



Life Cycle Perspectives on Carbon Capture and Storage for Sustainable Net-Zero Transitions

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ABSTRACT

Climate change is currently one of the serious environmental concerns that affects a wide range of sectors globally, including the stability of ecosystems, sustainability of economies, and resilience of communities. Consequently, there is a need to approach this menace with equal urgency and a search for sustainable alternatives. Among the proposed solutions, Carbon Capture and Storage (CCS) technology garnered a crucial spot as the antagonist against climate change (Shu et al., 2023). CCS is an active way of locking up CO₂ emissions at their point of origin, transporting them, and finally storing them safely underground so they can't have a negative impact on our planet. This paper takes a lifecycle approach to examining the contribution of CCS to reaching the net-zero target.

1. INTRODUCTION

True to its noble purpose, CCS's potential, as well as its realistic assessment, is, sadly, by and large, insufficiently known to the public. The performance measurements that are currently used are usually incomplete as they commonly evaluate only part of CCS tailoring, thus leading to wrongful conclusions about the performance. Besides this factor, there are economic, policy, and societal barriers that stand in the way of CCS deployment worldwide, which, in effect, fully limits its ability to help reduce emissions globally (Gabrielli et al., 2020; AlNajdawi et al., 2024; AlShawabkeh et al., 2013; Yas et al., 2024). However, the way the public perceives CCS is also very influential in the determination of whether it is widely accepted or rejected CCS technology (Becattini et al., 2021).

Carbon Capture and Storage (CCS) has become one of the significant technological interventions to

reduce the negative effects of greenhouse gas emissions, especially carbon dioxide, of industrial and energy-related sources (Shwedeh, 2022; Ahmed et al., 2024). With the ever-increasing temperature levels of the world caused by human activities, drastic measures must be taken to minimize the emission rates and transition to a more sustainable future of energy (Som et al., 2023; El Khatib et al., 2023; Shwedeh & F., 2022). CCS also has a potential to reduce emissions significantly even though it is possible to use fossil fuels till cleaner energy systems are implemented. Although CCS is technically feasible and is compliant with global climate goals, it is still relatively underused and, more to the point, misconceived (Alzoubi et al., 2024; Razmak et al., 2018; El Khatib et al., 2022). A significant part of the current debate on climate change touches on renewable energy, without taking into account CCS as a legitimate and complementary approach to cutting down on

emissions, particularly in hard-to-abate industries such as cement, steel, and chemical manufacture. There is a more fundamental problem with the fragmented knowledge and communication of CCS performance and utility. In many cases, CCS project evaluations do not consider the entire life cycle of managing the carbon, not only by capturing and transporting it, but also by storing it over time. Such half assessments may result in misconception of CCS effectiveness, which can cause distrust and opposition (Al-Kassem et al., 2022; Kharbat et al., 2021; Shwedehe et al., 2024). Additionally, CCS implementation is also negatively affected by incoherent policies, a lack of economic incentives, and an overall deficiency in the public awareness or confidence. The role of the public perception is crucially important in the overall adoption or non-adoption of CCS technologies; the lack of knowledge or unfavorable attitude can be the stop of the projects and the way of the decisions by the regulatory authorities (Joghee et al., 2020; AlQassem, 2022; Karthika et al., 2024). Thus, extensive research is badly needed that goes beyond the technical and economic sphere to embrace the societal and perceptual ones. The quantitative survey-based research method is expected to allow obtaining a more comprehensive image of the perception and vision of CCS and contribute to the creation of more efficient strategies to implement it and integrate it with the population. The objective of this research is to overcome these challenges by using a quantitative approach that is based on surveys so that the necessity, amenity and nature of CCS should be understood more broadly.

1.1. Research Objectives

The central aim of the study is to place emphasis on the functions of the CCS in reaching net zero emissions through a quantitative examination of its lifecycle. Specifically, the research aims to:

1. Evaluate the complete environmental impacts of CCS technology by looking at it from start to end, taking into consideration all processes from capture to storage.
2. Analyze the energy consumption of every CCS step, as well as the resultant greenhouse gas emissions and carbon footprint.
3. Highlight economic and policy barriers that act as inhibiting factors to the extension of sulfur dioxide capture and determine

viable solutions.

4. Look into the public mindset about CCS technology and examine the factors that can cause its adoption or refusal.

1.2. Research Questions

To achieve the stated objectives, this research addressed the following key questions:

1. What are the full life cycle environmental impacts of carbon capture and storage (CCS) technology in the context of net zero emissions?
2. How do the energy requirements for the capture, transportation, and storage phases of CCS affect its carbon footprint?
3. What economic and policy barriers exist that impede the widespread adoption of CCS, and how can they be overcome?
4. How does public perception influence the deployment of CCS technology, and what factors contribute to its acceptance or rejection by society?

1.3. Scope of the Study

This paper takes a global view of CCS in the context of a variety of industries and sectors polluting with carbon emissions. The study carried out to look at CCS projects as being spread all over different regions to get a better picture of both its feasibility and difficulties. Nonetheless, the study does not discuss the technical issues of CCS technology but rather highlights its larger scope, e.g., its environmental, economic, and societal impact.

1.4. Structure of the Research

The remainder of this research is organized as follows: Chapter 2 focuses on a critical literature review in which the available articles were evaluated, bringing together the existing research on CCS and exploring what doesn't exist yet. Chapter 3 describes the theoretical framework, where the principal variables are mentioned and tested hypotheses are presented. Chapter 4 designates research design, which includes using survey methodology, item development, and sampling processes. Chapter 5 is about data gathering methods, and Chapter 6 discusses the data analysis of the survey and relates the findings to the research questions. The last chapter summarizes the investigation results and highlights the recommendations that can be drawn from them.

2. CRITICAL LITERATURE REVIEW

2.1. Environmental Impacts of CCS

Numerous research studies conducted under laboratory conditions have studied the consequences of carbon capture and storage (CCS) for the environment, pointing out that it can reduce the accumulation of greenhouse gases and the average global temperature. Hong (2022) demonstrates the highly potent CCS reducing CO₂ emissions average of 80-90% for power plants that rely on fossil fuels (Joghee et al., 2018; Alzoubi et al., 2025; Som et al., 2023). However, getting the environmental benefits from CCS is very dependent on the energy source for CCS operations, as other CO₂ capture technologies are crucial factors (Hao et al., 2022). Also, it is LCA CCS (LCACC), which has shown that there are potential environmental trade-offs in the process that have to be very carefully assessed. Regarding the CCS, capturing CO₂ emissions at the turn of its capture process is one of its benefits (Alshurideh et al., 2025; Sihag et al., 2024; El Khatib et al., 2022). However, the energy-intensive nature of the processes in capture, transport, and storage may pile up higher emissions in the lifecycle itself (Tokimatsu et al., 2017). The problem of potential leakage from storage sites is also among the environmental risks that people are trying to mitigate. Similar to these perceptions, research shows that a well-characterized and robust geological formation could be the most secure and lasting form of storage (Kharbat et al., 2017; Anifa et al., 2024; Salloum et al., 2024; Alshurideh et al., 2022; Joghee et al., 2018; Kumar et al., 2024).

The environmental effects of Carbon Capture and Storage (CCS) are complex and encompass both positive and negative effects, depending on the implementation stage, technology employed and the geographical factors (AlAmiri et al., 2024; Hanaysha et al., 2021; AlQassem et al., 2024). On the other hand, CCS is largely meant to cut down on the emission of greenhouse gases by trapping CO₂ in large point sources including power plants, cement industries, and refineries and burying it in underground geological formations (AlShawabkeh et al., 2023; Shwedeh et al., 2024; El Khatib et al., 2024). The impact of this decrease in emissions is a significant contribution to curbing global warming and addressing global climate targets, including the Paris Agreement (IPCC, 2022). CCS

can play a tremendous role in mitigating climate change, particularly in areas where emissions are otherwise hard to eliminate, by preventing the entry into the atmosphere of millions of tons of CO₂ each year (Kabiraj et al., 2011; Joghee et al., 2021; Rosmadi et al., 2025). Besides, combined with bioenergy (in Bio-CCS or BECCS), it may result in net-negative emissions, required to offset residual emissions in a net-zero future (Tanzer & Ramirez, 2019). The process is also useful in increasing the life of the existing fossil-fuel infrastructure whilst giving renewable technologies time to scale (Alzoubi et al., 2024; Anifa et al., 2024; Shao et al., 2025).

Nonetheless, the usage of CCS also has some environmental issues that should be closely considered. The long-term integrity of the CO₂ storage sites is one of the main risks (Joghee et al., 2013; Habbal et al., 2019; Alshurideh et al., 2025). Although geological features like depleted oil and gas deposits or deep salty aquifers may be regarded as safe, any spillage of the stored CO₂ may reduce the benefits of capture, may lead to acidification of groundwater or may pose health hazards to the people living close to it (Sihag et al., 2024; Treacy et al., 2025; El Khatib et al., 2023). Even the capture itself may be a consuming activity, and as a result, a phenomenon of the so-called energy penalty can be observed, which can necessitate the use of more fossil fuel and which can also lead to other environmental costs, including air pollution emissions and water usage (AlMidfa et al., 2024; Naim et al., 2024; Khan et al., 2023). Moreover, the infrastructures needed to operate CCS such as pipelines, compressors and injection wells may cause land disturbances, habitat fragmentation and may affect biodiversity (Shwedeh et al., 2023; AlQassem, 2022; Kofinas et al., 2016). These environmental trade-offs emphasize the need to have lifecycle assessment, rigorous monitoring system, and effective regulatory frameworks that would make sure that CCS is capable of achieving its climate mitigation potential without causing unintended impacts to the ecosystems or human health.

2.2. Economic Viability of CCS

The economic feasibility of CCS in the absence of proper CCS policy is still very controversial, and, therefore, different views on the economic viability of CCS are backed in the literature (Al-Qassem et al.,

2024; Naim et al., 2024; AlKurdi et al., 2023). The projects that were looked upon to delineate the picture of CCS posed a challenge, arguing that it may be economically undesirable, with opponents suggesting that it may not be widely used as an emissions reduction strategy (Fan et al., 2023; Yas et al., 2024; El Khatib et al., 2024; Alblooshi et al., 2025). Nevertheless, recent evaluations have shown the nature of change, which is characterized by the drop in technology costs as well as the effect of production size due to technical advances (Kumar et al., 2024; Ahmed et al., 2024; Alshurideh et al., 2024). Significantly, during the course of the last 10 years, the CCS cost for power generation has dropped to approximately 60%, suggesting the rising competitiveness of CCS as compared to other low-carbon technologies (Peters & Sognnæs, 2019). Although these positive developments have been successful, the following difficulties remain pivotal, especially when it comes to investing in and incentivizing CCS (Al-Qassem et al., 2021; Rana et al., 2025; Halder et al., 2024). According to the International Energy Agency (IEA), the two main problems hindering CCS from introducing carbon capture to the full extent of its possibilities are lacking good policy support and effective carbon prices (Martin-Roberts et al., 2021). This lack of supportive rule-making set-ups, as the reason, significantly hinders investments in CCS, causing only a small-scale dispersal compared to what it might be when implemented under suitable conditions (Lau et al., 2021; Alzoubi et al., 2024; Pande et al., 2024; Al-Nakeeb et al., 2024). Another important factor adding to the lukewarmness of the private sector towards project inventions is the market- uncertainties, such as struggling carbon prices and regulatory environment changes that create more hurdles to the projects (Chlela & Selosse, 2024; Kanwal et al., 2023; AlMidfa et al., 2024; El Khatib et al., 2023). At the core is the fact that though the economic environment for CCS has shaken up a little bit, key obstacles still remain that act as barriers to its rapid uptake (Khatib et al., 2024; Hanaysha et al., 2021; AlNajdawi et al., 2024).

Economic feasibility of Carbon Capture and Storage (CCS) is one of the most controversial and not most straightforward features of its extensive usability (Razmak et al., 2018; Murtaza et al., 2024; Yasir et al., 2024). Although CCS has a lot of potential as a technology that can dramatically decrease CO₂

emissions, particularly in hard-to-abate sectors such as cement, steel, and petrochemicals, its high cost has frequently been cited as one of the primary obstacles to deployment (Neyara Radwan et al., 2025; El Khatib et al., 2022; Joghee et al., 2020). CCS costs occur at every phase of its operation and capture, which is the primary phase, contributes to up to 70 percent of all costs (AlShawabkeh et al., 2016; AlKatheeri et al., 2025; Naim et al., 2025). The capital cost of CCS infrastructure such as specialized equipment and pipeline networks is very high and the operation costs are continuous. In addition, energy cost of the capture process increases fuel consumption, which also contributes to the economic burdens. Unless CCS is strongly policy favored (via carbon pricing, tax credits, or subsidies), it may not be cost-competitive with other types of emission reduction, particularly in markets where renewable energy sources are rapidly becoming less expensive (Alzoubi et al., 2024; El Khatib et al., 2023; Joghee et al., 2024). Nevertheless, economic prospects of CCS are slowly changing as technology advances, policy backing, and awareness on the need to adopt it, rise (Alshurideh et al., 2022; AlNajdawi et al., 2024; Ma'asor et al., 2023). Efforts such as the U.S. 45Q tax credit, the European Union Innovation Fund as well as the increasing amount of carbon pricing schemes around the world have started to supply the financial stimulus necessary to drive investment (Alzoubi et al., 2025; El Khatib et al., 2024; Kanwal et al., 2023). Moreover, the cost is also expected to be reduced in the long term by economies of scale and learning-by-doing, especially in modular capture technology and common infrastructure models (AlHamadi et al., 2024; El Khatib et al., 2023; Khan et al., 2024). CCS may even offer economic opportunity in other situations, with the so-called enhanced oil recovery (EOR) in which captured CO₂ is reinvested into closed oil fields in order to boost production, providing a stream of revenue which can be used to partially cover the costs (Shwedeh et al., 2024; Khan et al., 2024; El Khatib et al., 2023). Furthermore, CCS, particularly as BECCS or Direct Air Capture with Storage (DACCS), might be more cost effective and crucial as a means of carbon removal because it becomes more significant in mitigating residual emissions (AlShawabkeh et al., 2017; Maydybura et al., 2024; Karthika et al., 2024). Hence, CCS is not the lowest cost mitigation

solution yet, but its strategic contribution to the ultimate decarbonization of numerous sectors also warrants the increased financial investment of people and industries, particularly when the long-term climate targets are considered (Shwedeh & F., 2021; Shao et al., 2025; Kabiraj et al., 2009).

2.3. Societal Acceptance of CCS

Community support for Carbon Capture and Storage (CCS) as an effective tool proves to be a key factor in achieving its widespread use; however, the complexity of public opinion towards the technology is seen more in recent research (Karthika et al., 2024; Naim et al., 2025; Murtaza et al., 2024). Some surveys show the public's generally positive disposition towards CCS as a component of the complex climate mitigation strategies overall, whereas some others highlight the public's fears and uncertainties associated with CCS, all stemming from CO₂ storage risks (Shu et al., 2023; Alshurideh et al., 2025; Khatib et al., 2024; AlKurdi et al., 2025). Furthermore, CCS social acceptance depends on ways in which the influence of cultural issues on community values challenges the belief that environmental effects have a deeper meaning (Treacy et al., 2025; AlKatheeri et al., 2025; Shehab et al., 2023). Because of the complex nature of this problem, the regulatory authorities' trustworthiness, transparency in the decision-making process, and local communities' welfare play an important role, yet they are not enough (AlShawabkeh et al., 2023; Shao et al., 2025; Ilyas et al., 2023). According to Gabrielli et al. (2020), it seems that the situation is more complicated. To be more precise, it was found that a strongly organized community engagement program, along with a stakeholder consultation process, responsible for the success of any CCS project (Khan et al., 2023; Rosmadi et al., 2025; Kukunuru et al., 2019). The community trust in the project maintained; thus, the concerned parties avoid showing any form of opposition (Peters & Sognnæs, 2019).

2.4. Gaps in Literature and Future Research Directions

With the amount of research on carbon capture and storage (CCS), the knowledge gap is still there, and there is a need for the research to continue (Joghee et al., 2024; AlShawabkeh et al., 2021; Joghee et al., 2021). First and foremost, a thorough life cycle

analysis of the environmental effects of CCS is an urgent prerequisite. Such evaluations should comprise information from a variety of projects and geographical regions to deliver the comprehensibility of technology's footprint on nature (Hao et al., 2022; Alzoubi et al., 2025; Ma'asor et al., 2023; Nuseir et al., 2021). Also, it should be noted that a research question aimed at the economic viability of CCS could be further investigated, giving additional focus to the importance of policy frameworks and markets in investment and deployment stimulation (Vij et al., 2025; Kharabsheh et al., 2024; Kabiraj et al., 2009). Knowledge of how these policies interact and dynamically work with the market and ongoing technology is an important factor in bringing out how CCS becomes an important emissions reduction strategy (AlQassem et al., 2022; Lee et al., 2024; Khadragy et al., 2022). Besides, the fact that the CCS acceptance research periodically monitored and trend analyzed can greatly help in making adjustments where necessary (Hong, 2022; Samer Hamadneh et al., 2023; Alshurideh et al., 2022; Tangri et al., 2023). By making use of a long-term approach, the researchers may distinguish the existing trends of public opinion, single out the underlying issues for the growing incapability of society to accept CCS, and develop strategies that can enable them to build a CCS culture in society (AlShawabkeh et al., 2018; Joghee et al., 2023; Sun et al., 2016). Generally, these knowledge voids could be filled by rigorous research that furthers the development and utilization of CCS as one of the solutions against climate change (AlShawabkeh et al., 2014; Kanwal et al., 2023; Nazeer et al., 2025).

3. THEORETICAL FRAMEWORK DEVELOPMENT

The theoretical framework serves as the conceptual backbone of this research, providing a structured lens through which to analyze the interplay of variables relevant to Carbon Capture and Storage (CCS) technology.

3.1. Dependent Variable: Public Perception of CCS

The main focus of this research is how public perception of carbon capture and storage (CCS) forms the dependent variable. It rather portrays the collective beliefs, values, and emotions of the whole society regarding the implementation of CCS

(Yang et al., 2016). Public opinion evaluated using survey questions, which are designed to find out how aware CCS is, how these respondents react to the idea, and whether or not they support CCS as a climate mitigation strategy.

3.2. Independent Variables: Economic Factors, Policy Frameworks, and Trust in Regulatory Authorities

Economic factors include various economic aspects that may affect public opinion about CCS, such as cost-effectiveness, job growth, and affordability (AlHamadi et al., 2024; El Khatib et al., 2023; Nuseir et al., 2019). Survey responses were centered around respondents' evaluations of CCS viability for the economy, including job creation and household income (Tanveer et al., 2025; Kofinas et al., 2016; El Khatib et al., 2024). Also, policy frameworks cover the system of the rules and laws that regulate the CCS application, both on carbon pricing tools like subsidies and incentives (Yang et al., 2016). The survey questions were determined whether a respondent has knowledge of existing policies regarding CCS and their views on the success of these policies in ensuring that CCS adoption is encouraged (Yasir et al., 2024; AlKatheeri et al., 2025; Rana et al., 2025). Furthermore, public trust in rule-making institutions depends on the percentage of people who believe in the government and rule-making authorities working on carbon capture and storage (Romasheva & Ilinova, 2019). Survey questions inquire into the respondents' perspectives of the regulators working towards transparency, accountability, and competence in the management of CCS-related risks as well as the continuity of safety in the public (Anifa et al., 2022; Al-Kassem & A. H., 2021; Kurdi et al., 2025).

3.3. Schematic Diagram

The schematic diagram below illustrates the hypothesized relationships between the dependent variable (Public Perception of CCS) and the independent variables (Economic Factors, Policy Frameworks, Trust in Regulatory Authorities):

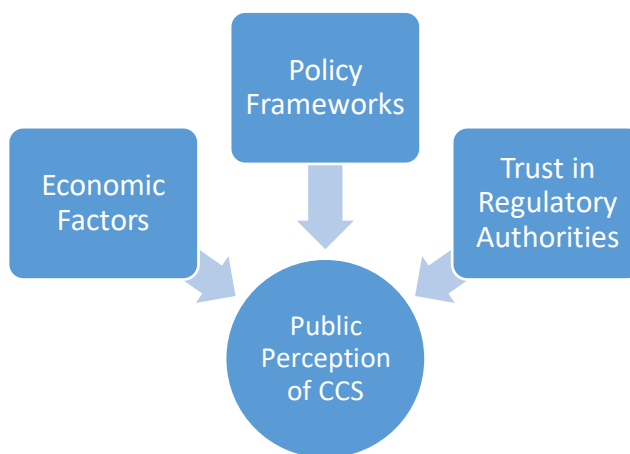


Figure 1: Conceptual Diagram

Hypotheses

Based on the theoretical framework outlined above, the following hypotheses are formulated for testing in this research:

1. H1: Positive perceptions of the economic viability of CCS positively associated with public support for CCS implementation.
2. H2: Perceptions of the effectiveness of policy frameworks in incentivizing CCS deployment positively associated with public support for CCS.
3. H3: Higher levels of trust in regulatory authorities overseeing CCS projects positively associated with public support for CCS.

4. RESEARCH DESIGN

4.1. Different Research Methods

Research methods consist of a spectrum of techniques utilized to accurately assess and explore various phenomena. Quantitative research uses the collection and processing of numerical data and the help of structured surveys or experiments to reveal and measure relationships and patterns. On the flip side, qualitative data explores the depths of human experiences and behaviors without using statistics like interviews and observations, offering invaluable firsthand insights, although there may be a problem with generalizing a phenomenon from a small sample. Mixed methods research combines quantitative

and qualitative methods that comprehensively investigate research problems by triangulating the obtained results (Saunders & Lewis, 2017). Every research technique has its strengths and weaknesses. The research objectives, the dynamics and the practical options mainly guide the choice.

4.2. Justification for the Quantitative Approach

The quantitative method is utilized because of several factors discussed below. In the first place, the aim is to evaluate the public's quantitative image of carbon capture and storage (CCS) and underpin the hypotheses on how the variables are interrelated. The application of quantitative methods enables the precise measurement and investigation of numerical data and a test of the hypotheses and statistical inferences. The second quantitative method allows for the collection of structured data through surveys that can specifically reach large and diverse samples with high efficiency (Saunders & Bezzina, 2015). This is especially useful in observing public perceptions, for it permits the habits of diverse population segments for the systematic study. Furthermore, quantitative research contributes to statistical rigor that can support the generalization of research findings to larger populations. The research can be more precise using simple statistical methods like correlation and regression analysis. These would add to the empirical understanding of how people feel about clean coal technology.

4.3. Sampling

Convenience sampling was employed for participant selection in the study type. 68 individuals have been contacted through social media, with social media platforms such as Facebook, Twitter and LinkedIn. Convenience sampling was preferred due to its feasibility and simplicity, which enabled swifter recruitment of participants from diverse backgrounds. Although the advantages of the convenience sampling method outweigh the limitations, some drawbacks, such as the possible sample bias and the low generalized findings of the findings to the whole population, are worth mentioning.

4.4. Data Gathering

4.4.1. Selection of Data Gathering Methods

Data collection is a significant stage of the research operation since the analysis and interpretation depend on this empirical evidence. In this research,

data collection was mainly conducted using online survey tools in the mode of a questionnaire sent to respondents through social media networks. Choosing an online survey has been motivated by its accessibility, cost-effectiveness, and ability to survey a wide and heterogeneous sample (Saunders & Lewis, 2017). Although offering conveniences for both researchers and respondents, online surveys ensure that collected data is obtained through an efficient process, thus enabling easy data analysis.

4.4.2. Development of a Survey Questionnaire

The survey questionnaire was elaborately structured to cater to various dimensions of how the public perceives CCS, bearing in mind the research objectives and hypotheses discussed earlier in Chapter 3. The questionnaire included Likert scale items covering various topics, such as perceptions of economic indicators, trade policy frameworks, trust in regulatory bodies, and demographic information.

4.4.3. Recruitment of Participants

Participants in the study were randomly sampled through convenience sampling with a wide range of social media platforms, such as Facebook, Twitter, and LinkedIn. Convenience sampling was considered for its desirable simplicity and accessibility, whereby instances of demographic variety in participants can be experienced relatively quickly. To stimulate the recruitment process, the messages were posted on the relevant groups, forums, and networks, calling individuals to participate in the study by accessing an online survey.

4.5. Data Collection Procedures

When participants clicked on the survey link, they were prompted by informed consent information introducing the study goals, privacy statement, and an option to withdraw from the study if they desired. While participants expressed their opinions, they were assured of the anonymity and confidentiality of their comments. Next, the respondents filled out the questionnaire, which took around 3 to 5 minutes to complete.

5. DATA ANALYSIS

5.1. Overview

Data analysis is the stage at which the result of the analysis of the study is revealed as the relationships between variables are discovered.

Different analysis techniques were used to explore the relationships between views on economic factors, policy systems, acceptable regulatory authorities, and shared support for CCS. Quantitative data analysis techniques, such as correlation analysis and regression analysis, were applied to this problem-oriented approach, and they helped us discover those relationships in a systematic way and make sense of the data. As qualitative data was gathered from the questionnaire survey, interpretation was included in the research process, which deepened the investigation further. Correlation analysis was employed in order to estimate the strength and the direction of the relationship between individual variables, while multiple regression was used to explore predictors' relationships among variables. A correlation analysis is performed to identify the grade of association among economic issues, such as policy measurements and regulatory bodies' trust and support for CCS. It did uncover dependencies among these variables and assisted in discovering the predictors of CCS extension in the proposed candidacy. To determine the synergistic predictive power concerning perceptions of economic aspects, policy frameworks and trust in regulatory authorities on the level of CCS acceptance, regression analysis was then conducted.

5.2. Testing of Hypotheses

The correlation analysis revealed a strong positive correlation between perceptions of economic factors and support for CCS ($r = 0.8927, p < 0.001$). Additionally, in the regression analysis, perceptions of economic factors emerged as a significant predictor of support for CCS ($\beta = 0.4025, p < 0.001$). These results provide robust evidence supporting Hypothesis 1, suggesting that individuals with positive perceptions of the economic viability of CCS are more likely to support its implementation. Therefore, Hypothesis 1 is accepted. While perceptions of policy frameworks demonstrated a moderate positive correlation with support for CCS ($r = 0.6693, p < 0.001$) in the correlation analysis, the relationship was not statistically significant in the regression analysis ($\beta = 0.1159, p = 0.0532$). Despite the positive correlation observed, the lack of statistical significance in the regression analysis suggests that perceptions of policy frameworks may not be a significant predictor of support for CCS. Therefore, Hypothesis 2 is rejected. Both correlation and regression analyses yielded strong positive relationships between trust in regulatory authorities and support for CCS ($r = 0.8530, p < 0.001; \beta = 0.3298, p < 0.001$). These findings indicate that individuals with higher levels of trust in regulatory authorities are more likely to support CCS initiatives. As such, Hypothesis 3 is accepted.

Table 1: Pearson Correlation

	Perceptions of Economic Factors	Perceptions of Policy Frameworks	Trust in Regulatory Authorities	Support for CCS
Perceptions of Economic Factors	1			
Perceptions of Policy Frameworks	0.665283	1		
Trust in Regulatory Authorities	0.817522	0.556497	1	
Support for CCS	0.892676	0.66933	0.852987	1

Table 2: Regression

Regression Statistics	
Multiple R	0.922838
R Square	0.85163
Adjusted R Square	0.844675
Standard Error	0.311255
Observations	68

Table 3: ANOVA

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	3	35.58921	11.86307	122.4513	1.82E-26
Residual	64	6.200316	0.09688		
Total	67	41.78952			

Table 4: Regression Coefficients

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.56334	0.175616	3.207	0.002	0.21251	0.9141	0.212511	0.91417
Perceptions of Economic Factors	0.40252	0.073697	5.461	8.23E-07	0.25530	0.5497	0.255301	0.54975
Perceptions of Policy Frameworks	0.11585	0.058829	1.969	0.053	-	0.2333	-	0.23337
Trust in Regulatory Authorities	0.32982	0.075241	4.383	4.44E-05	0.00167	0.4801	-0.00167	0.48013

Table 5: Hypothesis Tests

Hypothesis	Correlation Result	Regression Result	Conclusion
Hypothesis 1: Positive perceptions of the economic viability of CCS positively associated with public support for CCS implementation.	Strong positive correlation (Accepted)	Significant predictor (Accepted)	Accepted
Hypothesis 2: Perceptions of the effectiveness of policy frameworks in incentivizing CCS deployment positively associated with public support for CCS.	Moderate positive correlation	Not statistically significant	Rejected
Hypothesis 3: Higher levels of trust in regulatory authorities overseeing CCS projects positively associated with public support for CCS.	Strong positive correlation (Accepted)	Significant predictor (Accepted)	Accepted

6. DISCUSSION OF RESULTS

Data analysis results serve as an important guide for identifying key elements that have a bearing on people’s views towards CCS projects. The strong positive linkage between economic perception and support of CCS, plus the substantial predictive ability of economic perception on CCS support, suggest the major influence of economic viability in generating public opinion on CCS implementation (AlShawabkeh et al., 2021; El Khatib et al., 2023; Pande et al., 2024). This stressing of the economic perks and reasonableness of CCS projects serves to generate support from members of the general public and foster their uptake as meaningful climate mitigation programs (Gaurina-Medimurec et al., 2018). Adding to these, the fact that probably the strongest appropriate correlation between trust in the regulatory authorities responsible for CCS projects and support for CCS promotion

indicates that it is fundamental to create trust and confidence in the regulator in order to support the public acceptance level of CCS projects. Good communication, openness, and accountability in regulating CCS technologies are how people become confident and sure about the effectiveness and safety of these technologies (Shaw & Mukherjee, 2022). Contrary to this, there is no evidence that there is an association both statistically and practically between policy frameworks and CCS promotion, and this indicates the difficulty of policy impact on the promotion of CCS (Shen et al., 2022). Although it is true that policy frameworks are of the uttermost importance in terms of creating the foundation for regulatory systems and aid projects related to CCS, the findings imply that the subjective evaluation of relevant policy effectiveness on the public might not be enough to steer public opinion towards CCS

(Maydybura et al., 2024; AlQassem & A. H., 2024; Khan et al., 2024). This brings about the need for policymakers to revise existing policy frameworks in order to address the gaps and improve the effectiveness of the policies in building public support for the CCS initiatives.

7. CONCLUSION

In conclusion, the results depict direct links between public opinion on CCS programs and causes that are the main determinants. This relation between the positive evaluation of the economy of CCS projects and support for them is a signal and proves the fact that the economic model of CCS projects is very important for the approval of the public. Furthermore, trust is the essential attribute of the regulators, which requires transparent and accountable regulation as well as confidence building in the use of CCS technologies. However, the perceived nature of CCS policy frameworks did not emerge as a significant predictor of the support for CCS. In order to encourage the deployment process of CCS projects, policymakers have to develop and refine policy frameworks constantly. Overall, appealing to economic viability, regulatory trust, and policy effectiveness is basic for creating public support for CCS and the development of its implementation as an effective alternative for combating climate change. Such impediments are well-known to stakeholders. Together, they can work out a supportive environment for CCS and contribute to the global fight against climate change and the sustainable development goals.

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