feedback of the pretest participants. Then, the formal questionnaire will be distributed and analyzed.

The research design clearly outlines a concise and logically coherent plan for addressing the established research questions through data collection, interpretation, analysis, and discussion. In the study of acceptance of carbon capture, utilization and storage (CCUS), the ABC (affect, behavior, and cognition) attitude theory has been proven to be a more authoritative model. On the basis of retaining traditional research variables, this study combines the social license theory and institutional trust theory, expands the research variables, and explores and verifies the hypothesized influence paths, mediating effects, direct effects, or indirect influences among them.

3.2.1 Research Tool

3.2.1.1 Operational Definition of Variables

On the basis of previous research, this study summarizes and defines the variables in the model, such as public cognition, perceived interests, perceived risks, fairness, legal protection, trust, environmentalism and acceptance. In the context of CCUS project, the definitions and references of related variables are shown in Table 3.1.

Table 3.1 Operational Definition of Variable

Variable name	Definition	Source
Public Cognition	The public's understanding of the scientific knowledge of CCUS project.	Itaoka et al. (2012)
Perceived benefits	The degree to which the public perceives that CCUS project will bring economic and employment benefits.	Wallquist et al. (2012)
Perceived risk	The extent to which the public perceives that CCUS projects will have potential environmental risks and health risks such as carbon dioxide leakage and earthquakes.	Shackley et al., (2005); Wallquist et al. (2012)
Fairness	Fairness generally includes three different types of fairness, that is, distribution fairness related to results, procedural fairness related to how resources are allocated, and interactive fairness felt by people in the process of resource allocation.	Liu, B. S. et al. (2021)
Legal protection	A legal system with special laws and policies on carbon peak and carbon neutrality as the core and environmental protection law, climate change law, energy law, CCUS and other relevant laws as the framework.	Hemmert et al. (2016)

Table 3.1 (continued)

Variable name	Definition	Source
Trust	Public recognition of CCUS project executors and their technologies.	Kim et al. (2004)
Environmentalism	Public awareness of environmental protection and intensity of environmental protection action.	de Best-Waldhober et al. (2010)
Public Acceptance	The public's permission for technology development, implementation and use, and the acceptance of CCUS include two dimensions: social politics and community acceptance.	Jones et al. (2017)

3.2.1.2 Measurement of Variables

According to the questionnaire design method put forward by Saito, A (2019), and referring to the questionnaire on the influencing factors of public acceptance of CCUS projects put forward by scholars such as Yang, L (2016), Liu, B. S. (2021) and Venkatesh & Zhang (2010), the questionnaire of this study is designed. Combined with the research content and social background such as floods caused by climate change, the scale in the previous questionnaire was modified appropriately, which improved the reliability and effectiveness of the questionnaire and could deeply explore the core factors affecting the public acceptance of CCUS projects.

The study draws lessons from the empirical research methods of classical management at home and abroad. In order to facilitate the respondents to understand and improve the accuracy of data reporting, the scale design follows the principles of simple questions before complex questions and colloquial academic language. Then, this study invited relevant research experts to give feedback on the scale and modify the questionnaire. According to the theoretical model proposed by the research, the scale involved in this study includes the following variables.

3.2.1.3 Perceived Risk

Table 3.2 Items used to Measure Perceived Risk

Constructs	Original Items	Revised Items	Items Sources
Perceived Risk (PR)	PR1: CCUS is an immature technology, and accidents may occur during implementation	PR1: Carbon capture, utilization and storage (CCUS) is an immature technology, and accidents may occur during its implementation in Guizhou.	Seigo et al. (2014); Wallquist, Visschers, et al. (2012)
	PR2: The transport of CO_2 is dangerous, a leakage of CO_2 during transport is bad for the environment.	PR2: The transportation of carbon dioxide is very dangerous. During the transportation process in Guizhou, the leakage of carbon dioxide is harmful to the environment.	
	PR3: The geological storage of CO_2 is hazardous, which may cause earthquakes.	PR3: The geological storage of carbon dioxide in Guizhou poses a danger and may trigger earthquakes in Guizhou.	
	PR4: CO_2 products are harmful to human health.	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.	PR5: CCUS is harmful, which allowing the use of fossil fuels will further worsen the environment.	

3.2.1.4 Perceived Benefits

Table 3.3 Items used to Measure Perceived Benefits

Constructs	Original Items	Revised Items	Items Sources
Perceived Benefits (PB)	PB1:CCUS is an environmentally-friendly technology that effectively alleviates climate change	PB1: Carbon capture, utilization and storage (CCUS) is an environmental protection technology that can effectively alleviate climate change in Guizhou.	Arning et al. (2020); Xiao et al. (2026)
	PB2:CCUS is a trustworthy technology that improves oil recovery rates and oil supply.	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.	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.	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.	PB5: Carbon capture, utilization and storage (CCUS) is a mature technology that can provide more job opportunities for Guizhou.	

3.2.1.5 Environmentalism

Table 3.4 Items used to Measure Environmentalism

Constructs	Original Items	Revised Items	Items Sources
Environmentalism (EN)	EN1: CCS technologies are an effective means of climate mitigation.	EN1: CCUS technologies are an effective means of climate mitigation.	Saito et al. (2019)
	EN2: CCS will improve our energy efficiency, reduce energy consumption.	EN2: CCUS will improve our energy efficiency, reduce energy consumption.	
	EN3:CCS can reduce CO_2 emissions.	EN3:CCUS can reduce CO_2 emissions.	
	EN4:CCS technologies can benefit environmental protection.	EN4:CCUS technologies can benefit environmental protection.	
	EN5:I think "Not reducing CO_2 emissions means that we just shift the responsibility onto the next generation."	EN5:I think "Not reducing CO_2 emissions means that we just shift the responsibility onto the next generation."	

3.2.1.6 Public Cognition

Table 3.5 Items used to Measure Public Cognition

Constructs	Original Items	Revised Items	Items Sources
Public Cognition (PC)	PC1:I have heard about CCUS.	PC1:I have heard about CCUS.	Yang et al. (2016)

Table 3.5 (continued)

Constructs	Original Items	Revised Items	Items Sources
	PC2:I have an understanding of CO_2 capture processes.	PC2: I have some knowledge about the application of carbon dioxide capture technology in Guizhou.	
	PC3:I have an understanding of CO_2 transportation processes.	PC3: I have some knowledge about the carbon dioxide transportation process suitable for Guizhou.	
	PC4:I have an understanding of CO_2 utilization.	PC4: I have some knowledge about the utilization of carbon dioxide that is suitable for Guizhou.	
	PC5:I have an understanding of CO_2 storage.	PC5: I have some knowledge about carbon dioxide storage suitable for Guizhou.	

3.2.1.7 Trust

Table 3.6 Items used to Measure Trust

Constructs	Original Items	Revised Items	Items Sources
Trust (TR)	TR1:I believe that CCUS stakeholders can judge risks and forecast returns.	TR1:I believe that CCUS stakeholders can judge risks and forecast returns.	Xiao et al. (2026)
	TR2:I believe that the information about the risk and benefits provided by CCUS stakeholders is objective.	TR2:I believe that the information about the risk and benefits provided by CCUS stakeholders is objective.	

Table 3.6 (continued)

Constructs	Original Items	Revised Items	Items Sources
	TR3:I believe that CCUS stakeholders would inform the public of the risks and benefits in a timely manner.	TR3: I believe that the stakeholders of carbon capture, utilization and storage (CCUS) will promptly inform the public of Guizhou of the risks and benefits.	
	TR4:If there is an accident in CCUS project, I believe the project implementer has the ability to protect the interests of citizens.	TR4：If an accident occurs in a carbon capture, utilization and storage (CCUS) project, I believe that the project implementers have the ability to protect the interests of the public in Guizhou.	
	TR5:I believe that CCUS stakeholders are environmentalists.	TR5:I believe that CCUS stakeholders are environmentalists.	

3.2.1.8 Fairness

Table 3.7 Items used to Measure Fairness

Constructs	Original Items	Revised Items	Items Sources
Fairness (FA)	FR1:I believe that the decision-making process of CCUS projects is open and transparent.	FR1: I believe that the decision-making process for the carbon capture, utilization and storage (CCUS) project carried out in Guizhou is open and transparent.	Visschers & Siegrist (2012)

Table 3.7 (continued)

Constructs	Original Items	Revised Items	Items Sources
	FR2:The financial compensations (e.g., tax payments of the operators) counterbalance the disadvantages (e.g., accident risks and construction annoyance).	FR2: Economic compensation (such as taxes paid by operators) offsets the adverse factors that may be encountered during the implementation of CCUS projects (such as accident risks and construction disturbances).	
	FR3:Before the implementation of a CCUS project, there is sufficient publicity and notice.	FR3：Before implementing carbon capture, utilization and storage (CCUS) projects, Guizhou will provide adequate publicity and notification.	
	FR4:I have a say in the decision-making process of CCUS project.	FR4：The public in Guizhou will have a say in the decision-making process of local carbon capture, utilization and storage (CCUS) projects.	
	FR5:When I question the implementation results of a CCUS project, I can get a good response.	FA5: When I raised questions about the implementation results of a carbon capture, utilization and storage (CCUS) project to be carried out in Guizhou, I received a very good response.	

3.2.1.9 Legal Protection

Table 3.8 Items used to Measure Legal Protection

Constructs	Original Items	Revised Items	Items Sources
Legal protection (LP)	LP1:The legal system prevents us from suffering losses.	LP1: The legal system concerning CCUS protects the public in Guizhou from suffering losses.	Cai et al. (2010); Child & Möllering (2003)
	LP2:Existing environmental laws and regulations can restrain CCUS project from affecting the surrounding public.	LP2: The current environmental laws and regulations in place can restrict the impact of carbon capture, utilization and storage (CCUS) projects in Guizhou on the surrounding public.	
	LP3:The environmental impact assessment law stipulates that the public can participate in environmental impact assessment in an appropriate way.	LP3: According to the relevant provisions of the Environmental Impact Assessment Law, the public in Guizhou can participate in the environmental impact assessment of relevant CCUS projects through appropriate means.	
	LP4:I think the decision-making process of CCUS projects is in accordance with the law.	LP4: I believe that the decision-making process for carbon capture, utilization and storage (CCUS) projects in Guizhou will be carried out in accordance with the law.	

Table 3.8 (continued)

Constructs	Original Items	Revised Items	Items Sources
	LP5:The legal system prevents us from being cheated.	LP5: The current legal system regarding CCUS projects will protect the public in Guizhou from being deceived.	

3.2.1.10 Public Acceptance

Table 3.9 Items used to Measure Public Acceptance

Constructs	Original Items	Revised Items	Items Sources
Public Acceptance (PA)	PA1:I think CCUS is acceptable.	PA1: I think it is acceptable to carry out carbon capture, utilization and storage (CCUS) in Guizhou.	Arning et al., (2020); Yang et al. (2016)
	PA2:I support China's large-scale development of CCUS.	PA2: I support the large-scale development of carbon capture, utilization and storage technology in Guizhou.	
	PA3:I can accept CO_2 transportation pipelines through my residential area.	PA3:I can accept CO_2 transportation pipelines through my residential area.	
	PA4:Public finances should be used to support CCUS.	PA4:Public finances should be used to support CCUS.	
	PA5:I'm a proponent of CCUS-related public training.	PA5:I'm a proponent of CCUS-related public training.	

3.2.2 Data Collection Administration

3.2.2.1 Target Population

The subjects of this survey and research are the public mainly with a certain educational background in Guizhou Province, China. This is because carbon capture, utilization and storage (CCUS) is not well known in Guizhou Province. Therefore, before filling in the online questionnaire, it is necessary to have certain learning ability to master the relevant scientific knowledge of CCUS, which makes it easier for the public to know CCUS. If the interviewee doesn't understand CCUS, then his answer is unreliable.

3.2.2.2 Questionnaire Design

In this study, data are collected by questionnaire to verify the conceptual model proposed above. In order to make the subjects know about CCUS items, the author explains CCUS items at the beginning of the questionnaire and makes a simple classification, so that the subjects can understand what CCUS is. The first part of the formal questionnaire investigates the basic personal information of the respondents. The second part is a scale used to measure the public's acceptance of CCUS projects. See Appendix 1 for the questionnaire.

The scale part mainly measures the influencing factors of public acceptance of CCUS projects, as shown in Annex 1. The designed scale includes 8 variables and 40 questions. Each question was measured by Likert scale. Likert scale method was developed by Rensis Likert in 1970, which has a good effect on measuring the attitude of the subjects to something (Emerson, 2026). All measurement items in this study were assigned values using a 5-point Likert scale, corresponding to scores from 1 to 5. The scores were given based on the participants' options. A score of 5 indicates strong agreement, 4 indicates agreement, 3 indicates basic agreement, 2 indicates disagreement, and 1 indicates strong disagreement. According to the questions raised in each question, the respondents choose one of the five different levels of options that best meets their own cognition, so as to show their degree of recognition of this question. The design of this scale is based on mature related literature, and generally has good reliability and validity.

3.2.2.3 Sampling Method

Step 1: To determine the target population. In order to make the survey results more authentic, universal and reliable, the research object of this paper is mainly the Guizhou, China public with certain educational background, including staff of state organs

or institutions, employees of enterprises or companies, doctors or nurses, teachers, retirees and students, etc. These public can basically understand CCUS after reading the introduction of CCUS.

Step 2: Obtain samples by means of convenient sampling. In the aspect of data collection, the convenient sampling method is used to distribute questionnaires to the public in Guizhou Province, and then the questionnaires are collected. It is worth noting that the respondents are the second-selected public in the conceptual sense, that is, the public who can understand what CCUS is to ensure the reliability of the survey.

Convenient sampling samples are representative, and the sampling method is simple, economical, timely, accurate and flexible, which can well reflect the overall characteristics.

3.2.2.4 Sample Size

Referring to the relevant literature of convenient sampling, the sample size is usually greater than or equal to 5 to 10 times the number of items (Heller-Krippendorf, 2025). In this study, the number of items in the scale is 40, so the sample size is 400.

3.2.2.5 Data Collection Method

In order to ensure data quality, data collection is divided into online collection and offline collection. Online collection is mainly conducted in the form of questionnaires issued by questioners. In order to prevent some participants from not understanding the design problems very well, offline questionnaire collection was supplemented. Questionnaire Star is a platform focusing on the distribution, recycling and management of questionnaires. After entering the questionnaire, Questionnaires generated the questionnaire link and QR code. You can spread the links and QR codes corresponding to the questionnaire through online tools such as WeChat, Weibo and QQ. Many studies show that this method can save time and cost and ensure data quality (Dütschke et al., 2016).

The offline questionnaire collection mainly relies on researchers and recruited students. This is because the working environment of the author of this study is a university, and it is possible to gather a certain number of researchers and students, which is more convenient for communication and ensures the effectiveness and reliability of the answer as much as possible. For business personnel, doctors, civil servants and other types of respondents, they mainly answer through pure online questionnaires. In order to ensure

the answer effect, try to choose people with high education. The offline questionnaires are still distributed in the form of Wenjuanxing, but also accept oral explanations or on-site training. The recruited students need to receive training first, understand the overall structure of the questionnaire, fully comprehend the specific content and meaning of each questionnaire item, be aware of the data investigation methods and recording methods, and pay attention to ethical issues during the investigation. When distributing offline questionnaires, the investigators will also explain and clarify to the respondents.

Throughout the entire data collection process, the privacy and informed consent of the participants must be given top priority. During the investigation, the consent of the participants was first obtained, and support from relevant institutions was also secured, which enabled the questionnaire to be disseminated rapidly.

The questionnaire was distributed to different regions and types of respondents at one time. For the questions that the interviewees don't understand, the researchers and research assistants will explain the questions. The data collection time is mainly from December 2023 to January 2024.

3.2.3 Data Analysis

Before data analysis, it is necessary to process the collected data. The first is data screening, which excludes questionnaires with incomplete information, random information, irregular information and logical errors in information filling. Then, the data is encoded and saved. Through the examination and screening of questionnaires, the effective questionnaires are sorted out, and Excel tables are established. All data are entered into the tables, and the information is checked twice to ensure the accuracy of information preservation. Finally, using SPSS 27 software, the variables of explanatory variables, explained variables, intermediate variables and control variables are set, and then the survey data in the saved Excel table are imported.

3.2.3.1 Pilot and Modification

This study adopts a quantitative research method. The factors influencing public acceptance of CCUS are all measured through scales. The quality of the scales directly affects the research results. Validating the scales is an important prerequisite for ensuring the subsequent research. Therefore, it is necessary to conduct a pre-survey before the formal research to test the reliability and validity of the scales.

Following the completion of measurement indicator design for each latent variable, a 5-point Likert scale was employed to construct the questionnaire items corresponding to each indicator. The preliminary questionnaire assessing public acceptance of CCUS projects was composed of two sections: (1) demographic information of respondents, including gender, age, educational background, occupation, average monthly income, and awareness of carbon dioxide reduction methods; and (2) 40 Likert-scaled items grouped under 8 latent variables. To ensure the reliability and validity of the final research data, a pilot survey was conducted using the initial questionnaire prior to the formal data collection. The pilot survey was primarily administered online to faculty members and students at Liupanshui Normal University, resulting in the collection of 86 valid responses.

After the pre-survey, the author first optimized the issues such as the description of the questions and the sequence setting based on the feedback from some of the respondents. Subsequently, the author used SPSS 27.0 to conduct exploratory factor analysis and reliability tests on the pre-survey data to ensure the reliability and validity of the final survey questionnaire. The analysis results showed that 40 measurement items were extracted into 8 common factors, and the Cronbach's coefficient of reliability test for the 8 factors was all greater than 0.7, indicating that the questionnaire design had good reliability and validity (as shown in Table 3.10 and Table 3.11). Moreover, the factor loadings of each measurement index were all greater than 0.5. Based on the pilot study results and participant feedback, minor wording adjustments were made to three items (e.g., PC2, FR4) to improve clarity. The final questionnaire retained all 40 items.

Table 3.10 Pilot-test Reliability Statistics

Study variables	Number of items	Cronbach's α
Public Cognition	5	0.899
Fairness	5	0.851
Legal Protection	5	0.877
Environmentalism	5	0.858
Perceived benefits	5	0.860
Perceived risks	5	0.868
Trust	5	0.874
Public Acceptance	5	0.826

Table 3.11 Pilot-investigation KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.844
Bartlett's Test of Sphericity	Approx. Chi-Square	2310.355
	df	780
	Sig.	<.001

3.2.3.2 Descriptive Statistical Analysis

The effective questionnaire in the questionnaire survey, that is, the public in Guizhou Province, is divided into two parts: the analysis of demographic characteristics and the mastery of basic knowledge of carbon emission reduction, and the public's acceptance of CCUS projects in Guizhou.

(1) Demographic Characteristic

The basic personal information in the sample is statistically analyzed to understand the basic characteristics of the respondents. From the perspective of gender distribution, age distribution, education level, occupation distribution and average monthly income level, the demographic characteristics of the sample were preliminarily observed.

(2) Analyze the public acceptance of CCUS project

This study investigated the public's understanding of carbon emission reduction. Through the statistical analysis of CCUS and other carbon emission reduction technologies, the degree of public acceptance of CCUS projects is estimated and the influencing reasons are predicted.

3.2.3.3 Reliability Analysis and Validity Analysis

Reliability and validity are indispensable conditions for all measuring tools. The observed value of any measurement includes the actual value and the error value. The better the reliability, the lower the error value, so the observed value will be closer to the actual value and have higher stability.

The so-called validity includes two aspects: on the one hand, the measuring tools used are indeed measuring what researchers want to study, on the other hand, the measuring tools must accurately measure the concept of the required measurement (Shen, 2022). Reliability and validity are both indispensable for researchers to measure the concept. This study will use a variety of data analysis methods to measure the reliability and validity of the scale.

(1) Reliability Analysis

Reliability analysis generally includes internal reliability analysis and external reliability analysis (Xu et al., 2023). Internal reliability focuses on measuring whether the same characteristics are evaluated by the same group of projects and whether there is high internal consistency between projects. If the internal reliability is good, it means that the evaluation project is meaningful and the evaluation results are credible. External reliability means that when we measure the same object repeatedly in different time periods, if the measurement results are basically the same, then our task external reliability is good, and vice versa. Due to the limitation of time and cost, this study only makes internal consistency measurement. At present, Cronbach's value is widely used by most scholars to measure the internal reliability of the questionnaire. This study will also use SPSS tools to measure the internal consistency of the scale by Cronbach's value. Cronbach's reliability standard is shown in Table 3.12.

Table 3.12 Cronbach's (reliability criterial)

Cronbach's α	**Standard**
α<=0.3	Unreliable
0.3<α<=0.4	Grudgingly credible
0.4<α<=0.5	Slightly credible
0.5<α<=0.6	Credible
0.7<α<=0.9	Very Credible
0.9<α	Relly Credible

This study holds that only when Cronbach's is greater than 0.7 can the data reflected by the sample be credible, otherwise it is not credible, and the question should be deleted accordingly.

(2)Validity Analysis

There are three main methods commonly used to analyze the validity of questionnaires: content validity, criterion validity and structural validity. Exploratory factor analysis (EFA) is used to measure the structural validity of data. KMO value and Bartlett sphere test are often tested before factor analysis. According to KAISER's point of view, only when KMO value is greater than 0.5, Bartlett sphere test is significant, it is

suitable for factor analysis (Dütschke et al., 2016). In addition, the factor load determines whether the question will be deleted. The criteria are as follows:

(1) When a question is a factor of its own, it is deleted.

(2) When the factor load of a question is less than 0.45, delete it.

3.2.3.4 Confirmatory Factor Analysis

In order to confirm whether the scale contains the same factors as the original structure, confirmatory factor analysis is usually carried out. At this time, which factor each question belongs to has been determined. What we need to verify is whether the collected data is consistent with the pre-set factor structure model. This process of factor analysis is called confirmatory factor analysis.

According to the standard factor load, the Composite Reliability, CR) of variables can be calculated. This study takes the composite reliability as a reliability index of potential variables. The calculation formula is as follows: Formula 3-1, where c represents the combination reliability and λ represents the standard factor load. The value of c is between 0 and 1, and the closer it is to 1, the better the reliability is.

$$\rho_c = \frac{(\sum \lambda)^2}{(\sum \lambda)^2 + \sum (1-\lambda^2)} \quad (3\text{-}1)$$

Average Variance Extracted (AVE), another important index, can be calculated according to the standard factor load. AVE can directly show how much variance explained by variables comes from measurement error. The greater the AVE value, the greater the percentage of variance explained by variables and the smaller the relative measurement error. The calculation method of AVE value is shown in Formula 3-2.

$$\rho_v = \frac{\sum \lambda^2}{\sum \lambda^2 + \sum (1-\lambda^2)} \quad (3\text{-}2)$$

3.2.3.5 Difference Analysis

Difference analysis is to study the difference of variables in different dimensions, and the test methods include independent sample t test, chi-square test and one-way ANOVA. This study mainly studies whether gender, age, education, occupation, income status and understanding of carbon emission reduction technology will have significant differences on CCUS project acceptance.

Independent sample t-test was used to analyze the gender difference, age difference, educational background difference and income difference respectively. When sig<0.05, it showed that there were significant differences in control variables.

3.2.3.6 Structural Equation Model Analysis

(1) The concept of structural equation model

Structural Equation Modeling (SEM) is a multivariate analysis method that includes two types: directly observed variables and potential variables by establishing models and estimating parameters. Structural equation model is a statistical method that integrates variance analysis, factor analysis, path analysis and correlation analysis.

Structural equation model consists of measurement model and structural model. The measurement model is used to test the relationship between observation indexes and potential variables, and the structural model is used to test the relationship between potential variables. Compared with the traditional regression analysis method, the structural equation model can not only handle a variety of variables, but also clearly analyze the relationship between various indicators, so that practical problems can be analyzed and explained.

(2) Construction of public acceptance model for CCUS project

Based on the data obtained from the questionnaire survey, the structural equation model of public acceptance of CCUS project is constructed by using Amos 24 software. In this study, the influence of each factor is verified by fitting analysis and path analysis of the influencing factors in different dimensions. At the same time, the hypothesis put forward by the study is tested and the influence degree of each variable on acceptance is analyzed.

(3) Overall model fitting and path analysis

In order to judge whether the structural equation model is established, it needs to be measured by measuring the fitting index of the structural equation model. When the chi-square to degree of freedom ratio (c2/df) is less than 3, the approximate error square root index (RMSEA) is less than 0.08, and the goodness of fit index (GFI), goodness of fit index (AGFI), standard fitting index (NFI), non-standard fitting index (TLI) and comparative fitting index (CFI) are all greater than 0.9, the model has good adaptability.

Table 3.13 Fit Indices of Structural Equation Models

Fit index	Criteria	Source of theory
χ^2/df	<3	Hair et al. (2014)
Goodness of Fit Index (GFI)	>0.9	Hair et al. (2014)
Adjusted Goodness of Fit Index (AGFI)	>0.9	Arpaci & Baloglu (2016)
Root Mean Square Error of Approximation (RMSEA)	<0.08	Hair et al. (2014)
Normed Fit Index (NFI)	>0.9	Bentler & Bonett (1987)
PNFI	>0.9	Bentler & Bonett (1987)
Comparative Fit Index (CFI)	>0.9	Bentler & Bonett (1987)
NNFI(TLI)	>0.9	Bentler & Bonett (1987)

3.3 Ethical Considerations

As a form of social science research, ethical consideration involves human interviewees and must be treated with respect, fairness, integrity and charity. When potential research subjects are asked to participate in such research, researchers must realize that they seek permission to invade their privacy, so it is very important to obtain consent to participate. According to the Belmont Report, a report issued by the National Committee of the United States in 1978 on the protection of subjects in humanities and social studies, and the six ethical principles put forward by Hoyos(2000), this study considers the following ethical issues (Hoyos, 2000):

(1) The principle of respect

The principle of respect means respect for participants and respect for people. Participants have the right to decide for themselves whether to participate in the research. If the participants are underage children, they need to be approved by the children's main guardians. If the study is conducted in a school, the school’s approval can also be sought.

(2) The principle of good faith

Researchers should be honest, fully report the survey results, minimize or eliminate the bias in methods, disclose basic assumptions, and do not fabricate data, falsify results or omit relevant data.

(3) The principle of public welfare

The principle of public welfare means that researchers can't harm participants, and can't get research results at the expense of hurting participants' body and mind. Researchers should try their best to maximize the benefits and effects of research participants and ensure that the benefits outweigh the disadvantages.

(4) Principle of informed consent

The principle of knowing refers to the right of research participants to know the steps, purposes, risks and benefits of the research and the right of participants to withdraw from the research at any time. These contents must be communicated in a way that participants can understand.

(5) Principles of understanding

The principle of understanding means that participants should have the ability to make decisions and understand the content of the right to know and the risks in research. Children as participants need the consent of their guardians.

(6) The principle of voluntariness

The principle of voluntariness means that participants must be able to make decisions freely, and participants will not be guided by threats and mistakes, whether in research or not.

3.4 Conclusion

This chapter provides a comprehensive overview of the research methods adopted in this study, which is based on the positivist paradigm and conducted using quantitative methods. Firstly, the rationality of adopting positivism is justified. Then, the quantitative stage is further elaborated, during which 415 valid structured questionnaire data from the public were collected. The proposed model was empirically verified using SPSS 27 and Amos 24 tools, and the hypothesized relationships among the constructs were tested. The measurement tools were carefully adapted from existing valid scales, and the survey design included multiple sections to capture constructs such as public perception, perceived risk, perceived benefit, trust, fairness, environmentalism, legal protection, and public acceptance. The data analysis strategy included reliability and validity tests, descriptive statistics, confirmatory factor analysis, and structural equation modeling. Finally, ethical considerations guiding participant recruitment, informed consent, and data

processing are also discussed. In summary, the methodological components detailed in this chapter lay a rigorous foundation for the analysis and interpretation of research results in subsequent chapters.



CHAPTER 4
RESULTS

This study employs a quantitative research methodology, whereby all proposed hypotheses are rigorously examined through the developed research model and the collected empirical data. In this chapter, reliability and validity assessments will be conducted on both the gathered data and the constructed measurement scales, incorporating confirmatory factor analysis (CFA) and exploratory factor analysis (EFA). Upon establishing satisfactory levels of reliability and validity, descriptive statistical analysis, structural equation modeling (SEM), difference analysis, and mediation analysis will be performed to empirically test the formulated hypotheses.

4.1 Sample Data Collection and Processing

4.1.1 The Implementation Situation of the Questionnaire Survey

Following the completion of the pre-research phase and the preliminary validation and refinement of the results, the author proceeded to distribute the finalized questionnaires via the Wenjuanxing platform. The target participants of this survey were members of the general public in Guizhou Province. The data collection period spanned 10 days, during which a total of 500 completed questionnaires were collected.

4.1.2 Sample Data Cleaning

Upon completion of the survey, the author downloaded 500 sample datasets from the Wenjuanxing platform for further processing and analysis. Given that the Wenjuanxing platform requires all questions to be answered before submission, all 500 samples were complete and contained no missing values. Subsequently, the author performed a data cleaning process to remove non-applicable samples from the original dataset, thereby ensuring high data quality for subsequent empirical analysis.

Firstly, given the substantial number of questions in the survey, which typically required 2 to 5 minutes to complete, an initial screening was conducted to exclude responses with abnormally short completion times (less than 120 seconds). Based on the

response time statistics provided by Wenjuanxing, a total of 50 such rapid responses were identified and removed. Secondly, to further enhance data validity, an additional manual review was carried out on the remaining 450 questionnaires. Through this process, 35 questionnaires exhibiting homogeneous responses (i.e., consistently selecting the same rating option across all items, such as all 1s, 2s, 3s, 4s, or 5s) were excluded. As a result, the overall quality and reliability of the dataset were significantly improved. Following the data cleaning process, a final dataset of 415 valid responses was obtained from the original 500, yielding an effective response rate of 83.2%.

4.1.3 Descriptive Statistical Analysis of Sample Distribution

Among the 415 valid questionnaires, 172 respondents were male (41.45%) and 243 were female (58.55%). In terms of age distribution, 327 participants (78.80%) were aged between 18 and 30, 44 participants (10.60%) were aged between 31 and 40, 32 participants (7.71%) were aged between 41 and 50, and 12 participants (2.89%) were aged over 51. Regarding educational background, 26 respondents (6.27%) had a high school, technical secondary school, or lower level of education, 20 (4.82%) held a junior college diploma, 319 (76.87%) possessed a bachelor's degree, and 50 (12.05%) held a master’s degree or higher.

(1) In terms of gender distribution, the sample included 172 male respondents (41.45%) and 243 female respondents (58.55%), indicating a slightly higher proportion of female participants compared to male participants.

(2) Regarding age distribution, the majority of respondents fell within the 18–30 age range, accounting for 78.80%. This demographic is predominantly found in higher education institutions, where students and university faculty generally demonstrate a stronger capacity to understand and adapt to new concepts.

(3) With respect to educational background, the largest group comprised individuals with a bachelor’s degree (76.87%), followed by those with educational attainment below the bachelor’s level (11.09%). These figures suggest that individuals with higher education exhibit greater interest in the topic under study.

(4) Concerning occupational distribution, the sample was primarily composed of students (69.16%), followed by teachers (8.67%), staff members of government agencies and public institutions (7.23%), and employees working in enterprises or companies (6.99%).

(5) In terms of income distribution, the surveyed population was largely composed of low-income individuals. Specifically, 70.60% of respondents reported a monthly income below 3,000 yuan, while 19.76% earned between 3,000 and 8,000 yuan.

Table 4.1 Descriptive Statistical Analysis of Sample

Information and options		Frequency	Percent
Sex	Male	172	41.45%
	Female	243	58.55%
Age	18-30 years	327	78.80%
	31-40 years	44	10.60%
	41-50 years	32	7.71%
	51 years or above	12	2.89%
Education	High school education or below	26	6.27%
	Junior college student	20	4.82%
	Undergraduate student	319	76.87%
	Master's degree or above	50	12.05%
Occupation	Personnel of state organs and public institutions	30	7.23%
	Enterprise/company personnel	29	6.99%
	Doctor or nurse	4	0.96%
	Teacher	36	8.67%
	Student	287	69.16%
	Others	26	6.27%
Income	3000 yuan or below	293	70.60%
	3001-5000 yuan	32	7.71%
	5001-8000 yuan	50	12.05%
	8001-10000 yuan	24	5.78%
	10001 yuan or above	16	3.86%

4.2 Reliability and Validity Analysis of the Questionnaire

4.2.1 Reliability Analysis of Questionnaire Data

To assess the reliability of the research questionnaire, this study employed the "Reliability Analysis" function in SPSS Version 27 to evaluate the internal consistency of the questionnaire data through Cronbach's α coefficient (also known as Cronbach's alpha). According to Nunnally (1978), a Cronbach's α value above 0.7 indicates acceptable internal consistency (refer to Table 3.10). As shown in Table 4.2, the Cronbach's α reliability analysis revealed that the CCUS project public acceptance influencing factor model consists of 40 valid measurement items across 8 latent variables. The overall Cronbach's α coefficient was 0.857, which exceeds the threshold of 0.7 and reflects a high level of internal consistency. Furthermore, all eight dimensions yielded Cronbach's α values greater than 0.8, indicating strong measurement reliability for each latent variable and confirming the robust internal consistency of the data collected through the questionnaire.

Table 4.2 Reliability Test of the Questionnaire

Latent variable	Observation variable	Number of items	Cronbach's α
Public Cognition	PC1	5	0.886
	PC2		
	PC3		
	PC4		
	PC5		
Fairness	FR1	5	0.863
	FR2		
	FR3		
	FR4		
	FR5		
Legal Protection	LP1	5	0.880
	LP2		
	LP3		
	LP4		
	LP5		

Table 4.2 (continued)

Latent variable	Observation variable	Number of items	Cronbach's α
Environmentalism	EN1	5	0.850
	EN2		
	EN3		
	EN4		
	EN5		
Perceived benefits	PB1	5	0.859
	PB2		
	PB3		
	PB4		
	PB5		
Perceived risks	PR1	5	0.874
	PR2		
	PR3		
	PR4		
	PR5		
Trust	TR1	5	0.876
	TR2		
	TR3		
	TR4		
	TR5		
Public Acceptance	PA1	5	0.844
	PA2		
	PA3		
	PA4		
	PA5		
Total Scale		40	0.857

4.2.2 Validity Analysis of the Questionnaire

This study utilizes Exploratory Factor Analysis (EFA) to assess the construct validity of the survey questionnaire. EFA is a robust statistical method that enables the identification of the underlying structure among multiple observed variables by grouping highly correlated variables into a smaller set of core factors, thereby effectively reducing data dimensionality. Prior to conducting the factor analysis, Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy are employed to evaluate the suitability of the data for such analysis. It is widely accepted that a KMO value exceeding 0.7, in conjunction with a statistically significant result from Bartlett's test (based on a two-tailed significance criterion), indicates that the dataset is appropriate for factor extraction (Zhou et al., 2017).

Exploratory factor analysis was performed on the 40 measurement items of the survey questionnaire assessing factors influencing public acceptance of CCUS projects using SPSS Version 27. The results of the KMO and Bartlett's test of sphericity presented in Table 4.3 indicate a KMO value of 0.895 (exceeding the threshold of 0.7), with an approximate chi-square statistic of 8645.712, 780 degrees of freedom (df), and a significance level (Sig.) of 0.000, which is highly significant. These findings suggest that the assumption of variable independence is invalid, and the data collected through the questionnaire demonstrate sufficient inter-correlation, thereby supporting its appropriateness for factor analysis.

Table 4.3 KMO and Bartlett's Test of Sphericity for the Public Acceptance Questionnaire of CCUS Projects

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.895
Bartlett's Test of Sphericity	Approx. Chi-Square	8645.712
	df	780
	Sig.	0.000

Subsequently, the "Factor Analysis" module in SPSS Version 27 was employed to perform exploratory factor analysis on the collected data from the 40 questionnaire items. The analysis parameters were set as follows: the principal component method was used for factor extraction (retaining components with eigenvalues greater than 1), Varimax

rotation was applied, and the coefficient display format was configured to sort coefficients by magnitude while suppressing the display of small loadings (absolute values < 0.5). Following orthogonal rotation, the component matrix revealed that the 40 measurement indicators were grouped into 8 common factors with eigenvalues exceeding 1. These factors accounted for a cumulative variance of 66.61%, indicating that they collectively represent 66.61% of the information contained in the original 40 items. This demonstrates that the extracted 8 common factors effectively capture the underlying structure of the questionnaire data.

The rotated factor loadings and the corresponding explained variance are summarized in Table 4.4 and Table 4.5. Generally, when indicators measuring the same construct cluster together with high factor loadings (greater than 0.5) on their respective dimension and low cross-loadings (less than 0.5) on other dimensions, it suggests a clearer internal structure of the measurement data and higher overall construct validity. As shown in Table 4.4, the factor loadings of each measurement indicator associated with its latent variable all exceed 0.6 on the target dimension, and are substantially higher than their loadings on other latent dimensions (loadings below 0.5 are suppressed). This indicates that the measurement questionnaire assessing users' continuous usage intention demonstrates strong internal structural validity and meets the criteria for acceptable construct validity.

Table 4.4 Rotating Component Matrix of the Scale

Item	1	2	3	4	5	6	7	8
PR1	0.758							
PR2	0.784							
PR3	0.782							
PR4	0.784							
PR5	0.806							
LP1		0.812						
LP2		0.778						
LP3		0.744						
LP4		0.763						
LP5		0.801						
TR1			0.811					

Table 4.4 (continued)

Item	1	2	3	4	5	6	7	8
TR2			0.758					
TR3			0.73					
TR4			0.716					
TR5			0.755					
PC1				0.775				
PC2				0.782				
PC3				0.781				
PC4				0.719				
PC5				0.794				
FR1					0.737			
FR2					0.829			
FR3					0.763			
FR4					0.783			
FR5					0.752			
PB1						0.795		
PB2						0.788		
PB3						0.754		
PB4						0.789		
PB5						0.745		
EN1							0.792	
EN2							0.755	
EN3							0.774	
EN4							0.786	
EN5							0.775	
PA1								0.75
PA2								0.729
PA3								0.729
PA4								0.71
PA5								0.728

Extraction Method: Principal Component Analysis. Rotation Method: Varimax Rotation with Kaiser Normalization. a. The rotation matrix converged after 7 iterations.

Table 4.5 Summary of Total Variance Explained

	Initial eigenvalue			Extract the sum of squares of the loads.			Square sum of rotational load		
Ingredients	**Total**	**Percentage of variance**	**Accumulation%**	**Total**	**Percentage of variance**	**Accumulation%**	**Total**	**Percentage of variance**	**Accumulation%**
1	8.392	20.981	20.981	8.392	20.981	20.981	3.445	8.611	8.611
2	5.219	13.048	34.029	5.219	13.048	34.029	3.412	8.531	17.142
3	3.249	8.123	42.152	3.249	8.123	42.152	3.375	8.438	25.58
4	2.826	7.064	49.216	2.826	7.064	49.216	3.369	8.423	34.003
5	2.348	5.869	55.085	2.348	5.869	55.085	3.344	8.359	42.362
6	1.995	4.987	60.072	1.995	4.987	60.072	3.307	8.268	50.63
7	1.579	3.948	64.02	1.579	3.948	64.02	3.273	8.183	58.813
8	1.036	2.59	66.61	1.036	2.59	66.61	3.119	7.797	66.61
9	0.677	1.692	68.302						
10	0.639	1.598	69.899						
11	0.622	1.555	71.454						
12	0.602	1.505	72.959						
13	0.574	1.436	74.395						
14	0.544	1.36	75.755						
15	0.527	1.318	77.073						
16	0.515	1.288	78.361						
17	0.507	1.269	79.629						

Table 4.5 (continued)

	Initial eigenvalue			Extract the sum of squares of the loads.			Square sum of rotational load		
Ingredients	**Total**	**Percentage of variance**	**Accumulation%**	**Total**	**Percentage of variance**	**Accumulation%**	**Total**	**Percentage of variance**	**Accumulation%**
18	0.494	1.236	80.865						
19	0.462	1.156	82.021						
20	0.455	1.138	83.159						
21	0.451	1.127	84.286						
22	0.446	1.115	85.401						
23	0.427	1.069	86.469						
24	0.423	1.058	87.527						
25	0.416	1.039	88.567						
26	0.409	1.021	89.588						
27	0.391	0.978	90.567						
28	0.381	0.953	91.52						
29	0.358	0.896	92.416						
30	0.345	0.862	93.277						
31	0.331	0.828	94.106						
32	0.316	0.789	94.895						
33	0.309	0.772	95.668						
34	0.294	0.736	96.403						

Table 4.5 (continued)

	Initial eigenvalue			Extract the sum of squares of the loads.			Square sum of rotational load		
Ingredients	**Total**	**Percentage of variance**	**Accumulation%**	**Total**	**Percentage of variance**	**Accumulation%**	**Total**	**Percentage of variance**	**Accumulation%**
35	0.287	0.718	97.121						
36	0.278	0.695	97.816						
37	0.265	0.663	98.479						
38	0.233	0.584	99.062						
39	0.221	0.554	99.616						
40	0.154	0.384	100						

Extraction method: Principal Component Analysis (PCA)

4.2.3 Common Method Variance (CMV)

Based on the predetermined criteria, including the principle that initial eigenvalues (Kaiser's criterion) exceed 1 and the cumulative variance contribution rate surpasses 60%, a total of eight factors were extracted. According to the Harman single-factor test, which is grounded in factor analysis principles, if the variance explained by the first unrotated principal component does not exceed 40% of the total variance, it suggests that the data are not substantially influenced by common method bias. In this study, as presented in Table 4.5, the variance explained by the first principal component was 20.981%, which is significantly below the critical threshold of 40% (Podsakoff et al., 2024). Therefore, it can be reasonably concluded that the likelihood of common method bias in this research is minimal. The cumulative variance explanation rate reached 66.61%. As noted by Hair (2013, pp. 89–150) and other scholars, in the field of social sciences, a cumulative variance of over 60% for extracted common factors indicates that these factors are reliable (Manata & Boster, 2024).

4.3 Assessment of the Measurement Model's Reliability and Validity

4.3.1 Development of a Confirmatory Factor Analysis (CFA) Model

To further examine whether the factor loadings of each observed variable derived from the exploratory factor analysis are statistically significant within the structural equation model, and to assess the reliability and validity of the measurement model for latent variables, this study employed AMOS to perform confirmatory factor analysis (CFA) on the measurement model data. The CFA measurement model for the CCUS project public acceptance research model is presented in Figure 4.1.

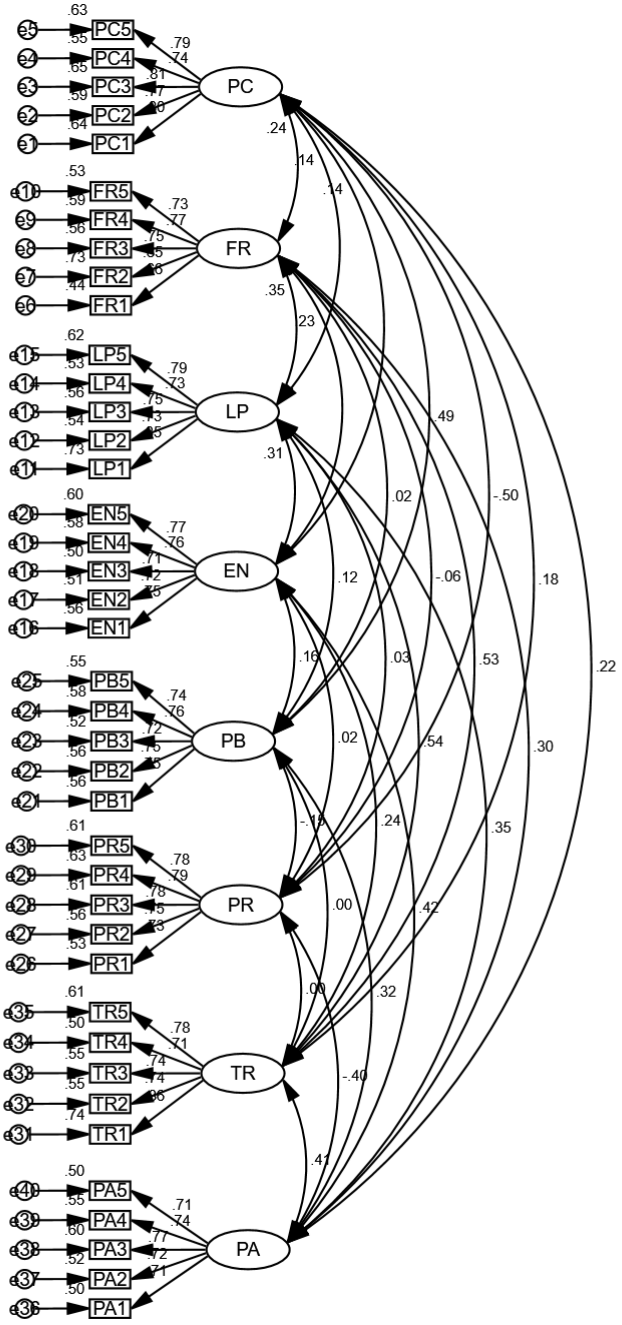


Figure 4.1 Confirmatory Factor Analysis (CFA) Results

4.3.2 Assessment of Reliability and Validity

Based on the output obtained from confirmatory factor analysis, the validity and reliability of the latent variables within the measurement model were evaluated. Validity refers to the extent to which the indicator variables accurately measure the intended latent constructs, and is categorized into convergent validity and discriminant validity.

Reliability, on the other hand, pertains to the internal consistency or measurement stability of the model.

The internal consistency of a measurement model is typically assessed using the composite reliability (CR) values of latent variables. This metric serves to evaluate the degree of consistency among the measurement indicators associated with each latent variable. A higher CR value indicates a stronger internal correlation among the measurement indicators corresponding to a given latent variable (Wu, 2013). When the path between a latent variable and its indicator variable is statistically significant ($p < 0.05$), the absolute value of the standardized path coefficient (i.e., standardized factor loading) exceeds 0.5, and the CR value surpasses 0.7, it suggests that the measurement model demonstrates satisfactory internal consistency.

Convergent validity (also referred to as aggregative validity) in a measurement model indicates that multiple measurement indicators designed to assess the same latent variable converge on the same underlying factor. When these indicators exhibit relatively high factor loadings on this common factor, they demonstrate stronger inter-correlations, greater homogeneity, and collectively reflect the latent construct with improved validity (Wu, 2013).

Discriminant validity (also known as discrete validity) in a measurement model refers to the low degree of correlation or the presence of significant distinctions between the latent variables representing the construct and other latent variables(Wu, 2013). To establish discriminant validity, the measurement model must first demonstrate acceptable composite reliability and convergent validity. Furthermore, the square root of the average variance extracted (AVE) for each latent variable should be greater than the absolute value of its correlation with any other latent variable. Meeting this criterion indicates that the latent variables exhibit strong discriminant validity.

Table 4.6 Criteria for Assessing the Validity and Reliability of the Measurement Model

Inspection category	**Reference standard**	**Source**
Reliability	1. Standardized factor loading > 0.5 (P < 0.05) 2. Composite reliability: CR > 0.7	Wu (2013)

Table 4.6 (continued)

Inspection category	Reference standard	Source
Convergent validity	1. Standardized factor loading > 0.5 (P < 0.05) 2. Composite reliability: CR > 0.7 3. Average variance extracted: AVE > 0.5	Fornell et al. (2023)
Discriminant validity	1. Standardized factor loading > 0.5 (P < 0.05) 2. Composite reliability: CR > 0.7 3. Average variance extracted: AVE > 0.5 4. Square root of AVE > absolute value of correlation coefficient between two latent variables	Wu (2013)

According to the measurement model reliability and validity test standards in Table 4.6 and the measurement results in Table 4.7, it indicates that the internal consistency and convergent validity of the measurement model in this study are acceptable

Table 4.7 Descriptive Statistics, Factor Loadings, Internal Consistency (Cronbach's α), Composite Reliability (CR), and Average Variance Extracted (AVE) of the Measurement Model

Items	M	SD	Factor loadings	α	AVE	CR
PC1	3.2699	1.10529	0.798	0.886	0.611	0.887
PC2	3.1976	1.04234	0.766			
PC3	3.1157	1.04309	0.808			
PC4	3.4	0.93199	0.743			
PC5	3.3157	0.95761	0.794			
FR1	3.641	0.7978	0.663	0.863	0.570	0.868
FR2	3.5349	0.87262	0.852			
FR3	3.5398	0.82692	0.748			
FR4	3.0434	1.08706	0.771			
FR5	3.2602	0.97294	0.729			

Table 4.7 (continued)

Items	M	SD	Factor loadings	α	AVE	CR
LP1	3.6892	0.90209	0.854	0.880	0.597	0.881
LP2	3.5735	0.77008	0.734			
LP3	3.7277	0.79587	0.75			
LP4	3.694	0.73579	0.729			
LP5	3.8819	0.8271	0.79			
EN1	3.8193	0.83615	0.748	0.850	0.549	0.859
EN2	3.8337	0.82463	0.716			
EN3	3.8241	0.82848	0.709			
EN4	3.9253	0.76878	0.759			
EN5	3.4096	1.15508	0.773			
PB1	3.7807	0.90496	0.746	0.859	0.554	0.861
PB2	3.5783	0.99419	0.751			
PB3	3.7614	0.92651	0.723			
PB4	3.9446	0.789	0.758			
PB5	3.6602	0.95944	0.742			
PR1	3.3663	0.93293	0.729	0.874	0.588	0.877
PR2	3.3663	1.19614	0.751			
PR3	3.0867	1.0551	0.781			
PR4	3.2602	1.08112	0.792			
PR5	3.0289	1.21946	0.778			
TR1	3.5831	0.86377	0.863	0.876	0.591	0.878
TR2	3.6554	0.77666	0.742			
TR3	3.6506	0.80208	0.742			
TR4	3.6313	0.84068	0.708			
TR5	3.6072	0.88871	0.78			

Table 4.7 (continued)

Items	M	SD	Factor loadings	α	AVE	CR
PA1	3.7952	0.74144	0.709	0.844	0.536	0.852
PA2	3.7422	0.75407	0.724			
PA3	3.294	1.05195	0.775			
PA4	3.5301	0.92126	0.742			
PA5	3.3807	1.08775	0.708			

Table 4.8 illustrates the discriminant validity of the measurement scale. The diagonal elements indicate the square roots of the average variance extracted (AVE) for each construct. The inter-construct correlation coefficients are all greater than 0.7 and surpass the correlations observed between each construct and other constructs, thereby demonstrating adequate discriminant validity (Hair et al., 2014). The results in Table 4.8 demonstrate good discriminant validity, as the square root of AVE for each construct(diagonal values) is greater than its correlations with other constructs.

Table 4.8 Result of Discriminate Validity Tests

	PC	FR	LP	EN	PB	PR	TR	PA
PC	**0.782**							
FR	0.241***	**0.755**						
LP	0.138*	0.350***	**0.773**					
EN	0.144*	0.234***	0.311***	**0.741**				
PB	0.489***	0.025	0.123*	0.162**	**0.744**			
PR	-0.501***	-0.057	0.029	0.023	-0.151**	**0.767**		
TR	0.176**	0.534***	0.539***	0.236***	0.003	-0.004	**0.769**	
PA	0.220***	0.297***	0.354***	0.419***	0.320***	-0.400***	0.410***	**0.732**

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.

4.4 Assessment of Demographic Factor Heterogeneity

Discriminant analysis serves as a statistical approach to investigate variability in research variables across multiple categorical dimensions. Standard methodologies employed for this purpose encompass the independent samples t-test, chi-square test, and one-way analysis of variance (ANOVA). This study aims to evaluate whether demographic characteristics—including gender, age, educational attainment, and income level—exhibit statistically significant effects on user willingness. Gender-based differences are assessed using the independent samples t-test, while ANOVA is applied to examine the influence of other demographic variables. One-way ANOVA is conducted to compute the associated P and F values, thereby determining the presence or absence of significant differences among demographic subgroups with respect to the dependent variable. If the significance of one-way ANOVA results is $P>0.05$, it means that there is no difference in the performance of different demographic factors in the research variables, and if $P<0.05$, it means that there are differences in the performance of different demographic factors in the research variables.

(1) Examining Gender-Based Variations in Public Acceptance of CCUS Projects

An independent samples T-test was carried out to investigate potential gender-related differences, and the findings are summarized in Table 4.9. With a significance level set at 0.05, the obtained p-value for the relationship between gender and public acceptance of CCUS initiatives was 0.731, which is greater than the threshold. This indicates that there is no statistically significant difference in public acceptance levels between genders, thereby leading to the conclusion that hypothesis H13a is not supported.

Table 4.9 Independent Samples T-Test Results for Gender-Based Differences in Public Acceptance of CCUS Projects

Variable	Gender	N	Mean value	Standard deviation	F	Sig.
PA	Male	172	3.710	0.710	0.118	0.731
	Female	243	3.434	0.714		

(2) Examining Age-Related Variations in Public Acceptance of CCUS Projects

Age-related differences were analyzed using one-way ANOVA. As presented in Table 4.10, the significance value is 0.133, exceeding the 0.05 threshold. This indicates that there is no statistically significant difference in public acceptance of CCUS projects among various age groups, thus H13b is not supported. Examination of the mean scores reveals that individuals aged 31 to 40 exhibit the highest level of acceptance, while those aged over 50 display comparatively lower acceptance. One plausible explanation for this pattern is that older individuals may be less receptive to novel ideas, encounter difficulties in understanding CO2 capture technology, and express heightened concerns regarding safety issues.

Table 4.10 One-way ANOVA Results Evaluating the Influence of Age on Public Acceptance Levels of CCUS Projects

Variable	Age	N	M	Standard deviation	F	Sig.
PA	18-30 years	327	3.554	0.706	1.875	0.133
	31-40 years	44	3.709	0.743		
	41-50 years	32	3.512	0.720		
	51 years or above	12	3.167	1.040		

(3) Educational attainment disparity

The association between educational attainment and public acceptance of CCUS projects was examined through one-way ANOVA. According to the results presented in Table 4.11, the significance value (Sig.) is less than 0.001, which falls below the 0.05 threshold. This indicates statistically significant differences in acceptance levels across varying educational backgrounds, thereby supporting H13c. Individuals with higher educational qualifications demonstrate greater acceptance of CCUS initiatives, whereas those with lower educational attainment exhibit relatively lower acceptance. Among them, the average acceptance score (M=4.056, SD=0.695) of the group with master's degree or above is significantly higher than that of all other educational groups. A plausible explanation for this trend is that individuals with higher education tend to possess greater

knowledge, enabling them to better understand and more readily accept novel concepts and technologies.

Table 4.11 Results of One-way ANOVA Test on the Relationship between Education Level and Public Acceptance of CCUS Projects

Variable	Education	N	M	Standard deviation	F	Sig.
PA	High school education or below	26	3.077	0.765	14.359	<0.001
	Junior college student	20	3.250	0.716		
	Undergraduate student	319	3.526	0.683		
	Master's degree or above	50	4.056	0.695		

(4) Income disparity

Income disparities in public acceptance of CCUS projects were examined through one-way ANOVA. As presented in Table 4.12, the significance value (Sig.) is less than 0.001, which is below the 0.05 threshold. This result indicates statistically significant differences in acceptance levels across different income groups, thereby supporting H13d. Among the groups, individuals with the highest income level demonstrate the strongest willingness to support CCUS initiatives, with an average score of 4.375. A plausible explanation for this pattern is that higher-income households tend to be more environmentally conscious. In contrast, individuals with medium and lower income levels exhibit relatively similar levels of willingness to use, with scores ranging between 3.4 and 3.9. Notably, the acceptance score for the low-income group is also 3.453, suggesting that they may place less emphasis on the technological sophistication of CCUS projects compared to other factors.

Table 4.12 Results of One-way ANOVA Test on the Relationship between Income and Public Acceptance of CCUS Projects

Variable	Average monthly income	N	M	Standard deviation	F	Sig.
PA	3000 yuan or below	293	3.453	0.683	9.545	<0.001
	3001-5000 yuan	32	3.456	0.771		
	5001-8000 yuan	50	3.744	0.752		
	8001-10000yuan	24	3.883	0.698		
	10000 yuan or above	16	4.375	0.588		

4.5 Structural Equation Modeling (SEM) Analysis

4.5.1 The Development and Specification of the Structural Equation Model (SEM)

The structural equation model (SEM) was constructed and analyzed using AMOS 26.0 software. Based on the theoretical framework established in the preceding section, four constructs—perceived benefits (PB), perceived risks (PR), trust (TR), and environmentalism (EN)—were identified as direct predictors of public acceptance (PA). Additionally, public cognition (PC) exerts an indirect influence on PA through its effects on PB and PR, while fairness (FR) and legal protection (LP) influence PA indirectly via their impact on TR. A schematic representation of the structural equation model is presented in Figure 4.2. In this diagram, error terms e1–e40 correspond to the observed variables, whereas e41–e44 represent the error terms associated with the endogenous latent variables.

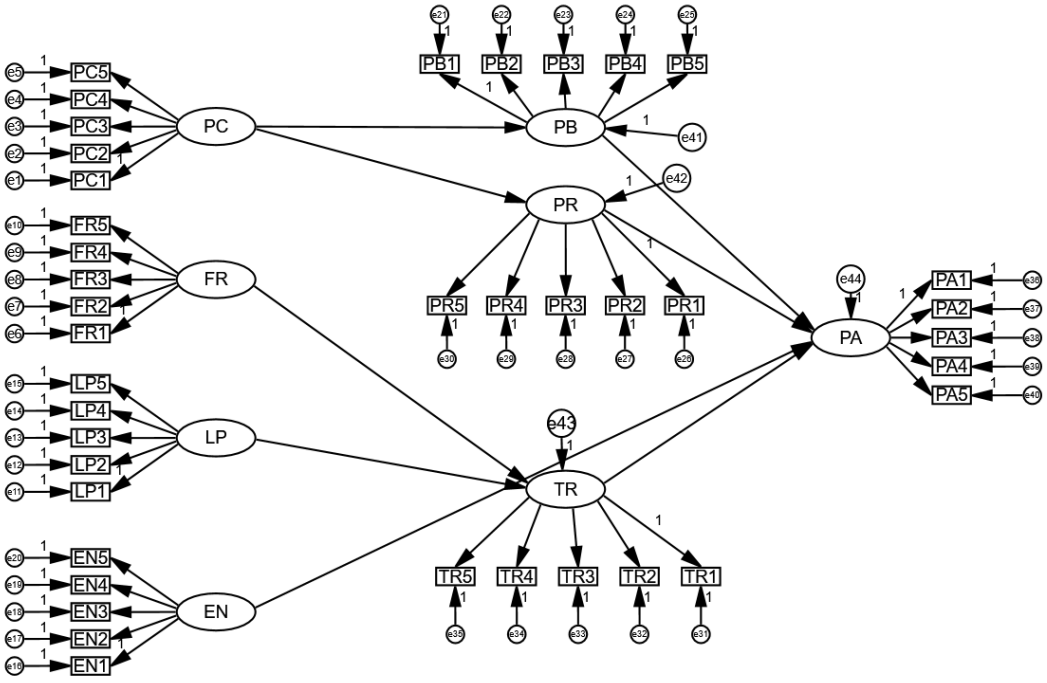


Figure 4.2 Structural Equation Model (SEM) of Public Acceptance Toward CCUS Projects

4.5.2 Goodness-of-Fit Assessment in Structural Equation Modeling (SEM)

Based on the developed structural equation model (SEM), observed variable data were input to perform model fitting and evaluate the model's goodness of fit. The results are presented in Table 4.13. The absolute fit indices indicate that the χ^2/df ratio is 1.177, which falls within the acceptable range of 1–3; the RMSEA value is 0.021, below the threshold of 0.08; and the GFI value is 0.911, exceeding the recommended cutoff of 0.9. All absolute fit indices meet the established fit criteria. For the incremental fit indices, the NFI, IFI, and CFI values are 0.905, 0.984, and 0.984, respectively, all above 0.9, indicating satisfactory model fit. Regarding the parsimony fit indices, the PNFI, PCFI, and PGFI values are 0.842, 0.916, and 0.807, respectively, all exceeding 0.5, which supports the model's parsimonious fit. Overall, all goodness-of-fit indicators meet the required standards, demonstrating that the model is well-supported by the data and exhibits a satisfactory level of fit, thereby enabling further analysis of the model results.

Table 4.13 Fit Test Results for the Structural Equation Model (SEM)

Test index	Absolute Fit Index					Incremental Fit Index			Minimalist Fit Index		
	χ^2	df	χ^2/df	RMSEA	GFI	NFI	IFI	CFI	PNFI	PCFI	PGFI
Standard			1~3	≦0.08	>0.9	>0.9	>0.9	>0.9	>0.5	>0.5	>0.5
Model fit values	854.307	726	1.177	0.021	0.911	0.905	0.984	0.984	0.842	0.916	0.807
Fit or not	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

4.5.3 Analysis of Structural Equation Modeling (SEM) Results

The model fitting results of the structural equation model (SEM) are presented in Figure 4.3.

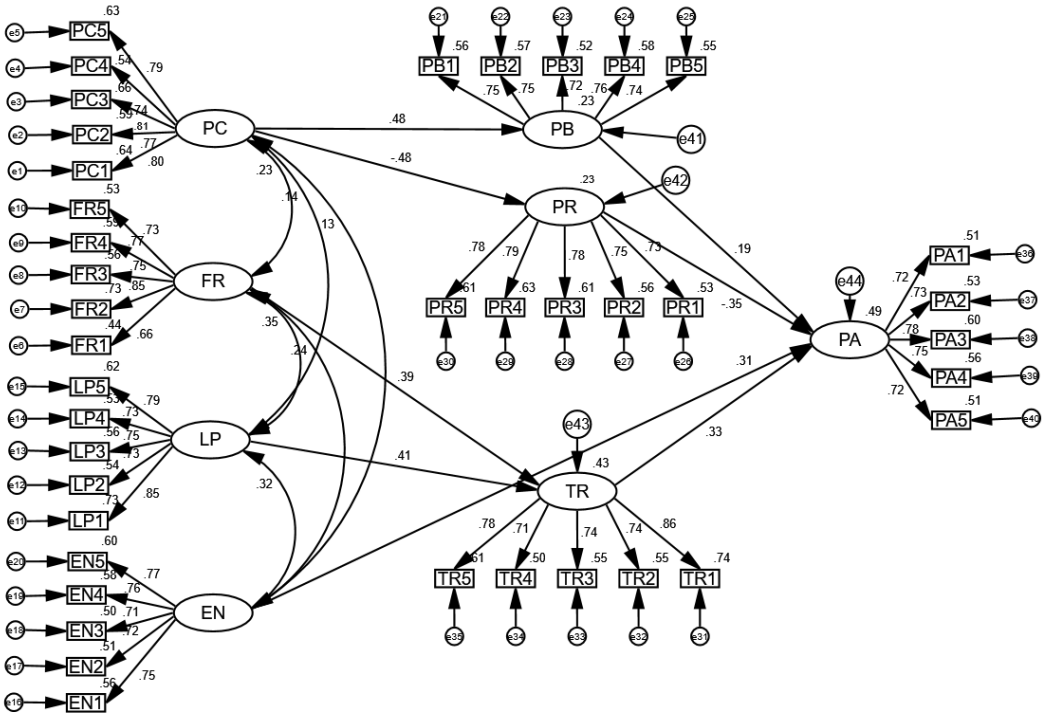


Figure 4.3 Fitting Results of Structural Equation Model

Table 4.14 Model Path Analysis Results

Hypothesis	Path	Non-standardized Path Coefficient	Standardized Path Coefficient(β)	S.E	C.R	P	Results
H2	PC→PB	0.365	0.475	0.044	8.233	***	Supported
H3	PC→PR	-0.372	-0.482	0.045	-8.336	***	Supported
H4	FR→TR	0.555	0.393	0.077	7.203	***	Supported
H5	LP→TR	0.392	0.406	0.049	7.974	***	Supported
H6	PB→PA	0.154	0.195	0.038	4.046	***	Supported
H7	PR→PA	-0.278	-0.353	0.041	-6.844	***	Supported
H8	TR→PA	0.235	0.327	0.036	6.614	***	Supported
H1	EN→PA	0.268	0.312	0.044	6.045	***	Supported

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 H2. PC significantly negatively affects PR(β=-0.482, C.R.=-8.336, P<0.001), which confirms the hypothesis H3.

FR significantly positively affects TR(β=0.393, C.R.=7.203, P<0.001), which confirms the hypothesis H4. LP has a significant positive effect on TR(β=0.406, C.R.=7.974, P<0.001), which confirms the hypothesis H5.

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 H1 was established.

4.6 Results of Mediation Analysis

This study hypothesizes that perceived benefits and perceived risks mediate the relationship between public cognition and the public acceptance of carbon capture, utilization, and storage (CCUS) projects. Furthermore, trust is proposed to mediate the effects of fairness and legal protection on CCUS public acceptance. In general, when an independent variable X influences a dependent variable Y through an intermediary variable M, M is referred to as a mediating variable. Within the theoretical framework of

this research, public cognition, fairness, and legal protection are defined as independent variables; perceived benefits, perceived risks, and trust serve as mediating variables; and the public acceptance of CCUS projects is the dependent variable.

The coefficient difference method, causal steps approach, coefficient product method, and Bootstrap method represent the four most commonly employed techniques for examining mediating effects in current research(Tian, 2021). The causal steps approach is associated with potential limitations that may compromise the accuracy of mediation testing, particularly in distinguishing between full and partial mediation. The coefficient difference method may produce misleading mediating effects that are not genuinely attributable to the mediator variable. The coefficient product method, exemplified by the Sobel test, assumes a relatively high degree of normality in the sample distribution. To address the shortcomings of these three traditional approaches, Preacher & Hayes (2008) introduced the Bootstrap method for assessing mediating effects. This method imposes fewer assumptions and constraints on the data, while also providing a confidence interval for improved estimation accuracy. The bias-corrected bootstrap confidence intervals (CI) were calculated from 5,000 resamples. An effect is significant if the CI does not include zero. Accordingly, this study employs the Bootstrap method to evaluate the mediating effect.

To examine the mediating effects of performance expectancy and effort expectancy within the model, the Bootstrap resampling procedure integrated with structural equation modeling was employed. A resampling size of 5,000 was specified. The Bootstrap method assesses the significance of the effects by computing the 95% confidence intervals for the indirect effect, total effect, and direct effect. If the 95% confidence interval for a given effect does not contain zero, the effect is considered statistically significant (Hayes, 2008). The corresponding statistical results are summarized in Table 4.15.

Table 4.15 Summary of Mediation Analysis for Each Mediating Path in the Model

Hypothesis	Mediated Influence Path	Intermediate coefficient	Standard error	95% Confidence Intervals		Results
				Lower	Upper	
The overall Mediated Influence of (PC→PA)		0.263	0.029	0.206	0.320	
H9	PC→PB→PA	0.093	0.023	0.048	0.141	Supported
H10	PC→PR→PA	0.170	0.024	0.126	0.220	Supported
H11	FR→TR→PA	0.125	0.028	0.076	0.186	Supported
H12	LP→TR→PA	0.109	0.030	0.057	0.175	Supported

The results in Table 4.15 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 H12 is established.

The research hypothesis test results of the model are shown in Table 4.16.

Table 4.16 Result of Testing the Structure Equation Model

Number	Hypothetical content	Results
H1	Environmentalism is positively affecting the public's acceptance of CCUS in Guizhou.	Supported
H2	Public cognition positively affects Guizhou public's perceived benefits in CCUS.	Supported

Table 4.16 (continued)

Number	Hypothetical content	Results
H3	Public cognition negatively affects Guizhou public's perceived risk of CCUS.	Supported
H4	Fairness positively affects trust in the government and enterprises carrying out CCUS projects in Guizhou.	Supported
H5	Legal protection positively affects trust in the government and enterprises carrying out CCUS projects in Guizhou.	Supported
H6	Perceived benefits positively affect the public acceptance of CCUS in Guizhou.	Supported
H7	Perceived risk negatively affects the public acceptance of CCUS in Guizhou.	Supported
H8	Trust positively affects the public acceptance that carry out CCUS projects in Guizhou.	Supported
H9	In the upcoming CCUS project, perceived benefits has an intermediary role between Guizhou public's cognition of CCUS and Guizhou public's acceptance of CCUS.	Supported
H10	Perceived risk plays an mediate role between public cognition of CCUS and public acceptance of CCUS.	Supported
H11	Trust mediates fairness of the government and CCUS project enterprises to the public in Guizhou and public acceptance of CCUS projects in Guizhou.	Supported
H12	Trust mediates legal protection for the local public in the implementation of CCUS project and public acceptance in Guizhou.	Supported
H13	Guizhou people with different gender, age, education level and income status have different acceptance of CCUS.	Supported
H13a	Guizhou people with different gender have different acceptance of CCUS.	Rejected
H13b	Guizhou people with different age have different acceptance of CCUS.	Rejected

Table 4.16 (continued)

Number	Hypothetical content	Results
H13c	Guizhou people with different education level have different acceptance of CCUS.	Supported
H13d	Guizhou people with income status have different acceptance of CCUS.	Supported

Based on Table 4.16 and in combination with previous studies, the following conclusions are drawn:

(1) Trust has a significant positive impact on public acceptance of CCUS project, and H8 are established. The research in this paper confirms the research results of Peta Ashworth et al. (2012) and Midden et al. (2009). This conclusion shows that the more the public trusts the national policy, the government's executive power and the CCUS project enterprise brand, the higher the public's acceptance and support for CCUS project implementation. Therefore, in order to improve the public's acceptance of CCUS project, it is necessary to improve the existing national laws and policies, the transparency of government bidding, and the fairness of welfare distribution, reduce the public's strangeness to CCUS project, make the implementation of CCUS project smoother, and let the public get more benefits and employment opportunities during the development of CCUS project.

(2) Environmentalism has a significant impact on the public acceptance of CCUS project, and H1 is established. The results are consistent with those of (Hurlimann et al., 2008). The public’s awareness of environmental protection is the basis for the public to support CCUS project from the heart. There is a trade-off between environmentalism and neighborhood effect. If people have a strong sense of environmental protection, they will strongly support the implementation of CCUS project with emission reduction effect. If people have a weak sense of environmental protection, they have no sense of responsibility for the whole earth's ecological environment and only pay attention to the environmental interests at home, they will try their best to prevent the construction of CCUS project near residential areas. Therefore, the public awareness of environmental protection affects the public acceptance of CCUS project.

(3) Public cognition positively affects perceived interests, and then positively affects public acceptance; Public cognition negatively affects perceived risk, and then negatively affects public acceptance. H2, H6, H3 and H7 hold. The public's acceptance of CCUS project is the result of comprehensive consideration of perceived benefits and perceived risks, and the perception of benefits and risk is determined by cognition. Contrary to the findings of Liu et al. (2021) who reported a stronger effect of perceived benefits in a national Chinese sample, our results indicate that perceived risk exerts a more dominant influence on acceptance in the context of Guizhou. This may be attributed to the lower baseline familiarity with CCUS among our sample (mostly students) and the specific ecological concerns (e.g., karst geology) unique to Guizhou, making risk a more salient factor.

(4) Perceived interests play an intermediary role between public cognition and public acceptance. Perceived risk plays an intermediary role between public cognition and public acceptance. Trust plays an intermediary role between fairness and public acceptance. Trust plays an intermediary role between legal protection and public acceptance. H9, H10, H11 and H12 hold. Public cognition can affect the public acceptance of CCUS projects through perceived risks and perceived benefits, and the research results are consistent with those of previous scholars. Liu B. S. developed a behavior model based on ABC (Affect, Behavior and Cognition) attitude theory to predict the public's acceptance of CCUS, and obtained similar results (Liu B. S. et al., 2021).

(5) There is a significant difference in the public acceptance of CCUS project between the two individual characteristics of education and income. H13c and H13d are established. The public with bachelor's degree and master's degree or above has a higher acceptance of CCUS project. However, the public with low academic qualifications has low acceptance. The reason for this result may be that people with low academic qualifications have a weak understanding of new things and are prone to reject them. The higher the income, the higher the acceptance of CCUS project, which may be related to their higher cognitive level and their stronger desire to support a better ecological environment.

(6) There is no significant difference in public acceptance of CCUS project between gender and age. H13a and H13b are not valid. The reason for this result may be that with the improvement of education level, the proportion of women in the highly

educated population is close to that of men, even higher, so the difference in acceptance is not obvious. Although there is no obvious difference in the public acceptance of CCUS projects, the acceptance of different age groups is not only the same. For example, the public aged 31-40 have the strongest acceptance of CCUS projects.

4.7 Conclusion

This chapter primarily utilizes confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) to assess the reliability and validity of the measurement model, and applies structural equation modeling (SEM) to validate the research hypotheses. Initially, a pilot survey was conducted, the results of which demonstrated that the questionnaire exhibited strong reliability and validity. Following this, a formal survey was administered to collect data, upon which subsequent reliability and validity analyses were performed. The analytical outcomes confirmed that the data met the required psychometric standards, and the model fit indices achieved acceptable levels as per established benchmarks. Thereafter, demographic analysis, variance analysis, structural equation modeling, and mediation effect testing were carried out using the finalized questionnaire dataset.

This chapter employs structural equation modeling (SEM) to validate the proposed research hypotheses. Out of the 13 hypotheses, two were not supported by the data, while the remaining 11 were confirmed. Specifically, gender (H13a) and age (H13b) do not exhibit statistically significant effects on public acceptance of the CCUS project in Guizhou. In contrast, education level (H13c) and income level (H13d) demonstrate significant associations with public acceptance. Perceived benefits, perceived risks, trust, and environmentalism show significant direct effects on public acceptance of CCUS in Guizhou, supporting Hypotheses H6, H7, H8, and H1, respectively. Public awareness significantly influences both perceived benefits and perceived risks, confirming Hypotheses H2 and H3. Furthermore, fairness and legal protection are found to significantly affect trust, validating Hypotheses H3 and H4. Finally, perceived benefits, perceived risks, and trust exhibit mediating roles within the model, thereby supporting Hypotheses H9, H10, H11, and H12.

CHAPTER 5
DISCUSSION AND CONCLUSION

This chapter conducts a comprehensive analysis of the research findings, correlating them with existing literature and theoretical frameworks. It systematically explores the consistency or divergence of these results with previous studies, and deeply analyzes the factors influencing public acceptance of CCUS projects in Guizhou. Through comparative analysis with recent research, the discussion is grounded in the contemporary academic discourse system. After the discussion, this chapter summarizes the theoretical contributions and practical significance of the research, elaborating on the broader implications of public acceptance in the advancement of CCUS projects. It acknowledges the limitations of the study and proposes suggestions for future research. The chapter concludes by summarizing the key insights obtained from the research, emphasizing the importance of understanding social responses in the implementation of CCUS projects and the role of public acceptance in the advancement of CCUS projects.

5.1 Discussion

RO1: To analyze the key factors influencing the public acceptance of carbon capture, utilization and storage (CCUS) projects in Guizhou Province, China.

To analyze the factors influencing public acceptance of carbon capture, utilization and storage (CCUS) projects, this study, based on relevant literature in the CCUS field and with the aid of Citespace literature analysis software, identified latent variables such as public cognition, perceived benefits, perceived risk, fairness, legal protection, trust, environmentalism, and public acceptance, and initially constructed a framework for public acceptance of CCUS projects. The research results show that the public acceptance of CCUS projects is influenced by the combined effects of the knowledge level, emotional level, and institutional level.

The first core dimension - the knowledge level - serves as the foundation for public acceptance of CCUS projects. Factors such as awareness of CCUS-related technologies and the public's educational background have been found to significantly influence the

public’s inclination to support CCUS projects. Due to the specialized nature of CCUS projects, without a reserve of relevant knowledge, it is impossible to understand the essence and benefits of CCUS projects. These insights are consistent with previous research and further indicate that media promotion is an important way to popularize public cognition of CCUS (Jiang et al., 2022). Additionally, although perceived benefits and perceived risk are considered as emotional factors, they often depend on the level of understanding of CCUS, especially in regions where CCUS projects have not been implemented on a large scale. This suggests that the public's perception of CCUS projects is closely related to their level of knowledge (Liu B. S. et al., 2021).

The second core dimension - the emotional level - serves as a catalyst for public acceptance of CCUS projects. Public acceptance of CCUS projects is often influenced by environmental sentiments. Public support for CCUS projects often stems from concerns about climate change and environmental pollution, as well as recognition of the carbon reduction value of CCUS. It is worth noting that the establishment of environmental awareness is not only the result of knowledge about CCUS projects but also a positive emotion of “contributing to public welfare” that arises from the desire to protect the public ecological environment and benefit the survival and development of future generations (Nielsen et al., 2022). Additionally, the public's recognition of the innovative value of CCUS as a low-carbon technology aligns with their own values of “green and environmental protection” and “sustainable development”, generating an emotional resonance of “ideological alignment” (Fikru & Nguyen, 2024). These patterns highlight the significant impact of environmentalism on public acceptance of CCUS projects and support previous research on environmentalism as a latent variable in public acceptance (Yang et al., 2016).

The third core dimension - the institutional level - is the guarantee for public acceptance of CCUS projects. On the basis of public cognition and emotional factors, the improvement of CCUS-related institutions remains a significant challenge. The public expresses concerns about the transparency of the system, the intensity of supervision, and the systematic nature of the regulatory framework. These institutional loopholes often affect the public’s acceptance of CCUS projects. These findings indicate that institutional power - not just cognition and emotion - constitutes the guarantee for the public’s ultimate acceptance of CCUS projects (Fikru & Nguyen, 2024).

In conclusion, through the literature review, it is found that the public acceptance of CCUS projects stems from the multi-dimensional interaction among the public's knowledge level, emotional level, and the institutional level of society. This not only provides a context for established concepts such as perceived benefits, perceived risks, and fairness, but also reveals overlooked factors such as legal protection and environmentalism. Therefore, this qualitative model enriches the existing public acceptance model of CCUS projects by embedding it in the specific institutional and regional context of Guizhou Province, China.

When achieving the second, third and fourth research objectives, this study adopted the Structural Equation Model (SEM) approach to examine the causal relationships between key antecedents - public awareness, perceived risk, perceived benefit, legal protection, fairness, trust, and environmentalism - and their influence on public acceptance of CCUS projects in Guizhou. These constructs were based on the ABC (affect, behavior, and cognition) attitude theory, the Social License to Operate (SLO) theory, and the institutional trust theory, and were specified to capture the public's perception of CCUS projects and the broader contextual determinants (Hemmert et al., 2016; Liu, B. S. et al., 2021; Yang et al., 2016).

RO2: To identify the influence paths of public cognition affecting perceived benefits and perceived risk for public to accept CCUS projects in Guizhou Province, China.

Public perception has become a key factor in perceiving benefits and risk. The public who believe that CCUS can bring more job opportunities, compensation funds and improvement of the surrounding environment show a stronger and positive acceptance. While those who think that CCUS will cause hazards such as CO2 transportation or storage leakage and "rebound" of carbon emissions from CO2 utilization show a stronger and negative acceptance. This further confirms the basic view of the ABC (affect, behavior and cognition) attitude theory that the public forms emotional preferences for CCUS based on existing cognition, which in turn affects acceptance behavior (de Salvi, 2008). In the context of carbon neutrality in Guizhou Province, China, it is crucial to popularize the public's correct understanding of CCUS. If the public can truly perceive the benefits of CCUS and understand how to avoid its risks, it will become a powerful driving force for the implementation of CCUS projects.

RO3: To identify the influence paths of legal protection and fairness affecting trust for public to accept CCUS projects in Guizhou Province, China.

Fairness and legal protection can significantly and positively influence the public's acceptance of CCUS projects, and trust plays a significant mediating role in this process. The public forms their level of trust in the government, enterprises, and technical systems based on their judgment of the fairness of project decision-making, the fairness of risk and benefit distribution, and the degree of legal supervision and rights protection. The higher the level of trust, the stronger the public's willingness to support the project, ultimately resulting in a higher level of public acceptance. Therefore, to enhance the public's acceptance of CCUS projects, it is not only necessary to strengthen technical safety and environmental management, but also to start from procedural fairness, distributive fairness, interactional fairness, and to improve legal supervision, clarify responsibilities and compensation mechanisms, and build a stable trust mechanism to achieve an increase in the social acceptability of the project (Dörpmund et al., 2025; Reiner et al., 2006).

RO4: To assess the impact of environmentalism on public acceptance of CCUS projects in Guizhou, China.

Environmentalism mainly drives public acceptance of CCUS in a positive way, but there are conditional differences. People with strong environmental values and those concerned about climate change are more likely to recognize the value of CCUS in reducing emissions, and they have a higher acceptance rate and willingness to pay (Dörpmund et al., 2025; Schomakers et al., 2025). This is in line with the background of carbon neutrality. Against the backdrop of China's "3060" climate goals, experts and scholars with environmental identities, environmental protection departments, and news media are all calling on the public to accept CCUS as an important emission reduction project.

5.2 Implication to Theories

This section explores the theoretical significance of the research findings for the existing acceptance framework. By integrating insights from the ABC (Affect, Behavior and Cognition) Attitude Theory, Social License to Operate (SLO), Institutional Trust Theory, and Stakeholder Theory, this study expands the existing conceptual model by

incorporating specific contextual factors related to public acceptance of the CCUS project in Guizhou, China.

5.2.1 Implication to ABC (Affect, Behavior and Cognition) Attitude Theory

This study takes the CCUS project in Guizhou, China as an empirical scenario to systematically explore the formation mechanism and influence path of public acceptance, providing original empirical evidence from a developing region and an ecologically sensitive area in China for the ABC attitude theory, effectively enriching the application scope and theoretical connotation of this model in the field of low-carbon technologies. Through the integrated analysis of public cognition, emotion and behavioral tendencies, this study clearly demonstrates the intrinsic connection of the ABC tripartite structure in the process of CCUS technology acceptance, filling the empirical gap in non-Western countries and special geographical contexts in existing research, and promoting a closer integration of attitude theory and low-carbon governance practice (Breckler, 1984).

This study, by identifying and testing the key influencing factors of public acceptance of CCUS, further elaborates on the interaction mechanism between the cognitive and emotional dimensions in the ABC attitude theory, and clarifies their core role in driving public behavioral intentions. The research finds that the public's knowledge level, value understanding, and risk assessment of CCUS projects collectively form the cognitive basis and directly influence their positive or negative emotional responses, while the emotional state further shapes the final acceptance behavior. This process fully embodies the core logic of the ABC attitude theory of "cognition-affect-behavior", and also provides a more targeted theoretical perspective for understanding the formation of regional public attitudes (de Salvi, 2008).

The empirical results of this study strongly support the core proposition of the ABC attitude theory, which posits that individual behavioral tendencies are mainly driven by both cognition and emotion (de Salvi, 2008). The data show that public cognition has a significant impact on both perceived benefits and perceived risk, and indirectly affects acceptance through this path, fully demonstrating the fundamental role of cognition in attitude formation. At the same time, the more complete and systematic the public's cognition is, the stronger their perception of benefits and the weaker their perception of risks regarding the project, and their willingness to accept it also increases accordingly. This conclusion not only validates the theory's effectiveness but also reinforces the crucial

significance of the cognitive element in the research on the acceptance of energy technologies.

This study further confirms that perceived benefits and perceived risk play a significant mediating role between public cognition and acceptance, a finding that is highly consistent with the latest research both domestically and internationally (Liu B. S. et al., 2021). The results show that public cognition positively influences perceived benefits and negatively affects perceived risk, while perceived benefits positively promote acceptance and perceived risk negatively inhibit acceptance, forming a stable mediating transmission chain. This conclusion not only refines the internal action path of the ABC attitude theory but also enhances the theory's explanatory and predictive power in the CCUS field, providing a clearer framework for the operational application of the attitude theory.

Based on the core structure of the ABC attitude theory, this study has theoretically simplified and logically optimized the traditional research framework, significantly enhancing the model's rigor and applicability. Previous studies often incorporated variables such as trust and fairness as moderating variables into the ABC attitude theory, which easily led to construct overlap and blurred theoretical boundaries. This study has separated such variables from the attitude model and independently analyzed them within the institutional trust theory, making the relationship among cognition, emotion, and behavior more pure and clear, and also making the overall theoretical framework more academic and efficient in explanation (Huber et al., 2022).

This study tested the ABC attitude theory in the specific context of the CCUS project in Guizhou, expanding the model's applicable boundaries in the ecological barrier area of Southwest China and regions undergoing energy transition, and achieving the localization of the theory. The research indicates that regional ecological culture, development demands, and public psychological characteristics can influence the intensity of cognition and emotion, thereby altering the speed and direction of attitude formation. This implies that the ABC attitude theory is not universally constant but requires adaptive adjustments based on regional contexts, providing important contextualized insights for subsequent research on public acceptance of low-carbon technologies (Zhang et al., 2022).

Overall, this study, through empirical analysis of the CCUS project in Guizhou, not only verified the core validity of the ABC attitude theory but also made theoretical contributions in terms of the intermediary mechanism, framework optimization, and

localized application. The research clarified the fundamental role of cognition, the driving role of emotion, and the mediating function of perceived benefits and risks. At the same time, by simplifying the structure, it enhanced the scientificity and practicality of the model. The conclusion not only responded to the core propositions of classic attitude theories but also provided a practical theoretical basis for the promotion of CCUS technology, public communication, and policy-making in China (Dütschke et al., 2023).

5.2.2 Implications to Social License to Operate (SLO)

This study takes the CCUS project in Guizhou, China as an empirical scenario to systematically reveal the key influencing factors of public acceptance, providing important empirical evidence for the localization and contextualization of the Social License to Operate (SLO) theory. The existing SLO theory is mostly derived from the practice of resource development and energy projects in the West, and the discussion on the social adaptability of low-carbon technologies in developing countries is still limited (Gehman et al., 2017; Prno, J. & Slocombe, D. S., 2012). Through empirical testing of the intrinsic connection between fairness, trust, legal protection and public acceptance, this study effectively supplements the formation mechanism of social license in the CCUS field, promotes the extension of the SLO theory from traditional industries to new low-carbon technology scenarios, and also provides a new theoretical perspective for understanding the construction of social recognition of major environmental projects in the Chinese context.

The core logic of the social license theory indicates that fairness is a fundamental variable influencing public acceptance and social legitimacy, and it can affect the final level of approval through the mediating role of trust (Garcia et al., 2019). The findings of this study are highly consistent with this classic theoretical judgment. Empirical data from the CCUS project in Guizhou show that the higher the perceived fairness by the public, the more significant their trust level and acceptance willingness towards the project. The dimensions of fairness, including participation opportunities, information disclosure, and decision transparency, can effectively reduce public risk perception and enhance the social recognition foundation of the project. This conclusion not only validates the applicability of the SLO theory in the CCUS field but also confirms the stability and cross-scenario consistency of fairness as a prerequisite for social license.

This study further echoes the recent cutting-edge findings on the social license of NIMBY facilities and low-carbon technologies, and provides a theoretical mutual validation with the perspective of Feng et al. (2024). It emphasized that procedural justice plays an irreplaceable role in the construction of social license for NIMBY infrastructure, especially in environmental projects with high risk perception, where a fair decision-making process can significantly alleviate social resistance. The CCUS project in Guizhou Province has typical NIMBY characteristics and ecological sensitivity. Public concerns over risks directly affect acceptance attitudes, and the lack of fairness can quickly lead to a loss of trust. This study, supported by data from Guizhou Province, China, validates the above judgment, demonstrating that fairness is a core component for obtaining and maintaining social license to operate (SLO), with cross-cultural and cross-regional explanatory power.

Based on the verification of the classic social license theory, this study has achieved the expansion and deepening of the SLO theoretical framework. Existing SLO research mostly focuses on the chain relationship among fairness, trust and acceptance, but pays less attention to the independent role of legal protection and institutional soundness (Moffat et al., 2016). This study finds that, in addition to fairness, legal protection, policy normativity and regulatory reliability have significant positive impacts on public trust, and this effect is particularly prominent in CCUS projects. This implies that the construction of social license not only depends on procedural fairness, but also on a stable, predictable and trustworthy institutional environment, thus breaking through the traditional SLO theory's explanation boundary of trust sources and enhancing the theory's explanatory power in the context of low-carbon technologies.

This study enriches the antecedent structure of the social license to operate (SLO) theory from an institutional perspective, revealing that legal protection and policy completeness are unique driving factors for the formation of SLO in the Chinese context. In the context of mature Western markets, social license is more dependent on corporate behavior and community interaction. However, this study shows that in the institutional environment of Guizhou and even China, the public has a higher reliance on government regulation, legal protection, and policy transparency (Zhang et al., 2018). When the public perceives that CCUS projects have a solid legal basis, clear responsibility definition, and reliable regulatory mechanisms, their level of trust will significantly increase. This finding

indicates that when applying the SLO theory in China, the dimension of institutional trust must be incorporated to achieve a localized revision of the theory.

Public trust plays a key mediating role between fairness, legal protection and the acceptance of CCUS, further consolidating the core mechanism of the social license theory. This study confirms that trust is not merely an attitude variable, but a core bridge connecting the institutional environment and public behavior, which is highly consistent with the "credibility-legitimacy-acceptance" path emphasized by the SLO theory (Demuijnck & Fasterling, 2016). The case of Guizhou shows that fairness and legal guarantees improve public acceptance by enhancing the level of trust, fully presenting the internal transmission chain of social license. This result strengthens the mechanism explanatory power of the SLO theory and also provides a clear path for CCUS projects to enhance social recognition: build trust through fair procedures and institutional guarantees, and obtain stable social license through trust.

In conclusion, this study, based on the empirical findings of the CCUS project in Guizhou, not only validates the core propositions of the social license theory but also expands the theory from dimensions such as justice, legal protection, and institutional trust. The research confirms that the SLO theory can effectively explain the public acceptance behavior of low-carbon technology projects in China, but it needs to be contextually modified in combination with the institutional environment. For the future social license governance of CCUS projects, it is necessary to strengthen procedural justice, improve legal protection, and enhance regulatory transparency, thereby building sustainable social recognition. This study not only contributes new evidence from a developing country to the social license theory but also provides practical social governance ideas for the large-scale promotion of CCUS in China, which has significant theoretical and application value.

5.2.3 Implications to Institutional Trust Theory

The empirical research on public acceptance of the CCUS project in Guizhou Province, with the core hypothesis that "legal protection and fairness influence trust, and trust affects public acceptance", provides localized evidence from the Chinese low-carbon technology scenario for the theory of institutional trust. In the ecologically fragile and energy structure transformation pressure significant southwest region, the public's acceptance of emerging low-carbon technologies does not solely rely on technological

advantages, but is premised on institutional guarantees. This finding supplements the generation logic of institutional trust in the governance of emerging technologies, breaks through the limitation of traditional research that mostly focuses on mature institutional environments in Europe and America, and reveals the pre-value of legal protection and procedural fairness in the construction of trust, providing solid regional experience for the contextual expansion of the theory of institutional trust (Batel et al., 2013).

Legal protection and fairness as antecedent variables of institutional trust have been robustly verified in the CCUS scenario in Guizhou, promoting the refinement of the antecedent structure of institutional trust theory. Existing literature mostly regards institutional effectiveness and government capacity as sources of trust, with less emphasis on the independent role of legal safeguards and fairness perception. This study shows that the stronger the public's perception of legal protection for environmental rights, informed participation, and compensation mechanisms, the higher their evaluation of the fairness of project decision-making and supervision, and the more stable the level of institutional trust. This conclusion strengthens the causal chain of "law - fairness - trust", confirming that legal protection is an indispensable normative basis for institutional trust and enriching the theoretical framework of antecedent dimensions of institutional trust (Fifaliana, 2025).

Trust plays a significant mediating role between legal protection, fairness and public acceptance, clarifying the transmission mechanism and theoretical boundaries of institutional trust. The Guizhou sample shows that law and fairness do not directly determine acceptance behavior, but rather reduce risk perception and increase expected benefits through trust, thereby promoting acceptance. This mediating mechanism addresses the issue of "ambiguous transmission paths" in institutional trust theory, proving that trust is the key bridge connecting institutional supply and public behavior. The research conclusion is consistent with the mainstream view in the field of low-carbon technology acceptance, providing empirical support from a Chinese regional perspective for the mediating effect of institutional trust in risk governance, and enhancing the explanatory power and applicability of the theory (Liu et al., 2019).

The research on public acceptance of the CCUS project in Guizhou reveals the context dependence of institutional trust, promoting the theory to move from universal explanations to scenario-based adaptation. CCUS, with its dual nature of low-carbon value and environmental risk, makes public trust in institutions more dependent on perceived

fairness and legal protection. Unlike traditional infrastructure projects, the promotion of low-carbon technologies requires balancing development and safety demands in ecologically sensitive areas, amplifying the signaling role of legal protection and fairness. This indicates that institutional trust is not a uniform structure but presents differentiated characteristics based on technological attributes, regional ecology, and cultural cognition. This finding prompts the institutional trust theory to pay attention to the moderating effects of technological risks and regional endowments, enhancing the theory's adaptability to scenarios (Arning et al., 2019).

The research expands the micro-foundation of institutional trust theory from the perspective of group differences, revealing the heterogeneous laws of justice perception and trust formation. In the survey conducted in Guizhou, groups with different levels of education, information access, and risk sensitivity have significantly different perceptions of legal protection and fairness. The high-cognition group pays more attention to procedural justice and the completeness of regulations, while the grassroots group values the implementation of rights and fair compensation more. This indicates that the formation of institutional trust has group heterogeneity, and a single institutional supply is difficult to achieve full coverage of trust construction. This conclusion makes up for the deficiency of macro-institutional trust research in insufficient attention to micro-differences and promotes the development of the theory towards a multi-level explanatory framework (Zheng et al., 2021).

This study provides an operational path for the practical transformation of the institutional trust theory, enhancing its application value and policy implications. The theory of institutional trust has long faced the challenge of an unclear construction path. The experience of CCUS in Guizhou shows that improving regulations, strengthening fair enforcement, ensuring public participation, and perfecting information disclosure and relief mechanisms can systematically enhance the level of trust. This converts institutional trust from an abstract concept into a practical governance tool, proving that institutional trust is not formed naturally but is a governance resource that can be designed, cultivated, and restored. The research offers a demonstration for the practical shift of the institutional trust theory and provides a trust-building solution for the promotion of low-carbon technologies (Boyd et al., 2017).

In conclusion, the research on public acceptance of CCUS in Guizhou has expanded the antecedents, mechanisms, contexts, heterogeneities and practical paths of institutional trust. The study has verified and strengthened the logical chains of “legal protection - trust - acceptance” and “fairness - trust - acceptance”, providing localized, contextualized and multi-level empirical support for the theory of institutional trust. The research not only provides a basis for institutional design for the promotion of low-carbon technologies in ecologically fragile areas in Southwest China, but also contributes Chinese experience to the innovative development of the theory of institutional trust in the context of global energy transition. Future research can further explore cross-regional comparisons and dynamic evolution, and continuously improve the theoretical system and application solutions of institutional trust in the governance of emerging technologies (CHANGE, 2021).

5.3 Implication to Practitioners

5.3.1 Implication to Government Departments

This research, based on the practical demands of energy transition and the implementation of CCUS projects in Guizhou Province, through empirical analysis, clearly identifies the lack of legal protection, insufficient decision-making fairness, and lagging environmental protection publicity as the core issues restricting public acceptance. The research conclusion provides theoretical support for local governments to build a legalized, fair, and transparent CCUS governance system. Integrating legal protection, procedural fairness, and science popularization is the key path to resolving the NIMBY effect and promoting the large-scale implementation of low-carbon technologies (Selma et al., 2014).

Establish a sound legal system for CCUS projects to safeguard public rights and interests. The Guizhou provincial government should expedite the formulation of local regulations for CCUS projects, clearly stipulating core provisions such as the safety of carbon dioxide storage, ecological damage compensation, public right to know and relief mechanisms, and define the responsibilities of enterprises and the rights of the public through rigid laws (WU, 2025). In light of the karst geological features of Guizhou, improve the legal regulations on environmental risks of CCUS projects, fill regulatory

gaps, and eliminate public safety concerns with legal certainty, providing a solid legal guarantee for the compliant advancement of projects.

Adhere to the full process fairness of decision-making to enhance public recognition through procedural justice. The selection of CCUS project sites, environmental impact assessment, and benefit distribution, among other stages, must strictly adhere to the principles of openness and fairness, ensuring that the public is fully involved in the decision-making process. Research has confirmed that the fairness of the decision-making process directly and positively influences the public's willingness to accept low-carbon projects (Tardin-Coelho et al., 2025). Guizhou Province should establish standardized hearing, public notice, and feedback mechanisms, balancing the public's emission reduction benefits with the immediate interests of communities, and eliminating any under-the-table operations to solidify the legitimacy of policies and the foundation of social trust through fair decision-making.

Build a precise CCUS environmental protection publicity matrix to break down the public’s cognitive barriers. In response to the insufficient understanding of CCUS technology and the vague perception of its environmental value among the public in Guizhou, the government should collaborate with research institutions to carry out professional science popularization and publicity. Through official media, community lectures, and on-site demonstrations, the benefits of CCUS in reducing emissions and its environmental safety should be explained in a simple and understandable way (Ashworth, P. et al., 2012). By taking into account the characteristics of Guizhou's energy structure, focus on local demonstration project cases, and use visualized publicity to dispel technical biases, allowing the public to fully understand the environmental protection and development value of CCUS.

Strengthening fair law enforcement and ensuring the implementation of laws is essential to safeguarding governance credibility. The effectiveness of laws depends on their fair enforcement. The government should establish an independent and transparent CCUS regulatory mechanism to conduct fair supervision throughout the entire process of project operation, risk prevention and control, and ecological protection (Pereira et al., 2025). Unobstructed channels for public legal redress should be provided, and enterprises that violate regulations should be held accountable in accordance with the law, with timely responses to public concerns. Considering the multi-ethnic community characteristics of

Guizhou, the methods of law enforcement publicity should be optimized to maintain the authority of the law through fair enforcement and enhance public trust in government governance.

Promote the coordinated governance of law, justice and publicity, and build a long-term guarantee mechanism. Enhancing public acceptance of CCUS is a systematic project that requires the deep integration and collaborative efforts of the three. The Guizhou provincial government should establish a cross-departmental coordination mechanism, incorporating legal protection, fair decision-making and environmental protection publicity into the full-cycle management of CCUS projects (Bala et al., 2025). Based on regional resource endowments and social characteristics, dynamically optimize governance strategies, taking the rule of law as the bottom line, justice as the core and publicity as the handle, to lay a solid social foundation for CCUS to assist Guizhou's low-carbon transformation.

5.3.2 Implication to CCUS Project Investment and Operating Enterprises

Based on the karst geological features and the background of energy transition in Guizhou Province, this study provides systematic operational optimization guidance for CCUS investment and operation enterprises from core dimensions such as perceived risk, perceived benefit, and public cognition. Enterprises need to take legal protection as the bottom line and fairness as the principle, and promote the dissemination of environmentalism, the construction of social trust, and the cultivation of public cognition in a coordinated manner, to build a full-chain mechanism for enhancing public acceptance. This is the key path for the project to be implemented and operated, and to achieve a win-win situation of commercial and social value (Nielsen et al., 2022).

Investment and operation enterprises should establish a precise risk perception and control system to alleviate public safety concerns. Focusing on core risks such as leakage from CCUS storage and ecological impacts, they should, in light of the geological characteristics of Guizhou, set up a closed-loop mechanism of real-time monitoring, public disclosure, and emergency response. They should proactively disclose risk prevention data and technical solutions to reduce public perception of health and environmental risk. Transparent risk control measures can weaken resistance from the source and lay a solid foundation for social trust (Renn & Levine, 1991).

Enterprises need to enhance the perception of benefit transfer and integrate environmentalism to highlight the value of the project. They should not only transform the emission reduction benefits of CCUS, local employment, and ecological compensation into tangible public welfare dividends that the public can perceive, but also convey the core concept of low-carbon and environmental protection, so that the public can recognize the ecological and social value of the project. By establishing a localized benefit-sharing mechanism to bind the public's sense of gain, they can counterbalance the perception of risk with positive perceived benefits and deepen the public's recognition of the project's value (Primahardani & Erlinda, 2025).

Deepen the cultivation of public cognition and carry out popular science publicity on CCUS environmentalism. In response to the problem of insufficient technical understanding among the public in Guizhou, enterprises should abandon professional jargon and collaborate with research institutions to create popular and scenario-based science popularization content. Relying on grassroots channels, they should regularly explain the principles and environmental significance of CCUS technology. Through precise communication, they can eliminate cognitive biases, popularize environmentalist concepts, and comprehensively enhance the public's scientific understanding of CCUS projects (Reyes-García et al., 2024).

Adhere to the fairness of procedures and consolidate the foundation of social trust through legal compliance. Enterprises must abide by the principles of openness and fairness throughout the entire process of project site selection, environmental impact assessment, and operation, ensuring the public's right to participate and supervise. At the same time, they should strictly implement relevant laws and regulations on CCUS and improve the mechanisms for ecological compensation and rights protection. A fair decision-making process and strict legal compliance can effectively restore the trust relationship among the government, enterprises, and the public, and significantly enhance public acceptance (Sonnberger & Ruddat, 2017).

To build a long-term trust operation mechanism by integrating multiple dimensions, enterprises need to deeply integrate the regulation of perceived risks, the transmission of perceived benefits, the enhancement of public cognition, the practice of fairness, legal protection, and the guidance of environmentalism. Based on the regional characteristics of Guizhou, a public-centered operation model should be established.

Through a multi-stakeholder collaborative strategy, social trust should be continuously consolidated to achieve a dual improvement in the commercial operation of CCUS projects and public acceptance (Morsing & Schultz, 2006).

5.3.3 Implication to Third-Party Professional Service Providers in CCUS Projects

As a professional support and neutral carrier for CCUS projects, third-party service institutions serve as the core link between enterprises, the public, and the government. This study indicates that institutions should base themselves on the karst geological features and regional social characteristics of Guizhou, and through professional services, coordinate the core dimensions of risk perception regulation, benefit perception transmission, and public cognition cultivation. They must adhere to fairness and legal boundaries, and integrate environmentalist concepts to build social trust. This is a key support for enhancing public acceptance of CCUS projects (Brauch et al., 2024).

Third-party institutions should leverage their professional strengths to carry out scientific and precise risk perception assessment and control services. Relying on their technological advantages, they should conduct quantitative assessments of risks such as the safety of carbon capture, utilization and storage (CCUS) projects in Guizhou and their ecological impacts, issue neutral and transparent risk reports, and objectively interpret the risk levels and control measures to the public (Xiao et al., 2025). By demonstrating professional authority, they can dispel the public's irrational risk perception, build a foundation of trust with scientific data, and provide professional basis for project risk communication.

Institutions need to professionalize the measurement and communication of perceived benefits, and deeply integrate the dissemination of environmentalist values. Precisely calculate the emission reduction benefits, public welfare gains and ecological value of CCUS projects, transform abstract benefits into tangible results that the public can perceive, and at the same time convey the core concept of low-carbon and environmental protection to the public (Sareen et al., 2023). Present the multi-faceted value of the project from a neutral perspective, offset risk perception with positive benefit perception, and enhance public recognition of the value of CCUS projects.

Deepen the cultivation of public cognition and service, and create a professional CCUS environmentalism popular science system. In response to the problem of

insufficient technical understanding among the public in Guizhou, abandon the obscure professional jargon, develop popular and localized popular science products, and popularize the technical principles and environmental significance of CCUS through multiple channels (Ottoa & Grossa). Correct cognitive biases through professional popular science, integrate environmentalism concepts into the communication process, and comprehensively enhance the public's scientific understanding level.

Adhering to the principle of neutrality and impartiality, we provide professional legal protection and compliance services. As an independent third party, the institution must abide by the principle of fairness in project environmental impact assessment, site selection, and operation supervision. At the same time, it should offer specialized legal services for CCUS projects and improve the compliance system for public rights protection and ecological compensation (Maestre-Andrés et al., 2019). By maintaining impartiality, we safeguard the public's right to know. With professional legal expertise, we build a strong barrier for rights protection. Through neutral services, we continuously accumulate social trust.

To build a trust-based collaborative mechanism by integrating multi-dimensional elements, third-party institutions need to perceive risk, interests, cognition, justice, law, and environmentalism in a coordinated manner, and establish a professional bridge for communication among the government, enterprises, and the public. Based on the regional characteristics of Guizhou, customized service plans should be developed. With professional capabilities, they can resolve differences and build consensus, creating a stable social environment for CCUS projects (Braga & Pinto Jr, 2024), and become the core professional support for enhancing public acceptance.

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. In the selection of samples, due to environmental constraints, there are also some deviations. The sample predominantly comprised young, highly educated students (69.2% students; 76.9% bachelor's degree), limiting generalizability to the broader Guizhou population. In addition, the use of convenience sampling may have introduced selection bias.

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, in this study, there are some deviations in the selection of samples due to environmental limitations. In the selection of samples, due to environmental constraints, there are also some deviations. The sample predominantly comprised young, highly educated students (69.2% students; 76.9% bachelor's degree), limiting generalizability to the broader Guizhou population. In addition, the use of convenience sampling may have introduced selection bias. In this study, the common method bias is used. Although the Harman test indicated minimal bias, the reliance on self-reported data from a single source is a potential concern.

Finally, 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). Therefore, the existing research models can be extended to other fields, such as cultural differences and technological innovation.

5.5 Conclusion

This article consists of five chapters. The first chapter mainly introduces the research background, significance, questions, objectives, scope, and definitions of key terms. The second chapter is a literature review, covering the concepts, characteristics,

classifications, current research status of CCUS projects and public acceptance, the theories used in the study, research hypotheses, and models. The third chapter describes the research methods, including the philosophical paradigm adopted, research methods used, such as determining the target population, sample size, selecting sampling methods, designing measurement tools, conducting reliability and validity checks, and ethical considerations. The fourth chapter presents data analysis. Based on the data collected through Questionnaire Star, data screening and processing were carried out, resulting in 415 valid questionnaires. Then, reliability and validity checks and structural equation model analysis were conducted to verify the research hypotheses. The fifth chapter is a summary and discussion. It combines the research content, theories, hypotheses, methods, and experimental results for a summary and discussion, and provides reasonable suggestions for stakeholders to promote the development of CCUS projects.

This study, in light of the regional background of Guizhou Province, China, integrates the ABC (Affect, Behavior, and Cognition) attitude theory, social license theory, institutional trust theory, and stakeholder theory to establish and explore a novel model for public acceptance of CCUS projects. 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).

BIBLIOGRAPHY

Adams, S., & Nsiah, C. (2019). Reducing carbon dioxide emissions; Does renewable energy matter? *Science of the Total Environment*, 693: 133288. https://doi.org/10.1016/j.scitotenv.2019.07.094.

Ajzen, I. (1991). THE THEORY OF PLANNED BEHAVIOR. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-t.

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology & Health*, 26(9), 1113-1127. https://doi.org/10.1080/08870446.2011.613995.

Akerboom, S., Waldmann, S., Mukherjee, A., Agaton, C., Sanders, M., & Kramer, G. J. (2021). Different This Time? The Prospects of CCS in the Netherlands in the 2020s. *Frontiers in Energy Research*, 9: 644796. https://doi.org/10.3389/fenrg.2021.644796.

Arning, K., Linzenich, A., Ziefle, M., Meuleneers, L., Rezo, D., & von der Assen, N. (2024). Eliciting laypeople's mental models and risk perceptions of direct air carbon capture and storage: Implications for effective risk communication. *Energy Reports*, 12, 1068-1079. https://doi.org/10.1016/j.egyr.2024.06.070.

Arning, K., Offermann-van Heek, J., Linzenich, A., Kaetelhoen, A., Sternberg, A., Bardow, A., & Ziefle, M. (2019). Same or different? Insights on public perception and acceptance of carbon capture and storage or utilization in Germany. *Energy Policy*, 125, 235-249. https://doi.org/10.1016/j.enpol.2018.10.039.

Arning, K., Offermann-van Heek, J., Sternberg, A., Bardow, A., & Ziefle, M. (2020). Risk-benefit perceptions and public acceptance of Carbon Capture and Utilization. *Environmental Innovation and Societal Transitions*, 35, 292-308. https://doi.org/10.1016/j.eist.2019.05.003.

Arpaci, I., & Baloglu, M. (2016). The impact of cultural collectivism on knowledge sharing among information technology majoring undergraduates. *Computers in Human Behavior*, 56, 65-71. https://doi.org/10.1016/j.chb.2015.11.031.

Ashworth, P., Bradbury, J., Wade, S., Feenstra, C., Greenberg, S., Hund, G., & Mikunda, T. (2012). What's in store: Lessons from implementing CCS. *International Journal of Greenhouse Gas Control*, 9, 402-409. https://doi.org/10.1016/j.ijggc.2012.04.012.

Ashworth, P., Sun, Y., Ferguson, M., Witt, K., & She, S. (2019). Comparing how the public perceive CCS across Australia and China [; Proceedings Paper]. *International Journal of Greenhouse Gas Control*, 86, 125-133. https://doi.org/10.1016/j.ijggc.2019.04.008.

Baines, J. T., Taylor, C. N., & Vanclay, F. (2013). Social impact assessment and ethical research principles: ethical professional practice in impact assessment Part II. *Impact Assessment and Project Appraisal*, 31(4), 254-260. https://doi.org/10.1080/14615517.2013.850306.

Bala, R., Kaur, M., Thakur, H., Kashyap, P., Karnwal, A., & Malik, T. (2025). A sociotechnical review of carbon capture, utilization, and storage (CCUS) technologies for industrial decarbonization: current challenges, emerging solution, and future directions. *International Journal of Chemical Engineering*, 1: 7195300.

Bandura, A., & Cherry, L. (2020). Enlisting the Power of Youth for Climate Change. *American Psychologist*, 75(7), 945-951. https://doi.org/10.1037/amp0000512.

Batel, S., Devine-Wright, P., & Tangeland, T. (2013). Social acceptance of low carbon energy and associated infrastructures: A critical discussion. *Energy Policy*, 58, 1-5.

Bauer, R. A. (1960). Consumer behavior as risk taking (I. R. S. Hancock, Ed.). American Marketing Association.

Beck, B., Kulichenko-Lotz, N., & Surridge, T. (2016, Nov 14-18 2017). World Bank CCS Program activities in South Africa - Results and lessons learned.Energy Procedia [13th international conference on greenhouse gas control technologies, ghgt-13]. 13th International Conference on Greenhouse Gas Control Technologies (GHGT), Lausanne, SWITZERLAND.

Bentler, P. M., & Bonett, D. G. (1987). CITATION CLASSIC - SIGNIFICANCE TESTS AND GOODNESS OF FIT IN THE ANALYSIS OF COVARIANCE-STRUCTURES. Current Contents/Arts & Humanities(37), 16-16. <Go to ISI>://WOS:A1987J818400001

Boutilier, R. G., & Thomson, I. (2011). Modelling and measuring the social license to operate: fruits of a dialogue between theory and practice. *Social Licence*, 1, 1-10.

Boyd, A. D., Hmielowski, J. D., & David, P. (2017). Public perceptions of carbon capture and storage in Canada: Results of a national survey. *International Journal of Greenhouse Gas Control*, 67, 1-9. https://doi.org/10.1016/j.ijggc.2017.10.010.

Braga, L. P., & Pinto Jr, H. Q. (2024). The transnational governance model as a necessary tool for building a transnational regulatory system for the de-carbonization actions for the oil and gas sector. *The Journal of World Energy Law & Business*, 17(6), 422-443.

Brauch, M. D., Klonsky, E., Everard, F. M., Guanglin, Q., Alviano, T., Cuddihey, J., & Wang, M. (2024). An international law framework for climate-aligned investment governance.

Breckler, S. J. (1984). Empirical validation of affect, behavior, and cognition as distinct components of attitude. *Journal of Personality and Social Psychology*, 47(6): 1191.

Brewer, T. L., et al. (2019). Public acceptance of carbon capture and storage: The role of legal and regulatory certainty. *Energy Policy*, 132: 110824. https://doi.org/10.1016/j.enpol.2019.110824.

Brunsting, S., Upham, P., Dütschke, E., Waldhober, M. D. B., Oltra, C., Desbarats, J., Riesch, H., & Reiner, D. (2011). Communicating CCS: Applying communications theory to public perceptions of carbon capture and storage. *International Journal of Greenhouse Gas Control*, 5(6), 1651-1662. https://doi.org/10.1016/j.ijggc.2011.09.012.

Cai, S. H., Jun, M., & Yang, Z. L. (2010). Implementing supply chain information integration in China: The role of institutional forces and trust. *Journal of Operations Management*, 28(3), 257-268. https://doi.org/10.1016/j.jom.2009.11.005.

CHANGE, I. I. P. O. C. (2021). Sixth assessment report: mitigation of climate change. Geneva: IPCC.

Che, X. X., Yi, X. Y., Dai, Z. H., Zhang, Z. W., & Zhang, Y. (2022). Application and Development Countermeasures of CCUS Technology in China's Petroleum Industry. *Atmosphere*, 13(11): 1757. https://doi.org/10.3390/atmos13111757.

Child, J., & Möllering, G. (2003). Contextual confidence and active trust development in the Chinese business environment. *Organization Science*, 14(1), 69-80. https://doi.org/10.1287/orsc.14.1.69.12813.

Clarkson, M. B. E. (1995). A stakeholder framework for analyzing and evaluating corporate social performance. *Academy of Management Review*, 20(1), 92-117. https://doi.org/10.2307/258888.

Davoodi, S., Al-Shargabi, M., Wood, D. A., Rukavishnikov, V. S., & Minaev, K. M. (2023). Review of technological progress in carbon dioxide capture, storage, and utilization. *Gas Science and Engineering*, 117: 205070. https://doi.org/10.1016/j.jgsce.2023.205070.

de Best-Waldhober, M., Daamen, D., Ramirez, A. R., Faaij, A., Hendriks, C., & de Visser, E. (2012). Informed public opinion in the Netherlands: Evaluation of CO₂ capture and storage technologies in comparison with other CO₂ mitigation options. *International Journal of Greenhouse Gas Control*, 10, 169-180. https://doi.org/10.1016/j.ijggc.2012.05.023.

de Best-Waldhober, M., Paukovic, M., Brunsting, S., & Daamen, D. (2010, Sep 19-23). Awareness, knowledge, beliefs, and opinions regarding CCS of the Dutch general public before and after information. Energy Procedia [10th international conference on greenhouse gas control technologies]. 10th International Conference on Greenhouse Gas Control Technologies, Amsterdam, NETHERLANDS.

de Salvi, R. D. (2008). Consumer Behavior - Building the Marketing Strategy. *Revista Gestao Organizacional*, 1(2), 145-149. <Go to ISI>://WOS:000216149400007.

del Rio, P., Oviedo, J. L., & Kiefer, C. P. (2026). Drivers and barriers to social acceptance of carbon capture, utilisation and storage: A systematic literature review of survey-based studies. *Energy Strategy Reviews*, 65, Article 102198. https://doi.org/10.1016/j.esr.2026.102198.

Demuijnck, G., & Fasterling, B. (2016). The Social License to Operate. *Journal of Business Ethics*, 136(4), 675-685. https://doi.org/10.1007/s10551-015-2976-7.

Dörpmund, F., Brändle, C., Holland-Cunz, A., & Tank, L. (2025). Governance of Carbon Dioxide Removal: Practitioners' Perspectives on Fairness and Equity. *European Journal of Risk Regulation*. https://doi.org/10.1017/err.2025.10027.

Dütschke, E., Miu, L., Bonfiglio, E., & Marcu, A. (2023). Public perception of CCUS.

Dütschke, E., Wohlfarth, K., Höller, S., Viebahn, P., Schumann, D., & Pietzner, K. (2016). Differences in the public perception of CCS in Germany depending on CO₂ source, transport option and storage location. *International Journal of Greenhouse Gas Control*, 53, 149-159. https://doi.org/10.1016/j.ijggc.2016.07.043.

Emerson, R. W. (2026). Analyzing Likert Scale Data. *Journal of Visual Impairment & Blindness*, 120(2), 211-213. https://doi.org/10.1177/0145482x261427985.

Feng, D. Y., Liu, Y., & Ge, Y. J. (2024). Social License to Operate for NIMBY Infrastructures: The Mechanism of the Four Components of Procedural Justice. *Buildings*, 14(8): 2465. https://doi.org/10.3390/buildings14082465.

Fifaliana, R. M. (2025). A Systematic Literature Review of Empirical Research on the Impact of E-Government Use on Citizens' Trust in Government. *Chinese Public Administration Review*, 15396754251413048.

Fikru, M. G., & Nguyen, N. (2024). Factors Shaping Public Support for More Carbon Capture and Storage Projects in the United States. *Environmental Management*, 74(3), 425-438. https://doi.org/10.1007/s00267-024-02000-5.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention, and behavior: An introduction to theory and research. Addison-Wesley.

Fleishman, L. A., de Bruin, W. B., & Morgan, M. G. (2010). Informed Public Preferences for Electricity Portfolios with CCS and Other Low-Carbon Technologies. *Risk Analysis*, 30(9), 1399-1410. https://doi.org/10.1111/j.1539-6924.2010.01436.x.

Fuhrman, J., McJeon, H., Patel, P., Doney, S. C., Shobe, W. M., & Clarens, A. F. (2020). Food-energy-water implications of negative emissions technologies in a+1.5 °C future. *Nature Climate Change*, 10(10), 920-+. https://doi.org/10.1038/s41558-020-0876-z.

Garcia, J., Dumont, R. J., Joly, J., Morales, J., Garzotti, L., Bache, T. W., Baranov, Y., Casson, F. J., Challis, C., Kirov, K., Mailloux, J., Saarelma, S., Nocente, M., Banon-Navarro, A., Goerler, T., Citrin, J., Ho, A., Gallart, D., Mantsinen, M.,…Contributors, J. E. T. (2019). First principles and integrated modelling achievements towards trustful fusion power predictions for JET and ITER. *Nuclear Fusion*, 59(8): 086047. https://doi.org/10.1088/1741-4326/ab25b1.

Gehman, J., Lefsrud, L. M., & Fast, S. (2017). Social license to operate: Legitimacy by another name? *Canadian Public Administration-Administration Publique Du Canada*, 60(2), 293-317. https://doi.org/10.1111/capa.12218.

Gills, B., & Morgan, J. (2020). Global Climate Emergency: after COP24, climate science, urgency, and the threat to humanity. *Globalizations*, 17(6), 885-902. https://doi.org/10.1080/14747731.2019.1669915.

Glasser, H. (2005). The Shallow and the Deep, Long-Range Ecology Movement: A Summary (Reprinted from Inquiry: An Interdisciplinary Journal of Philosophy, 16, 95-100, 1973) (Publication Number 978-1-4020-3727-6) [Reprint; Book Chapter, <Go to ISI>://WOS:000272885300006.

Goetze, U., Richter, F., & Doering, J. (2024). A Stakeholder-Related Procedure Model for Social Sustainability Assessment. *Sustainability*, 16(23): 10396. https://doi.org/10.3390/su162310396.

Gough, C., Cunningham, R., & Mander, S. (2018). Understanding key elements in establishing a social license for CCS: An empirical approach. *International Journal of Greenhouse Gas Control*, 68, 16-25. https://doi.org/10.1016/j.ijggc.2017.11.003.

Gough, C., & Mander, S. (2022). CCS industrial clusters: Building a social license to operate. *International Journal of Greenhouse Gas Control*, 119: 103713. https://doi.org/10.1016/j.ijggc.2022.103713.

Gunningham, N., & Sinclair, D. (2014). Regulatory design for carbon capture and storage: Lessons from environmental law and regulation. *Journal of Environmental Law*, 26(3), 407-432. https://doi.org/10.1093/jel/egu017.

Gunningham, N., Kagan, R. A., & Thornton, D. (2004). Social license and environmental protection: Why businesses go beyond compliance. *Law & Social Inquiry*, 29(2), 307-341. https://doi.org/10.1086/423681.

Guo, Q. F., Xi, X., Yang, S. T., & Cai, M. F. (2022). Technology strategies to achieve carbon peak and carbon neutrality for China's metal mines. *International Journal of Minerals Metallurgy and Materials*, 29(4), 626-634. https://doi.org/10.1007/s12613-021-2374-3.

Guo, Z. Q., Zhang, X. P., Wang, D. J., & Zhao, X. N. (2019). The Impacts of an Energy Price Decline Associated with a Carbon Tax on the Energy-Economy-Environment System in China. *Emerging Markets Finance and Trade*, 55(12), 2689-2702. https://doi.org/10.1080/1540496x.2018.1562899.

Hair, J. F., Jr., Gabriel, M. L. D. S., & Patel, V. K. (2014). AMOS COVARIANCE-BASED STRUCTURAL EQUATION MODELING (CB-SEM): GUIDELINES ON ITS APPLICATION AS A MARKETING RESEARCH TOOL. *Revista Brasileira De Marketing*, 13(2), 43-53. https://doi.org/10.5585/remark.v13i2.2718.

Hair, J. F., Ring, C. M., & Sarstedt, M. (2014). Editorial Partial Least Squares Structural Equation Modeling: Rigorous Applications, Better Results and Higher Acceptance (vol 46, pg 1, 2013). *Long Range Planning*, 47(6), 392-392. https://doi.org/10.1016/j.lrp.2013.08.016.

Hall, N., Lacey, J., Carr-Cornish, S., & Dowd, A. M. (2015). Social licence to operate: understanding how a concept has been translated into practice in energy industries. *Journal of Cleaner Production*, 86, 301-310. https://doi.org/10.1016/j.jclepro.2014.08.020.

Hayes, K. J. P. A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior research methods*, 40(3), 879-891.

Heller-Krippendorf, D. (2025). Multivariate Data Analysis. In P. P. Michalowski (Ed.), Secondary Ion Mass Spectrometry (Vol. 16, pp. 229-262). <Go to ISI>://WOS:001716146800008.

Hemmert, M., Kim, D., Kim, J., & Cho, B. (2016). Building the supplier's trust: Role of institutional forces and buyer firm practices. *International Journal of Production Economics*, 180, 25-37. https://doi.org/10.1016/j.ijpe.2016.05.023.

Hoyos, J. G. O. (2000). Ethical principles of research in human beings and in animals. Medicina-Buenos Aires, 60(2), 255-258. <Go to ISI>://WOS:000086774000019.

Hu, X., Xi, L., Kou, I. T. E., & Su, X. (2021). Macau residents' attitude towards the free independent travellers (FIT) policy: an analysis from the perspective of the ABC model and group comparison. *Asia Pacific Journal of Tourism Research*, 26(9), 935-952. https://doi.org/10.1080/10941665.2021.1940223.

Huang, S. S., Chen, G. H., Luo, X. R., & Bao, J. G. (2019). Evolution of Tourism Research in China after the Millennium: Changes in Research Themes, Methods, and Researchers. *Journal of China Tourism Research*, 15(3), 420-434. https://doi.org/10.1080/19388160.2018.1515684.

Huber, R. A., Greussing, E., & Eberl, J. M. (2022). From populism to climate scepticism: the role of institutional trust and attitudes towards science. *Environmental Politics*, 31(7), 1115-1138. https://doi.org/10.1080/09644016.2021.1978200.

Huijts, N. M. A., Midden, C. J. H., & Meijnders, A. L. (2007). Social acceptance of carbon dioxide storage. *Energy Policy*, 35(5), 2780-2789. https://doi.org/10.1016/j.enpol.2006.12.007.

Huijts, N. M. A., Molin, E. J. E., & Steg, L. (2012). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable & Sustainable Energy Reviews*, 16(1), 525-531. https://doi.org/10.1016/j.rser.2011.08.018.

Huovila, A., Siikavirta, H., Rozado, C. A., Rökman, J., Tuominen, P., Paiho, S., Hedman, Å., & Ylén, P. (2022). Carbon-neutral cities: Critical review of theory and practice. *Journal of Cleaner Production*, 341: 130912. https://doi.org/10.1016/j.jclepro.2022.130912.

Hurlimann, A., Hemphill, E., McKay, J., & Geursen, G. (2008). Establishing components of community satisfaction with recycled water use through a structural equation model. *Journal of Environmental Management*, 88(4), 1221-1232. https://doi.org/10.1016/j.jenvman.2007.06.002.

IEA. (2017). Energy technology perspectives 2017. Retrieved Feb 16, 2024 from https://iea.blob.core.windows.net/assets/a6587f9f-e56c-4b1d-96e4-5a4da78f12fa/Energy_Technology_Perspectives_2017-PDF.pdf.

IEA. (2022). Legal and Regulatory Frameworks for CCUS, IEA, Paris. https://iea.blob.core.windows.net/assets/bda8c2b2-2b9c-4010-ab56-b941dc8d0635/LegalandRegulatoryFrameworksforCCUS-AnIEACCUSHandbook.pdf.

IEA. (2023). CCUS Policies and Business Models Building a commercial market. https://iea.blob.core.windows.net/assets/d0cb5c89-3bd4-4efd-8ef5-57dc327a02d6/CCUSPoliciesandBusinessModels.pdf.

IPCC6. (2023). AR6 Synthesis Report: Climate Change 2023. Retrieved Jun 24 from https://www.ipcc.ch/report/sixth-assessment-report-cycle/.

IPCC. (2014). Climate change 2014: Synthesis report. Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change. Retrieved Feb 16 from https://www.ipcc.ch/report/ar5/syr/.

Itaoka, K., Dowd, A. M., Saito, A., Paukovic, M., de Best-Waldhober, M., & Ashworth, P. (2012, Nov 18-22). Relating individual perceptions of carbon dioxide to perceptions of CCS: An international comparative study.Energy Procedia [Ghgt-11]. International Conference on Greenhouse Gas Technologies (GHGT), Kyoto, JAPAN.

Jasinski, M. P. (2011). The Social Trust Theory of International Conflict (Publication Number 978-0-23011-868-3) <Go to ISI>://WOS:000293219300006,

Jiang, K., Ashworth, P., Zhang, S. Y., & Hu, G. P. (2022). Print media representations of carbon capture utilization and storage (CCUS) technology in China. *Renewable & Sustainable Energy Reviews*, 155: 111938. https://doi.org/10.1016/j.rser.2021.111938.

Jiang, K., Ashworth, P., Zhang, S. Y., Liang, X., Sun, Y., & Angus, D. (2020). China's carbon capture, utilization and storage (CCUS) policy: A critical review. *Renewable & Sustainable Energy Reviews*, 119: 109601. https://doi.org/10.1016/j.rser.2019.109601.

Jones, C. R., Olfe-Kräutlein, B., Naims, H., & Armstrong, K. (2017). The Social Acceptance of Carbon Dioxide Utilisation: A Review and Research Agenda. *Frontiers in Energy Research*, 5: 11. https://doi.org/10.3389/fenrg.2017.00011.

Kaliszewski, I., Kiczkowiak, T., & Miroforidis, J. (2016). Mechanical design, multiple criteria decision making and Pareto optimality gap. *Engineering Computations*, 33(3), 876-895. https://doi.org/10.1108/ec-03-2014-0065.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., Kasperson, J. X., & Ratick, S. (1988). THE SOCIAL AMPLIFICATION OF RISK – A CONCEPTUAL-FRAMEWORK. *Risk Analysis*, 8(2), 177-187. https://doi.org/10.1111/j.1539-6924.1988.tb01168.x.

Keams, D. T. (2022). State of the Art: CCS Technologies 2022. https://domene.shop/web.

Kellou, D., Pratama, Y. W., Zuniga, C., Riany, F., Gidden, M. J., Heede, R., Ganti, G., & Schleussner, C.-F. (2025). The responsibility of investor-owned carbon majors to contribute to direct air carbon capture and storage investment [; Early Access]. Climate Policy. https://doi.org/10.1080/14693062.2025.2557230.

Kim, P. H., Ferrin, D. L., Cooper, C. D., & Dirks, K. T. (2004). Removing the shadow of suspicion: The effects of apology versus denial for repairing competence- versus integrity-based trust violations. *Journal of Applied Psychology*, 89(1), 104-118. https://doi.org/10.1037/0021-9010.89.1.104.

Knutti, R. (2019). Closing the Knowledge-Action Gap in Climate Change. *One Earth*, 1(1), 21-23. https://doi.org/10.1016/j.oneear.2019.09.001.

Krishna, B., Krishnan, S., & Sebastian, M. P. (2023). Examining the Relationship between National Cybersecurity Commitment, Culture, and Digital Payment Usage: An Institutional Trust Theory Perspective. *Information Systems Frontiers*, 25(5), 1713-1741. https://doi.org/10.1007/s10796-022-10280-7.

Leopold, A. (2007). The land ethic. *Revista Chilena De Historia Natural*, 80(4), 522-534. <Go to ISI>://WOS:000252317900013.

Li, Q., Liu, G. Z., Cai, B. F., Leamon, G., Liu, L. C., Chen, Z. A., & Li, X. C. (2017). Public awareness of the environmental impact and management of carbon dioxide capture, utilization and storage technology: the views of educated people in China. *Clean Technologies and Environmental Policy*, 19(8), 2041-2056. https://doi.org/10.1007/s10098-017-1387-0.

Li, Q., Liu, L. C., Chen, Z. A., Zhang, X., Jia, L., & Liu, G. Z. (2014, Oct 05-09 2014). A Survey of Public Perception of CCUS in China.Energy Procedia [12th international conference on greenhouse gas control technologies, ghgt-12]. 12th International Conference on Greenhouse Gas Control Technologies (GHGT), Austin, TX.

Li, Y. F., & Zhang, Z. T. (2022). Legal regulation and institutional improvement of CCUS technology in China. *China Legal Science,* (2), 146-164.

Liang, D. P., & Wu, W. W. (2009). Barriers and incentives of CCS deployment in China: Results from semi-structured interviews. *Energy Policy*, 37(6), 2421-2432. https://doi.org/10.1016/j.enpol.2009.02.032.

Lilliestam, J., & Hanger, S. (2016). Shades of green: Centralisation, decentralisation and controversy among European renewable electricity visions. *Energy Research & Social Science*, 17, 20-29. https://doi.org/10.1016/j.erss.2016.03.011.

Lima, P. R., Martins Pereira, A. A., Diniz Chaves, G. d. L., & Meneguelo, A. P. (2021). Environmental awareness and public perception on carbon capture and storage (CCS) in Brazil. *International Journal of Greenhouse Gas Control*, 111: 103467. https://doi.org/10.1016/j.ijggc.2021.103467.

Linzenich, A., Arning, K., & Ziefle, M. (2019, May 03-05). Identifying the "Do's" and "Don'ts" for a Trust-Building CCU Product Label. [Proceedings of the 8th international conference on smart cities and green ict systems (smartgreens)]. 8th International Conference on Smart Cities and Green ICT Systems (SMARTGREENS), Heraklion, GREECE.

Linzenich, M., Brüderl, J., & Renn, O. (2019). Information provision and public acceptance of CCS: The role of message framing and source credibility. *Energy Research & Social Science*, 51, 111-120. https://doi.org/10.1016/j.erss.2019.01.017.

Liu, B. S., Xu, Y. H., Yang, Y., & Lu, S. J. (2021). How public cognition influences public acceptance of CCUS in China: Based on the ABC (affect, behavior, and cognition) model of attitudes. *Energy Policy*, 156: 112390. https://doi.org/10.1016/j.enpol.2021.112390.

Liu, H. J., Were, P., Li, Q., Gou, Y., & Hou, Z. (2017). Worldwide Status of CCUS Technologies and Their Development and Challenges in China. Geofluids, Article Unsp 6126505. https://doi.org/10.1155/2017/6126505.

Liu, L., Bouman, T., Perlaviciute, G., & Steg, L. (2019). Effects of trust and public participation on acceptability of renewable energy projects in the Netherlands and China. *Energy Research & Social Science*, 53, 137-144.

Lu, S. J., Fang, M. X., Wang, Q., Huang, L., Sun, W. T., Zhang, Y. Y., Li, Q. F., & Zhang, X. J. (2021). Public acceptance investigation for 2 million tons/year flue gas CO2 capture, transportation and oil displacement storage project. *International Journal of Greenhouse Gas Control*, 111: 103442. https://doi.org/10.1016/j.ijggc.2021.103442.

Lutzke, L., & Arvai, J. (2021). Consumer acceptance of products from carbon capture and utilization. *Climatic Change*, 166(1-2): 15. https://doi.org/10.1007/s10584-021-03110-3.

Madichie, N. O. (2009). Consumer Behavior: Buying, Having, and Being, 8th edition. *Management Decision*, 47(5-6), 845-848. https://doi.org/10.1108/00251740910960169.

Maestre-Andrés, S., Drews, S., & Van Den Bergh, J. (2019). Perceived fairness and public acceptability of carbon pricing: a review of the literature. *Climate Policy*, 19(9), 1186-1204.

Maki, A. (2011). Consumer behavior (Publication Number 978-0-203-83949-2) <Go to ISI>://WOS:000295043400003

Manata, B., & Boster, F. J. (2024). Reconsidering the Problem of Common-Method Variance in Organizational Communication Research. *Management Communication Quarterly*, 38(3), 677-697. https://doi.org/10.1177/08933189231226242.

Mario, C. R. (2007). Attitude change. Guilford Press.

Mathew, P. M. (2016). Attitude segmentation of Indian online buyers. *Journal of Enterprise Information Management*, 29(3), 359-373. https://doi.org/10.1108/jeim-08-2014-0078.

McLaren, D. P. (2012). PROCEDURAL JUSTICE IN CARBON CAPTURE AND STORAGE. *Energy & Environment*, 23(2-3), 345-365. https://doi.org/10.1260/0958-305x.23.2-3.345.

Midden, C. J. H., & Huijts, N. M. A. (2009). The Role of Trust in the Affective Evaluation of Novel Risks: The Case of CO₂ Storage. *Risk Analysis*, 29(5), 743-751. https://doi.org/10.1111/j.1539-6924.2009.01201.x.

Miles, S. (2017). Stakeholder Theory Classification: A Theoretical and Empirical Evaluation of Definitions. *Journal of Business Ethics*, 142(3), 437-459. https://doi.org/10.1007/s10551-015-2741-y.

Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Academy of Management Review*, 22(4), 853-886. https://doi.org/10.2307/259247.

Moffat, K., Lacey, J., Zhang, A., & Leipold, S. (2016). The social licence to operate: a critical review. *Forestry*, 89(5), 477-488. https://doi.org/10.1093/forestry/cpv044.

Moffat, K., & Zhang, A. R. (2014). The paths to social licence to operate: An integrative model explaining community acceptance of mining. *Resources Policy*, 39, 61-70. https://doi.org/10.1016/j.resourpol.2013.11.003.

Morsing, M., & Schultz, M. (2006). Corporate social responsibility communication: stakeholder information, response and involvement strategies. *Business ethics: A European review*, 15(4), 323-338.

Multivariate Data Analysis (Publication Number 978-1-4200-6796-5). (2009). <Go to ISI>://WOS:000267754100006.

Mulyasari, F., Harahap, A. K., Rio, A. O., Sule, R., & Kadir, W. G. A. (2021). Potentials of the public engagement strategy for public acceptance and social license to operate: Case study of Carbon Capture, Utilisation, and Storage Gundih Pilot Project in Indonesia. *International Journal of Greenhouse Gas Control*, 108: 103312. https://doi.org/10.1016/j.ijggc.2021.103312.

Muttitt, G., & Kartha, S. (2020). Equity, climate justice and fossil fuel extraction: principles for a managed phase out. *Climate Policy*, 20(8), 1024-1042. https://doi.org/10.1080/14693062.2020.1763900.

NEA. (2017). The Environmental Impact Assessment Law of the People's Republic of China. Retrieved Jun 24 from https://www.nea.gov.cn/2017-11/02/c_136722887.htm.

Nielsen, J. A. E., Stavrianakis, K., & Morrison, Z. (2022). Community acceptance and social impacts of carbon capture, utilization and storage projects: A systematic meta-narrative literature review. *Plos One*, 17(8). https://doi.org/10.1371/journal.pone.0272409.

O'Rourke, S., & Lacey, J. (2010). Public perceptions of carbon capture and storage: The role of equity and procedure. *Energy Policy*, 38(10), 5707-5715. https://doi.org/10.1016/j.enpol.2010.05.044.

Ottoa, D., & Grossa, M. Pre-Print of: Stuck on coal and persuasion? A critical review of carbon capture and storage communication.

Pahle, M., Burtraw, D., Flachsland, C., Kelsey, N., Biber, E., Meckling, J., Edenhofer, O., & Zysman, J. (2018). Sequencing to ratchet up climate policy stringency. *Nature Climate Change*, 8(10), 861-867. https://doi.org/10.1038/s41558-018-0287-6.

Palmgren, C. R., Morgan, M. G., De Bruin, W. B., & Keith, D. W. (2004). Initial public perceptions of deep geological and oceanic disposal of carbon dioxide. *Environmental Science & Technology*, 38(24), 6441-6450. https://doi.org/10.1021/es040400c.

Pereira, E. G., Omotuyi, O., Righetti, T., & Edwards, H. H. (2025). CCUS: legal developments, policies, and challenges. In Carbon capture utilization and storage: law, policy and standardization perspectives (pp. 205-234). Springer.

Podsakoff, P. M., Podsakoff, N. P., Williams, L. J., Huang, C. Q., & Yang, J. H. (2024). Common Method Bias: It's Bad, It's Complex, It's Widespread, and It's Not Easy to Fix. *Annual Review of Organizational Psychology and Organizational Behavior*, 11, 17-61. https://doi.org/10.1146/annurev-orgpsych-110721- 040030.

Polson, D., Curtis, A., & Vivalda, C. (2012). The evolving perception of risk during reservoir evaluation projects for geological storage of CO₂. *International Journal of Greenhouse Gas Control*, 9, 10-23. https://doi.org/10.1016/j.ijggc.2012.02.010

Primahardani, I., & Erlinda, S. (2025). Environmental Citizenship: A Holistic Strategy To Realize Pro-Environmental Attitude Sustainability For Coastal Communities. *Jurnal Ilmu Lingkungan*, 23(3), 616-631.

Prno, J., & Slocombe, D. S. (2012). Exploring the origins of 'social license to operate' in the mining sector: Perspectives from governance and sustainability theories. *Resources Policy*, 37(3), 346-357. https://doi.org/10.1016/j.resourpol. 2012.04. 002.

Rawls, J. (1971). A Theory of Justice. Harvard University Press.

Reiner, D. M., Curry, T. E., de Figueiredo, M. A., Herzog, H. J., Ansolabehere, S. D., Itaoka, K., Johnsson, F., & Odenberger, M. (2006). Response to Comment on "American exceptionalism? Similarities and differences in national attitudes toward energy policy and global warming". *Environmental Science & Technology*, 40(21), 6866-6866. https://doi.org/10.1021/es068009+.

Renn, O., & Levine, D. (1991). Credibility and trust in risk communication. In Communicating risks to the public: International perspectives (pp. 175-217). Springer.

Reyes-García, V., García-del-Amo, D., Álvarez-Fernández, S., Benyei, P., Calvet-Mir, L., Junqueira, A. B., Labeyrie, V., Li, X., Miñarro, S., & Porcher, V. (2024). Indigenous Peoples and local communities report ongoing and widespread climate change impacts on local social-ecological systems. *Communications Earth & Environment*, 5(1), 29.

Rodríguez-Díaz, R., & McCombs, M. (2023). Personal Agenda-Public Agenda Congruency: A Contingent Condition for Agenda-setting Effects. *Communication & Society-Spain*, 36(4), 191-212. https://doi.org/10.15581/003.36.4.191-212.

Rosenberg, C. I. H. M. J. (1960). Cognitive, affective and behavioral components of attitudes. In C. I. H. M. J. Rosenberg (Ed.), Attitude organization and change. Yale University Press.

Saito, A., Itaoka, K., & Akai, M. (2019). Those who care about CCS-Results from a Japanese survey on public understanding of CCS [; Proceedings Paper]. *International Journal of Greenhouse Gas Control*, 84, 121-130. https://doi.org/ 10.1016/j.ijggc.2019.02.014.

Sareen, S., Girard, B., Lindkvist, M., Sveinsdóttir, A., Kristiansen, S., Laterza, V., Aguilar-Stoen, M., & Langhelle, O. (2023). Enabling a just energy transition through solidarity in research. *Energy Research & Social Science*, 101: 103143. https://doi. org/10.1016/j.erss.2023.103143.

Schomakers, E. M., Engelmann, L., & Ziefle, M. (2025). Public preferences for local carbon capture and utilization implementation: A French-German comparison. *Energy Policy*, 206: 114781. https://doi.org/10.1016/j.enpol.2025. 114781.

Seidl, C., & Wheeler, S. A. (2024). Breaking Water Laws in the Murray-Darling Basin: Understanding Water Compliance Challenges and Stakeholder Perceptions. *Water Resources Research*, 60(10): e2023WR035635. https://doi.org/10.1029/2023 wr035635.

Seigo, S. L., Arvai, J., Dohle, S., & Siegrist, M. (2014). Predictors of risk and benefit perception of carbon capture and storage (CCS) in regions with different stages of deployment. *International Journal of Greenhouse Gas Control*, 25, 23-32. https://doi.org/10.1016/j.ijggc.2014.03.007.

Selivanov, E., Cudlín, P., & Horácek, P. (2023). Carbon neutrality of forest biomass for bioenergy: a scoping review. *Iforest-Biogeosciences and Forestry*, 16, 70-77. https://doi.org/10.3832/ifor4160-15.

Selma, L., Seigo, O., Dohle, S., & Siegrist, M. (2014). Public perception of carbon capture and storage (CCS): A review. *Renewable and Sustainable Energy Reviews*, 38, 848-863.

Shackley, S., McLachlan, C., & Gough, C. (2005). The public perception of carbon dioxide capture and storage in the UK: results from focus groups and a survey. *Climate Policy*, 4(4), 377-398. https://doi.org/10.3763/cpol.2004.0428.

Shen, M., Kong, F., Tong, L. et al. . (2022). Carbon capture and storage (CCS): development path based on carbon neutrality and economic policy. *Carb Neutrality*, 1(37). https://doi.org/10.1007/s43979-022-00039-z.

Siegrist, M., & Cvetkovich, G. (2000). Perception of hazards: The role of social trust and knowledge. *Risk Analysis*, 20(5), 713-719. https://doi.org/10.1111/0272-4332.205064.

Sitinjak, C., Ebennezer, S., & Ober, J. (2023). Exploring Public Attitudes and Acceptance of CCUS Technologies in JABODETABEK: A Cross-Sectional Study. *Energies*, 16(10): 4026. https://doi.org/10.3390/en16104026.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1980). Facts and fears: Understanding perceived risk. In R. C. S. W. A. Albers (Ed.), Societal risk assessment: How safe is safe enough (pp. 181-216). Plenum Press.

Smith, J., Durucan, S., Korre, A., & Shi, J. Q. (2011). Carbon dioxide storage risk assessment: Analysis of caprock fracture network connectivity. *International Journal of Greenhouse Gas Control*, 5(2), 226-240. https://doi.org/10.1016/j.ijggc.2010.10.002.

Song, D. D., Jiang, T., & Rao, C. P. (2022). Review of Policy Framework for the Development of Carbon Capture, Utilization and Storage in China. *International Journal of Environmental Research and Public Health*, 19(24): 16853. https://doi.org/10.3390/ijerph192416853.

Sonnberger, M., & Ruddat, M. (2017). Local and socio-political acceptance of wind farms in Germany. *Technology in Society*, 51, 56-65. https://doi.org/10.1016/j.techsoc.2017.07.005.

State Council of the People's Republic of China. (2022). Opinions on supporting Guizhou to break new ground in the western development strategy in the new era (Guo Fa No. 2). Retrieved from https://www.gov.cn/zhengce/zhengceku/2022-01/26/content_5670527.htm.

Stavrianakis, K., Nielsen, J., & Morrison, Z. (2024). Public perception and acceptance of CCUS: preliminary findings of a qualitative case study in Greece. *Open Research Europe*, 3, 205.

Storrs, K., Lyhne, I., & Drustrup, R. (2023). A comprehensive framework for feasibility of CCUS deployment: A meta-review of literature on factors impacting CCUS deployment. *International Journal of Greenhouse Gas Control*, 125: 103878. https://doi.org/10.1016/j.ijggc.2023.103878.

Sun, X. P., Wang, P., Ferris, T., Lin, H., Dreyfus, G., Gu, B. H., Zaelke, D., & Wang, Y. (2022). Fast action on short-lived climate pollutants and nature-based solutions to help countries meet carbon neutrality goals. *Advances in Climate Change Research*, 13(4), 564-577. https://doi.org/10.1016/j.accre.2022.06.003.

Tardin-Coelho, R., Bharadwaj, B., & Ashworth, P. (2025). Carbon capture utilisation and storage (CCUS) and public perceptions: A systematic literature review. *International Journal of Greenhouse Gas Control*, 145: 104393. https://doi.org/10.1016/j.ijggc.2025.104393.

Terwel, B. W., Harinck, F., Ellemers, N., & Daamen, D. D. L. (2009a). Competence-Based and Integrity-Based Trust as Predictors of Acceptance of Carbon Dioxide Capture and Storage (CCS). *Risk Analysis*, 29(8), 1129-1140. https://doi.org/10.1111/j.1539-6924.2009.01256.x.

Terwel, B. W., Harinck, F., Ellemers, N., & Daamen, D. D. L. (2009b). How organizational motives and communications affect public trust in organizations: The case of carbon dioxide capture and storage. *Journal of Environmental Psychology*, 29(2), 290-299. https://doi.org/10.1016/j.jenvp.2008.11.004.

Terwel, B. W., Harinck, F., Ellemers, N., & Daamen, D. D. L. (2011a). Going beyond the properties of CO2 capture and storage (CCS) technology: How trust in stakeholders affects public acceptance of CCS. *International Journal of Greenhouse Gas Control*, 5(2), 181-188. https://doi.org/10.1016/j.ijggc.2010.10.001.

Terwel, B. W., Harinck, F., Ellemers, N., & Daamen, D. D. L. (2011b). Going beyond the properties of CO₂ capture and storage (CCS) technology: How trust in stakeholders affects public acceptance of CCS. *International Journal of Greenhouse Gas Control*, 5(2), 181-188. https://doi.org/10.1016/j.ijggc.2010.10.001.

Tian, X. J. (2021). The Mechanism of Online Health Community Usage's Impact on Health Behavior Intention(Master's Thesis, Chongqing University). https://doi.org/https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202301&filename=1021782042.nh.

Upham, P., Corner, A., & Poortinga, W. (2011). Justice and carbon capture and storage: An interdisciplinary review. *Climate Policy*, 11(3), 893-910. https://doi.org/10.3763/cpol.2010.0648.

van Alphen, K., Voorst, Q. V. T., Hekkert, M. P., & Smits, R. (2007). Societal acceptance of carbon capture and storage technologies. *Energy Policy*, 35(8), 4368-4380. https://doi.org/10.1016/j.enpol.2007.03.006.

Vanclay, F., Baines, J. T., & Taylor, C. N. (2013). Principles for ethical research involving humans: ethical professional practice in impact assessment Part I. *Impact Assessment and Project Appraisal*, 31(4), 243-253. https://doi.org/10.1080/14615517.2013.850307.

Venkatesh, V., & Zhang, X. J. (2010). Unified Theory of Acceptance and Use of Technology: US Vs. China. *Journal of Global Information Technology Management*, 13(1), 5-27. https://doi.org/10.1080/1097198x.2010.10856507.

Visschers, V. H. M., & Siegrist, M. (2012). Fair play in energy policy decisions: Procedural fairness, outcome fairness and acceptance of the decision to rebuild nuclear power plants. *Energy Policy*, 46, 292-300. https://doi.org/10.1016/j.enpol.2012.03.062.

Wallquist, L., L'Orange Seigo, S., Visschers, V. H. M., & Siegrist, M. (2012). Public acceptance of CCS system elements: A conjoint measurement. *International Journal of Greenhouse Gas Control*, 6, 77-83. https://doi.org/10.1016/j.ijggc.2011.11.008.

Wallquist, L., Visschers, V. H. M., Dohle, S., & Siegrist, M. (2012). The Role of Convictions and Trust for Public Protest Potential in the Case of Carbon Dioxide Capture and Storage (CCS). *Human and Ecological Risk Assessment*, 18(4), 919-932. https://doi.org/10.1080/10807039.2012.688719.

Wallquist, L., Visschers, V. H. M., & Siegrist, M. (2009). Lay concepts on CCS deployment in Switzerland based on qualitative interviews. *International Journal of Greenhouse Gas Control*, 3(5), 652-657. https://doi.org/10.1016/j.ijggc.2009.03.005.

Wang, H. K., Tseng, J. F., & Yen, Y. F. (2014). How do institutional norms and trust influence knowledge sharing? An institutional theory. *Innovation-Organization & Management*, 16(3), 374-391. https://doi.org/10.1080/14479338.2014.11081994.

Wang, Y. H., Wang, J. M., & Dong, Z. B. (2022). Interactions and Co-Governance Policies of Stakeholders in the Carbon Emission Reduction. *Sustainability*, 14(10): 5891. https://doi.org/10.3390/su14105891.

Wassermann, S., Schulz, M., & Scheer, D. (2010, Sep 19-23). Linking Public Acceptance with Expert Knowledge on CO₂ Storage: Outcomes of a Delphi Approach. Energy Procedia [10th international conference on greenhouse gas control technologies]. 10th International Conference on Greenhouse Gas Control Technologies, Amsterdam, NETHERLANDS.

Wennersten, R., Sun, Q., & Li, H. L. (2015). The future potential for Carbon Capture and Storage in climate change mitigation - an overview from perspectives of technology, economy and risk. *Journal of Cleaner Production*, 103, 724-736. https://doi.org/10.1016/j.jclepro.2014.09.023.

Williams, K. J. H., & Schirmer, J. (2012). Understanding the relationship between social change and its impacts: The experience of rural land use change in south-eastern Australia. *Journal of Rural Studies*, 28(4), 538-548. https://doi.org/10.1016/j.jrurstud.2012.05.002.

Wilson, R. S., Zwickle, A., & Walpole, H. (2019). Developing a Broadly Applicable Measure of Risk Perception. *Risk Analysis*, 39(4), 777-791. https://doi.org/10.1111/risa.13207.

WU, L. (2025). CCUS in China: Legal and Regulatory Perspectives. In Carbon Capture Utilization and Storage: Law, Policy and Standardization Perspectives (pp. 373-399). Springer.

Wu, M. L. (2013). Structural Equation modeling: An advance in Amos practice. Chongqing University Press.

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation:: An introduction to the concept. *Energy Policy*, 35(5), 2683-2691. https://doi.org/10.1016/j.enpol.2006.12.001.

Xiao, T., Middleton, E., Bakelli, O., Cheng, S. P., Zhu, D. Y., Xu, L., & McPherson, B. (2026). Public Perceptions and Engagement for Carbon Capture, Utilization, and Storage: Literature Review With a Case Study of Utah, USA. *Greenhouse Gases-Science and Technology*, 16(1), 125-157. https://doi.org/10.1002/ghg.2381.

Xu, Y. H., Liu, B. S., Chen, Y., & Lu, S. J. (2023). Public perceived risks and benefits of carbon capture, utilization, and storage (CCUS): Scale development and validation. *Journal of Environmental Management*, 347: 119109. https://doi.org/10.1016/j.jenvman.2023.119109.

Yang, L., Zhang, X., & McAlinden, K. J. (2016). The effect of trust on people's acceptance of CCS (carbon capture and storage) technologies: Evidence from a survey in the People's Republic of China. *Energy*, 96, 69-79. https://doi.org/10.1016/j.energy.2015.12.044.

Yingqing, X., Hasan, N. A. M., & Jalis, F. M. M. (2024). Purchase intentions for cultural heritage products in E-commerce live streaming: An ABC attitude theory analysis. *Heliyon*, 10(5): e26470. https://doi.org/10.1016/j.heliyon.2024.e26470.

Zangerolame Taroco, L. S., & Sabbá Colares, A. C. (2019). The un framework convention on climate change and the paris agreement: Challenges of the conference of the parties. *Prolegómenos*, 22(43), 125-135.

Zeithaml, V. A. (1988). CONSUMER PERCEPTIONS OF PRICE, QUALITY, AND VALUE - A MEANS-END MODEL AND SYNTHESIS OF EVIDENCE. *Journal of Marketing*, 52(3), 2-22. https://doi.org/10.2307/1251446.

Zhai, P., Pörtner, H., Roberts, D., Skea, J., Shukla, P., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., & Connors, S. (2018). Global Warming of 1.5° C. An IPCC Special Report on the impacts of global warming of 1.5° C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change. *Sustainable development, and efforts to eradicate poverty*, 32.

Zhang, A. R., Measham, T. G., & Moffat, K. (2018). Preconditions for social licence: The importance of information in initial engagement. *Journal of Cleaner Production*, 172, 1559-1566. https://doi.org/10.1016/j.jclepro.2017.10.323.

Zhang, L. H., Wang, J. G., & You, J. X. (2015). Consumer environmental awareness and channel coordination with two substitutable products. *European Journal of Operational Research*, 241(1), 63-73. https://doi.org/10.1016/j.ejor.2014.07.043.

Zhang, W., He, L., & Yuan, H. (2022). Enterprises' decisions on adopting low-carbon technology by considering consumer perception disparity. *Technovation*, 117, 102238.

Zhao, X. Y., Nan, D. Y., Chen, C. M., Zhang, S. A., Che, S. P., & Kim, J. H. (2023). Bibliometric study on environmental, social, and governance research using CiteSpace. *Frontiers in Environmental Science*, 10: 1087493. https://doi.org/10.3389/fenvs.2022.1087493.

Zheng, J. J., Yu, L. K., Ma, G., Mi, H. X., & Jiao, Y. Y. (2021). Residents' acceptance towards waste-to-energy facilities: formation, diffusion and policy implications. *Journal of Cleaner Production*, 287: 125560. https://doi.org/10.1016/j.jclepro.2020.125560.

Zhou, H., Zhang, L., Luo, X., Wu, L., Zou, X., Xia, K., Wang, Y., Xu, X., Ge, X., Jiang, Y.-H., Fombonne, E., Yan, W., & Wang, Y. (2017). Modifying the Autism Spectrum Rating Scale (6-18 years) to a Chinese Context: An Exploratory Factor Analysis. *Neuroscience Bulletin*, 33(2), 175-182. https://doi.org/10.1007/s12264-017-0104-7.

APPENDIXES

APPENDIX A

Questionnaire (English Version)

Appendix A. Questionnaire (English Version)

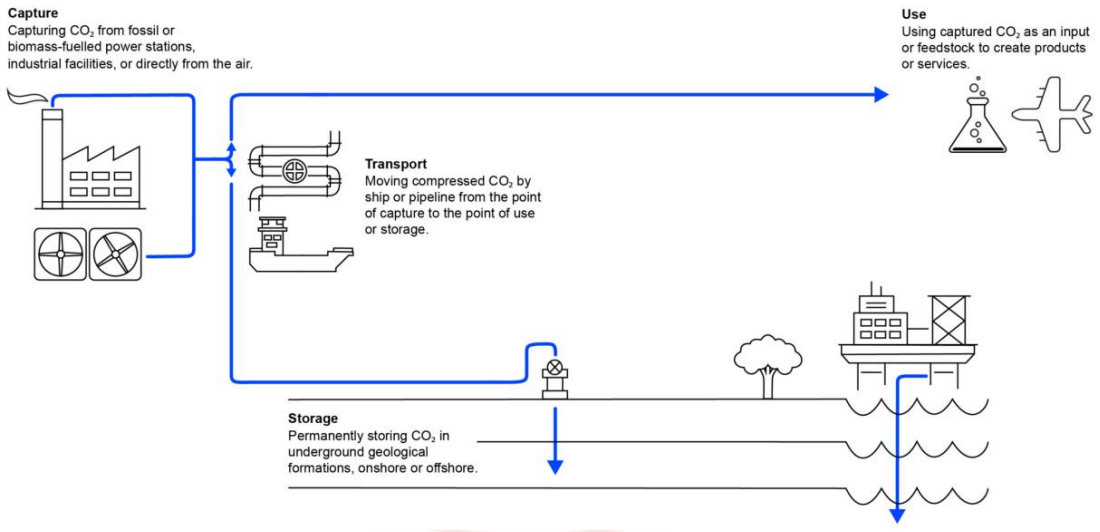
Rattanakosin International College of Creative Entrepreneurship
Of Rajamangala University of Technology, Rattanakosin
Questionnaire survey on public acceptance of CCUS project in Guizhou

---

Hello, I am a Ph.D. student from Royal Institute of Technology, Lantana Gongxin, Thailand. Due to the need of my graduation thesis, I am currently conducting a research on the public acceptance of CCUS project in Guizhou. Thank you for taking time out of your busy schedule to fill in this questionnaire. This questionnaire is anonymous, and all the data are used for academic research, and will not reveal any of your privacy!

There is no right or wrong answer to each question. Please answer according to your actual situation. Thank you again! Your careful filling will be of great help to me. I wish you good health and a happy life!

CCUS project is a project based on carbon capture, carbon utilization and carbon sequestration, which is of great significance in environmental protection. The schematic diagram of the process is as follows:



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

However, because the site selection of CCUS construction projects and the application and promotion of CCUS related products are related to public life, its public acceptance is challenged to some extent. (* stands for required questions)

If you can understand the concept of CCUS and are willing to continue to be investigated, please answer the question:

Part I: Personal Basic Information

1. What is your Gender?*

☐ Male

☐ Female

2. What's your age？ *

☐ From 18 to 30 ☐ From 31 to 40

☐ From 41 to 50 ☐ More than 51

3. What is your highest educational qualifications？ *

☐ High school, technical secondary school and below

☐ College graduate

☐ Undergraduate College

☐ Master degree or above

4. What is your current occupation？ *

☐ Staff of state organs and institutions ☐ Employees of enterprises/companies

☐ Doctor or nurse ☐ Teacher

☐ Retiree ☐ Student

☐ Others _____

5. What is your average monthly income? *

☐ Under3000 ☐ 3001-5000

☐ 5001-8000 ☐ 8001-10000

6. Which city do you live in?*

☐ Guiyang ☐ Liupanshui

☐ Anshun ☐ Zunyi

☐ Tongren ☐ Bijie

☐ Qiandongnan prefecture ☐ Qianxinan prefecture

☐ Qiannan prefecture

Part II: Explore the influencing factors of CCUS project public acceptance.

The following are the questionnaire questions. Please choose the option that best suits your situation according to your subjective feelings about developing CCUS project. Thank you for your serious answer! 1 represents very different opinions, 2 represents disagreement, 3 represents general, 4 represents agreement and 5 represents very agreement, and the influence degree is gradually increasing.

8. Regarding the influencing factors of public acceptance of CCUS project, please choose the option that best suits your situation.

Measurement Scales and Items

Question Number	Question	Score(1-5)				
		1	2	3	4	5
Perceived Risks: PR						
PR1:	Carbon capture, utilization and storage (CCUS) is an immature technology, and accidents may occur during its implementation in Guizhou.					
PR2:	The transportation of carbon dioxide is very dangerous. During the transportation process in Guizhou, the leakage of carbon dioxide is harmful to the environment.					
PR3:	The geological storage of carbon dioxide in Guizhou poses a danger and may trigger earthquakes in Guizhou.					
PR4:	Carbon dioxide products are harmful to human health.					
PR5:	CCUS is harmful, and allowing the use of fossil fuels will further worsen the environment.					

Question Number	Question	Score(1-5)				
		1	2	3	4	5
Perceived Benefits: PB						
PB1	Carbon capture, utilization and storage (CCUS) is an environmental protection technology that can effectively alleviate climate change in Guizhou.					
PB2	CCUS is a reliable technology, which can improve oil recovery and oil supply.					
PB3	CCUS is a sustainable technology, which can reduce the dependence on fossil resources.					
PB4	CCUS is beneficial to the development of low-carbon economy.					
PB5	Carbon capture, utilization and storage (CCUS) is a mature technology that can provide more job opportunities for Guizhou.					
Environmentalism: EN						
EN1	CCS technology is an effective means to slow down climate change.					
EN2	CCS will improve our energy efficiency and reduce energy consumption.					
EN3	CCS can reduce carbon dioxide emissions.					
EN4	CCS technology is beneficial to environmental protection.					
EN5	I think "not reducing carbon dioxide emissions means that we just pass the buck to the next generation."					

Question Number	Question	Score(1-5)				
		1	2	3	4	5
Public Cognition: PC						
PC1	I've heard of CCUS.					
PC2	I have some knowledge about the application of carbon dioxide capture technology in Guizhou.					
PC3	I have some knowledge about the carbon dioxide transportation process suitable for Guizhou.					
PC4	I have some knowledge about the utilization of carbon dioxide that is suitable for Guizhou.					
PC5	I have some knowledge about carbon dioxide storage suitable for Guizhou.					
Trust: TR						
TR1	I believe that stakeholders in CCUS can judge risks and predict returns.					
TR2	I believe that the risk and benefit information provided by CCUS stakeholders is objective.					
TR3	I believe that the stakeholders of carbon capture, utilization and storage (CCUS) will promptly inform the public of Guizhou of the risks and benefits.					
TR4	If an accident occurs in a carbon capture, utilization and storage (CCUS) project, I believe that the project implementers have the ability to protect the interests of the public in Guizhou.					
TR5	I believe that the stakeholders of CCUS are environmentalists.					

Question Number	Question	Score(1-5)				
		1	2	3	4	5
Fairness: FR						
FR1	I believe that the decision-making process for the carbon capture, utilization and storage (CCUS) project carried out in Guizhou is open and transparent.					
FR2	Economic compensation (such as taxes paid by operators) offsets the adverse factors that may be encountered during the implementation of CCUS projects (such as accident risks and construction disturbances).					
FR3	Before implementing carbon capture, utilization and storage (CCUS) projects, Guizhou will provide adequate publicity and notification.					
FR4	The public in Guizhou will have a say in the decision-making process of local carbon capture, utilization and storage (CCUS) projects.					
FR5	When I raised questions about the implementation results of a carbon capture, utilization and storage (CCUS) project to be carried out in Guizhou, I received a very good response.					
Legal protection: LP						
LP1	The legal system concerning CCUS protects the public in Guizhou from suffering losses.					
LP2	The current environmental laws and regulations in place can restrict the impact of carbon capture, utilization and storage (CCUS) projects in Guizhou on the surrounding public.					

Question Number	Question	Score(1-5)				
		1	2	3	4	5
LP3	According to the relevant provisions of the Environmental Impact Assessment Law, the public in Guizhou can participate in the environmental impact assessment of relevant CCUS projects through appropriate means.					
LP4	I believe that the decision-making process for carbon capture, utilization and storage (CCUS) projects in Guizhou will be carried out in accordance with the law.					
LP5	The current legal system regarding CCUS projects will protect the public in Guizhou from being deceived.					
Public Acceptance: PA						
PA1	I think it is acceptable to carry out carbon capture, utilization and storage (CCUS) in Guizhou.					
PA2	I support the large-scale development of carbon capture, utilization and storage technology in Guizhou.					
PA3	I can accept carbon dioxide transportation pipeline through my residential area.					
PA4	Public finance should be used to support CCUS.					
PA5	I am a supporter of CCUS-related public training.					

APPENDIX B

Publication of Journal during Ph.D. Study

APPENDIX B. Publication of Journal during Ph.D. Study

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

Deng Chaoyan[1], Dai Chunyan[2*]

[1,2] Rattanakosin International College of Creative Entrepreneurship, Rajamangala University of Technology Rattanakosin, Nakhon Pathom 73170, Thailand.

[1] Email: deng.chaoyan@rmutr.ac.th

[2*] Email: chunyan.dai@rmutr.ac.th

Corresponding Author:

Dai Chunyan

Email: chunyan.dai@rmutr.ac.th

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).

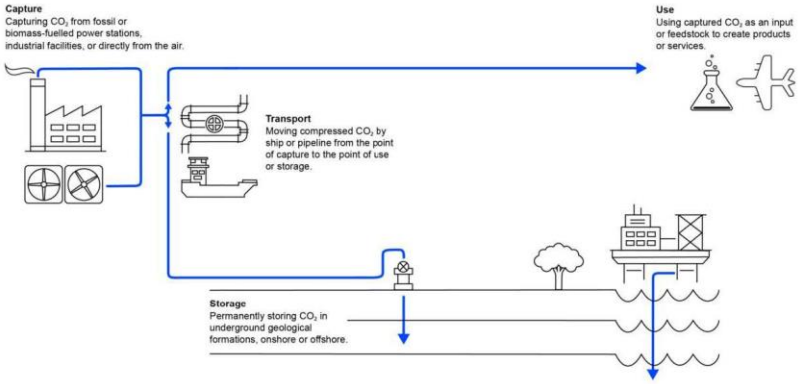


Figure 1.1 Schematic Diagram of CCUS(Carbon Capture, Utilization and Storage)

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.

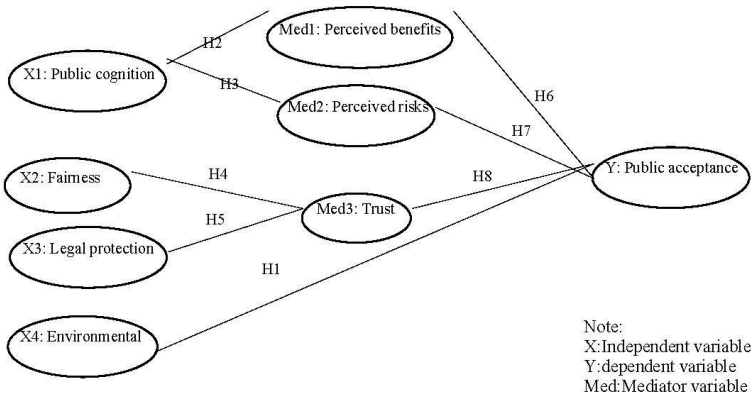


Figure 2 Research Model Based on Literature Review

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	0.01	-0.054	-0.083	**0.708**
A3	-0.057	-0.009	-0.007	0.005	0.06	-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	R	P	N	B	R	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	.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.

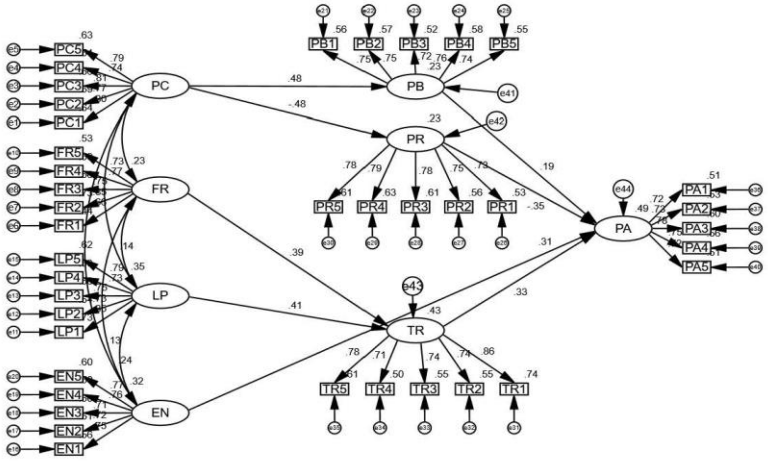


Figure 3 Fitting Results of Structural Equation Model

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.

Finally, 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.

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..

References

Ashworth, P., Sun, Y., Ferguson, M., Witt, K., & She, S. (2019). Comparing how the public perceive CCS across Australia and China [; Proceedings Paper]. International Journal of Greenhouse Gas Control, 86, 125-133. https://doi.org/10.1016/j.ijggc.2019.04.008

Beribisky, N., & Cribbie, R. A. (2024). Evaluating the performance of existing and novel equivalence tests for fit indices in structural equation modelling. British Journal of Mathematical & Statistical Psychology, 77(1), 103-129. https://doi.org/10.1111/bmsp.12317

Birkle, I., Klink-Lehmann, J., & Hartmann, M. (2022). Different and alike: Level and determinants of public acceptance of fattening pig, beef cattle and broiler farming in Germany. Meat Science, 193, Article 108946. https://doi.org/10.1016/j.meatsci.2022.108946

Brunsting, S., Upham, P., Duetschke, E., Waldhober, M. D. B., Oltra, C., Desbarats, J., Riesch, H., & Reiner, D. (2011). Communicating CCS: Applying communications theory to public perceptions of carbon capture and storage. International Journal of Greenhouse Gas Control, 5(6), 1651-1662. https://doi.org/10.1016/j.ijggc.2011.09.012

Council, T. S. (2022, 2022-1-18). The State Council's opinion on supporting Guizhou to break new ground in the western development in the new era. (Guo Fa [2022] No.2). The State Council, People's Republic of China (PRC). https://www.gov.cn/zhengce/zhengceku/2022-01/26/content_5670527.htm

Gough, C., & Mander, S. (2022). CCS industrial clusters: Building a social license to operate. International Journal of Greenhouse Gas Control, 119, Article 103713. https://doi.org/10.1016/j.ijggc.2022.103713

Hall, N., Lacey, J., Carr-Cornish, S., & Dowd, A.-M. (2015). Social licence to operate: understanding how a concept has been translated into practice in energy industries. Journal of Cleaner Production, 86, 301-310. https://doi.org/10.1016/j.jclepro.2014.08.020

Hemmert, M., Kim, D., Kim, J., & Cho, B. (2016). Building the supplier's trust: Role of institutional forces and buyer firm practices. International Journal of Production Economics, 180, 25-37. https://doi.org/10.1016/j.ijpe.2016.05.023

Huang, L., He, R., Yang, Q., Chen, J., Zhou, Y., Hammitt, J. K., Lu, X., Bi, J., & Liu, Y. (2018). The changing risk perception towards nuclear power in China after the Fukushima nuclear accident in Japan. Energy Policy, 120, 294-301. https://doi.org/10.1016/j.enpol.2018.05.007

Hurlimann, A., Hemphill, E., McKay, J., & Geursen, G. (2008). Establishing components of community satisfaction with recycled water use through a structural equation model. Journal of Environmental Management, 88(4), 1221-1232. https://doi.org/10.1016/j.jenvman.2007.06.002

IEA. (2017). Energy technology perspectives 2017.

Jones, C. R., Olfe-Kraeutlein, B., & Kaklamanou, D. (2017). Lay perceptions of Carbon Dioxide Utilisation technologies in the United Kingdom and Germany: An exploratory qualitative interview study. Energy Research & Social Science, 34, 283-293. https://doi.org/10.1016/j.erss.2017.09.011

Lima, P. R., Martins Pereira, A. A., Diniz Chaves, G. d. L., & Meneguelo, A. P. (2021). Environmental awareness and public perception on carbon capture and storage (CCS) in Brazil. International Journal of Greenhouse Gas Control, 111, Article 103467. https://doi.org/10.1016/j.ijggc.2021.103467

Liu, B., Xu, Y., Yang, Y., & Lu, S. (2021). How public cognition influences public acceptance of CCUS in China: Based on the ABC (affect, behavior, and cognition) model of attitudes. Energy Policy, 156, Article 112390. https://doi.org/10.1016/j.enpol.2021.112390

Luo, Y., Qin, J., Cai, J., & Tang, Y. (2023). The Influencing Factors of CO₂ Utilization and Storage Efficiency in Gas Reservoir. Applied Sciences-Basel, 13(6), Article 3419. https://doi.org/10.3390/app13063419

Mon, M. T., Tansuchat, R., & Yamaka, W. (2024). CCUS Technology and Carbon Emissions: Evidence from the United States. Energies, 17(7), Article 1748. https://doi.org/10.3390/en17071748

Parelius, J. M. (1998). Multivariate analysis based on data depth (Publication Number 978-0-591-75993-8) [Dissertation/Thesis, <Go to ISI>://PQDT:64781072

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies [; Review]. The Journal of applied psychology, 88(5), 879-903. https://doi.org/10.1037/0021-9010.88.5.879

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models [; Research Support, N.I.H., Extramural]. Behavior research methods, 40(3), 879-891. https://doi.org/10.3758/brm.40.3.879

Saito, A., Itaoka, K., & Akai, M. (2019). Those who care about CCS-Results from a Japanese survey on public understanding of CCS [; Proceedings Paper]. International Journal of Greenhouse Gas Control, 84, 121-130. https://doi.org/10.1016/j.ijggc.2019.02.014

Seigo, S. L. O., Arvai, J., Dohle, S., & Siegrist, M. (2014). Predictors of risk and benefit perception of carbon capture and storage (CCS) in regions with different stages of deployment. International Journal of Greenhouse Gas Control, 25, 23-32. https://doi.org/10.1016/j.ijggc.2014.03.007

Sitinjak, C., Ebennezer, S., & Ober, J. (2023). Exploring Public Attitudes and Acceptance of CCUS Technologies in JABODETABEK: A Cross-Sectional Study. Energies, 16(10), Article 4026. https://doi.org/10.3390/en16104026

Storrs, K., Lyhne, I., & Drustrup, R. (2023). A comprehensive framework for feasibility of CCUS deployment: A meta-review of literature on factors impacting CCUS deployment. International Journal of Greenhouse Gas Control, 125, Article 103878. https://doi.org/10.1016/j.ijggc.2023.103878

Swerdfager, T. M. (1988). The effects of Native land claims on public participation in environmental impact assessment in the Canadian North (Publication Number 978-0-315-53839-9) [Dissertation/Thesis, <Go to ISI>://PQDT:65252867

Terwel, B. W., & Daamen, D. D. L. (2012). Initial public reactions to carbon capture and storage (CCS): differentiating general and local views. Climate Policy, 12(3), 288-300. https://doi.org/10.1080/14693062.2011.637819

van Os, H. W. A., Herber, R., & Scholtens, B. (2014). Not Under Our Back Yards? A case study of social acceptance of the Northern Netherlands CCS initiative [Review]. Renewable & Sustainable Energy Reviews, 30, 923-942. https://doi.org/10.1016/j.rser.2013.11.037

Visschers, V. H. M., & Siegrist, M. (2012). Fair play in energy policy decisions: Procedural fairness, outcome fairness and acceptance of the decision to rebuild nuclear power plants. Energy Policy, 46, 292-300. https://doi.org/10.1016/j.enpol.2012.03.062

Wallquist, L., Visschers, V. H. M., & Siegrist, M. (2009). Lay concepts on CCS deployment in Switzerland based on qualitative interviews. International Journal of Greenhouse Gas Control, 3(5), 652-657. https://doi.org/10.1016/j.ijggc.2009.03.005

Wallquist, L., Visschers, V. H. M., & Siegrist, M. (2010). Impact of Knowledge and Misconceptions on Benefit and Risk Perception of CCS. Environmental Science & Technology, 44(17), 6557-6562. https://doi.org/10.1021/es1005412

Wang, Y., Wang, J., & Dong, Z. (2022). Interactions and Co-Governance Policies of Stakeholders in the Carbon Emission Reduction. Sustainability, 14(10), Article 5891. https://doi.org/10.3390/su14105891

Xiang, X., Li, K., Li, X., & Hou, Y. (2023). Investment feasibilities of CCUS technology retrofitting China's coal chemical enterprises with different CO2 geological sequestration and utilization approaches. International Journal of Greenhouse Gas Control, 128, Article 103960. https://doi.org/10.1016/j.ijggc.2023.103960..

VITAE

Name - Surname	Miss Chaoyan Deng
Date of Birth	August 22, 1988
Place of Birth	Hunan, China
Address	Wugang City, HunanProvince, China
Workplace	Liupanshui Normal University

Education Background

2020-present	Doctor Degree in Philosophy in Management Rajamanagala University of Technology Rattanakosin, Thailand
2010-2013	Master degree, Liaoning Normal University, China
2006-2010	Bachelor degree, Liaoning Normal University, China

Work Experience

2013-present	Lecturer, Liupanshui Normal University

Honors and Awards:

2022	Host Guizhou Social Sciences “Theoretical Innovation Project” special fund supported project (No. GZLCZB-2022-3-5-1)
2020	Host The Youth Science and Technology Talent Growth Project of the Department of Education of Guizhou Province (No.Qian Jiao He XY Zi [2020]127)

Publication of Journals during Ph.D. Study

Deng, C. and Dai, C. (2026). Harmony, Risk, and Trust: Public Acceptance of CCUS Projects in Guizhou Province, China from a Daoist Ecological Perspective. *Journal of Daoist Studies*, 19(S1), 43–63.