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Mapping Environmental Risks of Carbon Capture, Utilization, and Storage (CCUS): A Pre-LCA Approach

Maham Sohail, Shabana Kamal, Sharfuddin Ahmed Khan and Sama Hosseini Androod
Faculty of Engineering and Applied Sciences
University of Regina
Regina, Canada
msz298@uregina.ca, shabana.kamal@uregina.ca, sharfuddin.khan@uregina.ca,
sht775@uregina.ca

Saqib Khan
Faculty of Business Administration
University of Regina
Regina, Canada
saqib.khan@uregina.ca

Noha Razek
Faculty of Economics
University of Regina
Regina, Canada
noha.razek@uregina.ca

Abstract

Carbon Capture, Utilization, and Storage (CCUS) is a promising technology to reduce greenhouse gas emissions, presenting environmental opportunities alongside critical risks. The environmental risks of CCUS require preliminary investigation to ensure sustainable development. The current study presents a systematic literature review and a pre-LCA (Life Cycle Assessment) screening matrix to identify and prioritize environmental risks across the CCUS value chain. Using a heat map technique, with likelihood and severity criteria, showing pipeline rupture, carbon dioxide (CO_2) and methane leakage as high-priority risks by developing a 5x5 environmental risk matrix. Targeted mitigation strategies such as advanced monitoring, better material selection, and proactive maintenance are proposed to reduce the risks in the project lifecycle. By identifying these risks before full Life Cycle Assessment (LCA), this study provides practical strategies to improve CCUS sustainability. The study contributes to bridge current knowledge gaps for safer and more sustainable CCUS deployment.

Keywords
Environmental risk, risk matrix, CO_2 leakage, pipeline rupture and carbon capture.

1. Introduction
During the last century's industrial boom, the environmental degradation and climate change were largely overlooked and received limited international attention, regarded as unavoidable trade-offs for poverty alleviation (Yang et al., 2016). Global warming, marked by increasing temperatures, jeopardizes ecosystems and human well-being. Across different industries, the path to achieve Net Zero carbon emissions by 2050, requires an urgent balance between man-

made emissions and scalable carbon removal solutions (Bahman et al., 2023). Carbon capture, utilization, and storage (CCUS) have emerged as a significant technology that has the potential to reduce carbon dioxide emissions from the atmosphere. Its significance was emphasized in an Intergovernmental Panel on Climate Change (IPCC) report (IPCC, 2022). In conjunction with renewable energy sources, the report indicated the importance of CCUS technology to limit the global temperature increase to 2°C by 2050. In CCUS, CO_2 is captured from the emission sources, such as industrial power plants and this captured CO_2 can be stored in geological formations including oil and gas reservoirs or utilized in chemical production or enhanced oil recovery (EOR) (Yaashikaa et al., 2023) (Alli et al., 2024). CCUS may use green energy for operation, negative carbon processes, and clean energy in pre-combustion plants to produce blue hydrogen (Su et al., 2024). The present output of CCUS-based facilities has been designed to capture around 85-90% of their oversall CO_2 emissions, as per the International Energy Agency (IEA). There are CO_2 emissions of 694 Mtpa in 2023 in Canada with Alberta, the largest CO_2 emitter among all Canadian provinces due to oil and gas production. The CCS deployment in Canada is in a nascent phase (Canadian Discovery, 2021). The annual capture facility capacity exceeds 45 million tons (Mt) of CO_2 for over 40 commercial facilities, accounts for only one-third of the 1.2 Gt CO_2 per year required to meet Net Zero Emissions (NZE) by 2050 (IEA, 2023).

In the foreseeable future, more CCUS technology projects will be built and operated for addressing climate change issues. With increasing interest in CCUS, some challenges remain long-standing, including environmental risks that are emerging (He et al., 2011). The success of CCUS projects is hindered by both risk and uncertainty with inadequate identification and measurement. Risk relates to scenarios where outcomes and their probabilities are understood by decision-makers, complicating project planning (Park & Shapira, 2017). The reason may be that environmental risk management lags the development of CCUS technology (L.-C. Liu et al., 2016). Although some CCUS pilot projects have been carried out, there are many obstacles to entering the commercial application stage, including a serious lack of understanding of environmental risks (Li et al., 2017). Some CCUS pilot demonstration project has obvious deficiencies in terms of environmental impact assessment, project site selection, early risk warnings, emergency responses, leakage monitoring, accountability, insufficient storage capacity, high energy consumption, CO_2 leakage, and other basic research and supporting technology policies have hindered the large-scale deployment of CCUS (Lv et al., 2021), which is further added by influence of technology, economy, environment, and social factors. According to international experience, environmental impacts and risks are one of the key factors that affect or even determine the implementation of CCUS projects, and they are also the focus of public concern. Many international CCUS projects are hindered due to environmental problems. Like other large-scale energy systems, CCUS development entails constructing huge facilities like CO_2 injection wells and pipelines, which may provide environmental hazards to the surroundings. Understanding and mitigating environmental risks in the development of CCUS is important for carbon neutrality. The absence of comprehensive risk assessment makes it difficult for decision makers to select capture technology and identify suitable storage sites. Practical and research-based risk evaluation must be conducted by policy makers and governments for widespread use of CCUS.

A deeper understanding of the environmental outcomes related to the implementation of this kind of system could be obtained by means of Life Cycle Assessment (LCA). Holistic LCA, dealing with performance improvement of industrial processes, is recognized as a valid tool for governments in aiding decision-making processes (Wolf, 2010). This tool is crucial, since implementing CO_2 emission–mitigating technologies and shifting the energy supply towards more sustainable technologies could lead to significant environmental trade-offs, thus leading to further negative outcomes. While CCUS technologies continue, early environmental risk identification before life cycle assessment remains insufficient, remains a challenge for decision-makers. This paper aims to develop an environmental risk map based on literature studies to assist stakeholders and researchers in making better-informed decisions in CCUS project development.

The primary objective of this paper is to utilize a novel pre-LCA environmental risk matrix for initial assessment:

1. To determine environmental risks at each stage of the CCUS value chain (capture, transport, utilization, and storage).
2. To construct a quantitative 5x5 Environmental Risk Matrix based on literature analysis to aid as a decision-support tool for researchers and stakeholders.

2. Literature Review

Carbon capture, utilization, and storage (CCUS) offers a promising solution essential for decarbonizing hard-to-abate industries such as refineries, iron, and chemical plants (Azadnia et al., 2023). While it contributes to reaching sustainability goals, it depends on risk identification and effective mitigation measures. A schematic overview of an integrated CCUS system is illustrated in Figure 1.

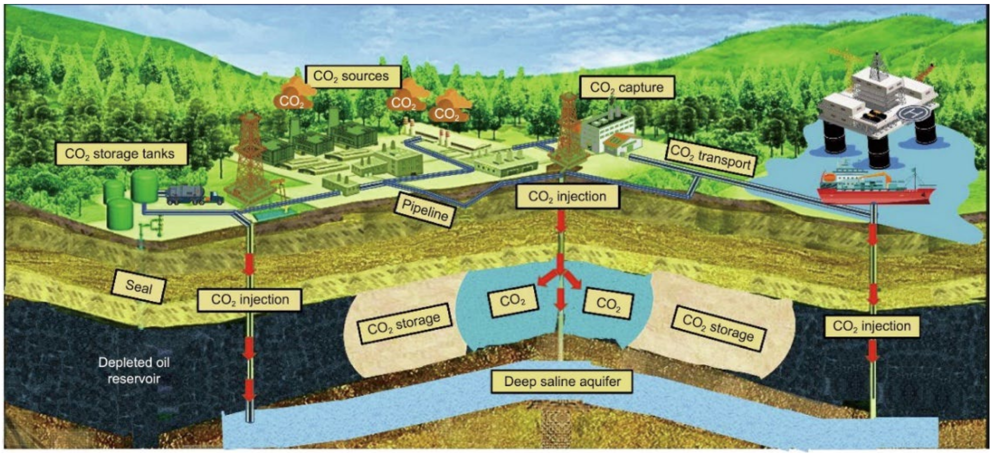


Figure 1. Illustration of an integrated CCUS system (Rui et al., 2025).

The capture stage in CCUS involves separating carbon dioxide from industrial emissions or directly from the atmosphere. This process typically uses chemical absorption (e.g., amine-based solvents), physical adsorption, or membrane separation. Key risks include process inefficiencies, chemical degradation, and equipment corrosion. CO_2 capture and compression require energy which results in an energy penalty for the power plant, reducing the net conversion efficiency of the power plant. (Veltman et al., 2010) reported that the emissions from the post-combustion capture system with a mono-ethanolamine absorbent caused a 10-fold increase in freshwater toxicity. Corrosion failures are the most frequent challenge in CO_2 capture processes globally. Industries such as petrochemicals and oil and gas have expertise in managing high concentrations of CO_2, carbon capture systems possess challenges due to the presence of NOx and SOx oxidizing acids, that results in corrosion. The consumption of solvents in the capture process is an important driver for solvent development as solvent loss deteriorates operational economics and has environmental consequences (Nath et al., 2024). (Guénan et al., 2011) described 11 storage risks for CCS, all dealing with CO_2 leakage. Although there are many different event scenarios that could lead to a CO_2 leak, they all represent varying degrees of risk to a CCS DM. Despite its environmental potential, CCUS technologies are also associated with CO_2 leakage from the storage sites due to the geographical complexities of storage formations (Mortezaei et al., 2018). To address these concerns, (Wilday et al., 2011) provided an outline for the identification of risks during capture, transport, injection, and storage by the bow-tie techniques, modified risk matrix approaches and the life cycle analysis approaches.

Different investigations have examined CCUS risks, regarding CO_2 geological storage, treatment technologies, and pipeline systems. (Cui et al., 2022) underscored the need for leakage response mechanisms and comprehensive risk assessment for CO_2 storage. (Duguid et al., 2022) adopted the bow-tie risk assessment model to analyze CO_2 leakage, while incorporating economic factors. (Wang et al., 2023) conducted quantitative insights into CO_2 leakage risks from geological fracture sites. (Lv et al., 2021) proposed an approach utilizing environmental monitoring indicators and hazard scores, primarily tailored for assessing risks associated with CO_2 storage. In September 2024, a CO_2 leak was reported at Archer-Daniels-Midland's (ADM) CCS facility in Decatur, Illinois, from a monitoring well at a Class VI injection site. The U.S. EPA issued a Notice of Violation for breaching underground injection regulations, raising concerns about storage integrity and monitoring failures (Douglas, 2024).

Safely operating pipelines are important for CCUS projects. Pipeline infrastructure for CO_2 transport also presents serious challenges. Through a quantitative risk assessment of CO_2 pipelines (Duguid et al., 2022) highlighted a higher likelihood of incidents coupled with lower severity of consequences. This risk profile has the potential to shape the CCUS development pathways with the objective of meeting carbon neutrality targets. Pipeline safety evaluation depends on both incident likelihood and consequence severity. According to (Leung et al., 2014), incident rates rose from 0.30 to 0.72 incidents per year per 621 miles between 1990-2001 and 2002-2008, as pipeline network expanded from 1,740 miles to 3,602 miles. Despite these trends, (Gale & Davison, 2004) noted CO_2 pipelines experience hazardous incidents, it could be expected to be equivalent to that of natural gas pipelines. Historical data between 1972 and 2012 recorded 46 CO_2 pipeline incidents caused by relief valve and gasket failure, corrosion, and outside force (Gale & Davison, 2004; Noothout et al., 2014). Moreover, internal corrosion from water contamination in CO_2 streams generates carbonic acid, as well as incidents due to human error (Gale & Davison, 2004).

Developing a robust CO_2 transport network is important for large-scale CCUS deployment and supporting global climate targets. Effective transport systems, especially pipelines for the majority of industrial capture sites, require connection to storage reservoirs (Kim et al., 2024). Recent advancements have surged to 260 million tonnes per year since early 2023. Projections indicate a shortfall of only 615 MT CO2 per year by 2030, compared to the 1000 MT required to meet net-zero emissions (Itul, 2023). Scaling CO_2 pipeline transportation presents different engineering challenges such as pipeline rupture or corrosion. non-condensable gases such as oxygen (O_2), nitrogen (N_2), and argon (Ar) elevate the operating pressures within pipelines and within the reservoir, as they can accumulate over time. This increase in pressure, which is commonly observed in pipelines across the United States and Canada, leads to higher transportation costs. Furthermore, free water within CO_2 (and other acid gases) poses significant problems, particularly regarding hydrate formations and accelerated corrosion rates on pipeline inner walls (Rui et al., 2025). Water consumption increases due to the energy penalty and the additional water demand by the CO_2 capture system. Additionally, the energy-intensive nature of capture systems can reduce the net carbon savings if the energy source is not low-carbon. Health and safety risks also arise from handling hazardous chemicals, and any failure in the capture system can lead to unintentional CO_2 release into the atmosphere. An increase in water consumption ranging between 32% and 93% and an increase in waste and by-product creation with tens of kilotonnes is expected for a 1 GW_e power plant, but exact flows and composition are uncertain (Koornneef et al., 2012).

The environmental performance of the CCUS has been explored by researchers utilizing Life Cycle Assessment (LCA). (Facchino et al., 2022) emphasized the substantial reduction in global warming potential through comprehensive CO_2 storage in CCUS supply chains, employing an LCA approach. Despite providing valuable insights into the environmental aspect of CCUS, these research studies lack comprehensive exploration of its risk safety dimensions. (Barbera et al., 2022) assessed the environmental performance of coupling the most promising CCS technologies into a gas-fired combined cycle (GFCC) power plant, considering the use of solvents. They also considered the integration of renewable energy sources (solar + wind), with Germany as a case study. The study focused on the negative consequences on human health and freshwater consequences. Despite the existing studies highlighting the environmental benefits and technical feasibility of CCUS, there remains a significant research gap regarding operational and environmental risks. To ensure effective CCUS advancement, a unified approach to environmental impact and risk assessment is significant.

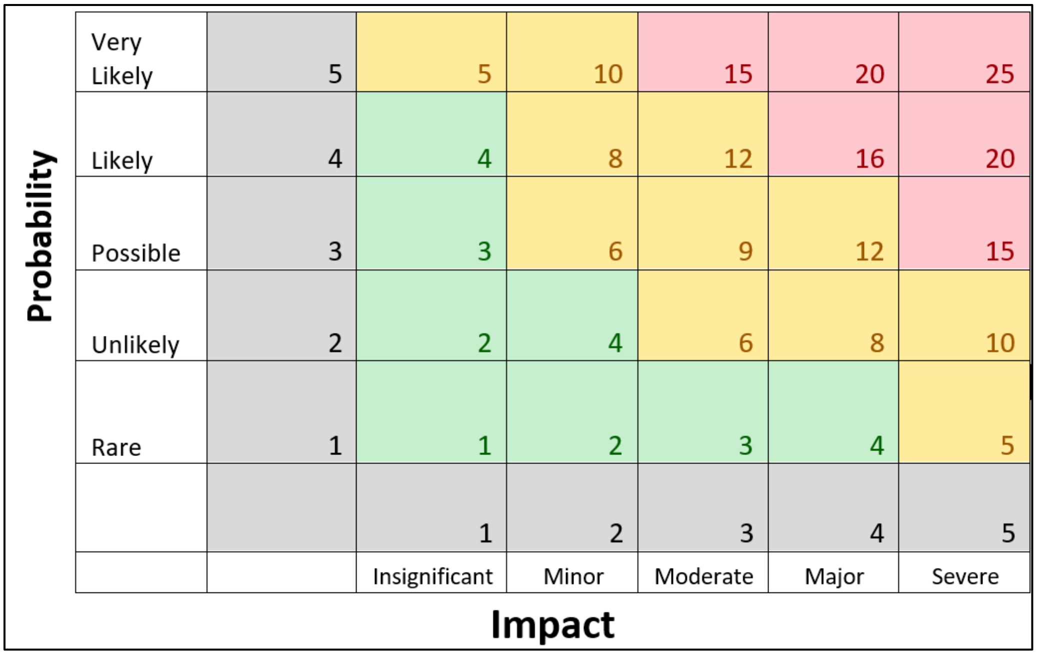
3. Methods

3.1. Risk assessment using risk matrix technique

The risk matrix approach stands as a key instrument in the domain of qualitative and semi-quantitative risk assessments, playing as essential role across different industries. This methodology rigorously evaluates risks by harmonizing two fundamental dimensions: the likelihood of occurrence and the severity of potential events. Within the scope of qualitative assessments, this approach classifies risks into categories such as low, medium, and high based on the literature review studies and judgement. This classification not only facilitates effective communication of risks to stakeholders but also assists in prioritizing them appropriately (Khan et al., 2024). The aim of this risk matrix is to ensure that the decision process is transparent, based on the best scientific knowledge and reflects the common understanding of stakeholders. It was made in excel using 5x5 matrix and shown in Figure 2. The high risk is colored as red, medium risk as yellow, and low risk as green color.

- *Risk identification:* It is a structured process for identifying, characterizing, and documenting environmental risks affecting a project. This study conducted risk identification step through peer-reviewed literature and classified risks across CCUS project stages such as capture, transport, and storage.
- *Risk Analysis:* It refers to the estimation of both the likelihood and severity of identified risks. The current paper uses 5x5 risk matrix methodology, combining likelihood and severity, ranked based on the scores. High-priority risks needs preventive measures and immediate safety measures.
  The total risk is calculated as: **Severity x Likelihood**
- *Risk Mitigation:* The final phase of the risk assessment process involves implementing measures and strategies to address, minimize, or eliminate identified risks and their potential negative impacts. In this study, to enhance environmental sustainability, safeguarding human and animal health and environment while

minimizing the likelihood of failures or accidents and their potential consequences, various strategies will be recommended.



Probability

Very Likely	5	5	10	15	20	25
Likely	4	4	8	12	16	20
Possible	3	3	6	9	12	15
Unlikely	2	2	4	6	8	10
Rare	1	1	2	3	4	5
		1	2	3	4	5
		Insignificant	Minor	Moderate	Major	Severe

Impact

Figure 2. Risk Matrix in Excel for this study.

4. Data Collection

In this study, data was collected through a comprehensive systematic literature review. More than 200 peer-reviewed articles were examined to extract relevant information on environmental risks. The criteria selected for this study is based on the literature review and judgement. For example, a greater risk arises from the potential for a major event such as CO_2 leak anywhere along the capture, transport, and especially storage phase.

Inclusion criteria focused on:

- Studies were published within 2010-2025.
- Empirical and review articles addressing CCUS environmental challenges

The heat map is color coded as:

- High priority risk: Score more than 12
- Medium risk: Score between 5 – 12
- Low risk: Score less than 5

5. Results and Discussion

The risk assessment matrix for key environmental issues related to CCUS was developed by evaluating five prominent risks across three dimensions: likelihood, severity, and the total risk score (risk level). The risk score was calculated using the product of the likelihood and severity ratings, as shown in Table 1. This paper identified and categorized key environmental risks across the CCUS value chain through a literature-based pre-LCA screening approach. A heat map was developed to visualize and prioritize these risks based on their probability and impact as reported in existing studies (Figure 3).

Table 1. Risk Matrix results for CCUS environmental hazards.

Risk No.	Risk Description	Severity (I)	Likelihood (P)	Score (I x P)
1	CO_2 Leakage	5	4	20
2	Water and Energy Consumption	3	3	9
3	Pipeline Rupture/Failure CO_2	5	5	25
4	Long-term storage	2	2	4
5	Methane Leakage	4	4	16

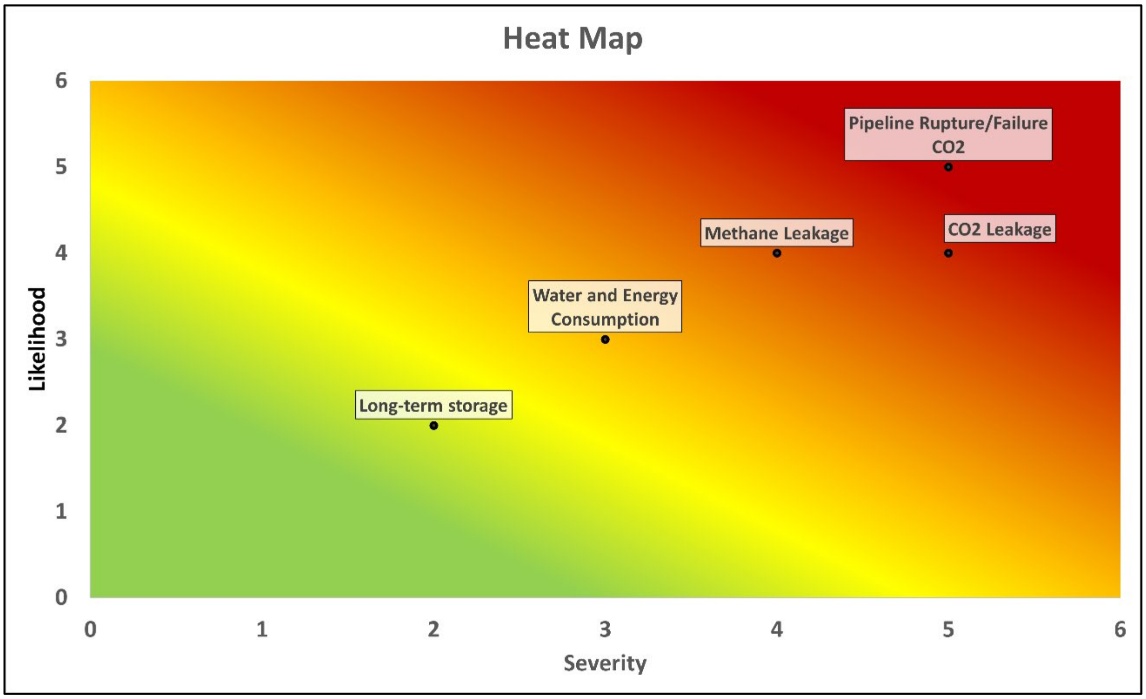


Figure 3. Risk Matrix Heat Map for our study.

The heat map (Figure 3) reveals that pipeline rupture or failure scored highest, with concerns related to land disturbance, human safety, and unintended CO_2 emissions. The reason could be unpredicted fluctuations in geological formations (heterogeneity) or unexpected CO_2 leakage due to natural disasters such as earthquakes, which are beyond human control. Rupture due to high pressure and corrosion represents a major failure mode with serious environmental implications. A pipeline failure can lead to the uncontrolled release of CO_2, contributing to soil degradation, ecological damage, and potential health hazards in surrounding areas (Kang & Noh, 2024).

CO_2 leakage emerged as the second critical risk, particularly during the storage phase, due to the potential for long-term environmental impacts, including potable groundwater, vegetation, fauna, and overall human well-being. The avenues for potential CO_2 leakage comprise both natural and anthropogenic pathways, each presenting distinct conduits through which unintended CO_2 release may occur. Natural pathways include active or reactivated faults, open fractures, and breaches in the confining strata, while man-made pathways primarily consist of wells. Whether intrinsic to the geological environment or human-engineered, these pathways necessitate comprehensive evaluation and effective management within the scope of carbon capture and storage endeavors (Y. Liu & Liu, 2022). This was followed by methane leakage, especially in projects integrating CCUS with blue hydrogen production, where methane losses during natural gas extraction and processing can offset climate benefits. In the context of CCS, a pure risk might be the possibility of equipment failures during the carbon capture or storage.

Additionally, moderate water and energy consumption—mainly during CO_2 capture —was noted for its potential to undermine the overall sustainability of CCUS systems, especially in water-stressed regions. Most literature-based values assume ideal operating conditions, but actual plants may experience deviations due to solvent degradation, poor absorber performance, or fluctuating flue gas compositions factors not fully captured in model-based assessments. Methane leakage may occur during pre-combustion capture or from natural gas inputs used in blue hydrogen production, while pipeline ruptures pose a risk during the transport phase, especially under high pressure and in aging infrastructure. Since this research does not use empirical data from actual plants, assumptions of ideal capture and containment may underestimate real-world risks. Early-stage deployment increases the likelihood of equipment failure, undetected leaks, and safety hazards, making these occurrences a primary concern in risk assessment and mitigation planning (Cao et al., 2024; Onyebuchi et al., 2018).

The heat map provided a clear visualization of these risk areas, offering a strategic tool for prioritizing further assessment. The results suggest that environmental risks are not uniformly distributed across the CCUS chain and that early identification of high-impact areas is critical for guiding full LCA studies and developing targeted mitigation strategies.

6. Risk Mitigation

By conducting pre-LCA screening, it is important to highlight prioritize mitigation strategies for pipeline rupture, CO_2 and methane leakage. This early-stage risk prioritization is vital for CCUS applications, especially before a detailed Life Cycle Assessment is executed.

- *Pipeline Rupture:* Based on the results, pipeline rupture or failure is a major environmental hazard in the heat map mentioned above. Strategies include continuous pressure and leak monitoring to reduce the probability of catastrophic ruptures, use of corrosion-resistant materials with dry CO2 transportation to maximize the pipeline lifetime, and routine maintenance inspections detecting corrosion or aging infrastructure (Kang & Noh, 2024).
- *CO_2 Leakage:* It is crucial to reduce the CO_2 leakage during capture, transport, and storage phases for the long-term environmental sustainability of CCUS projects. The heap map showed CO2 leakage mainly in storage phase, as high priority risk. Mitigation strategies such as site-specific geological evaluation to account for fault lines, and seismicity, monitoring techniques such as 4D seismic monitoring, and ground-penetrating radar (GPR) to detect leakage pathways, full-chain risk awareness to increase the credibility of environmental impact assessments and help investors revise their expectations (Y. Liu & Liu, 2022).
- *Methane Leakage:* It is one of the environmental risks from natural gas supply chains, integration with CCUS and blue hydrogen production. As mentioned in the risk matrix, methane losses can have disastrous effect on the environment that needs to be identified early. Future Strategies include leak detection across gas extraction, processing, and transport infrastructure to reduce the emissions and verify natural gas supplies with CCUS to inform more accurate LCA boundary circumstances.
- *Water and Energy Consumption:* It showed as a moderate risk during CO2 capture phase, mainly in resource-constrained regions. By enhancing the absorber performance, reducing the solvent degradation and advancing capture materials and methods with reduced energy and water consumption to make sure that CCUS projects align with the sustainability benchmarks.

7. Conclusion

This study successfully achieved its objective of identifying and evaluating key environmental risks associated with the implementation of Carbon Capture, Utilization, and Storage (CCUS) technologies through a pre-LCA screening approach. The novelty of this research is to develop a structured environmental risk map prior to performing a full Life Cycle Assessment (LCA), which is lacking in existing CCUS studies. These risks can have several implications for human health, ecosystems, water and energy consumption, underscoring the importance of careful planning for future CCUS projects. By conducting an extensive literature analysis, a heat map was developed to visualize the severity and likelihood of environmental risks across the CCUS value chain. The most critical risks identified were pipeline rupture, CO_2 leakage, methane leakage, long-term storage, and water and energy consumption, highlighting the need for sustainable CCUS deployment.

The study offers a unique contribution by providing a structured environmental risk map prior to conducting a full Life Cycle Assessment (LCA), enabling early-stage decision-making for researchers, policymakers, and industry stakeholders. It serves as a valuable screening tool for overall safety and sustainability of CCUS operations as a key climate mitigation strategy. The methodology used in the current study can be extended to other high-risk systems in CCUS infrastructure, supporting global carbon control strategies that are safe and more effective.

Nevertheless, this study presents only a preliminary step. Future investigations should focus on quantitative site-specific analysis and integrating dynamic risk assessment tools into pre-LCA frameworks. Studies should also consider social, regulatory, and governance and policy factors, as well as public perceptions for the success and safety of CCUS. Furthermore, it is important to understand the environmental trade-offs by integrating CCUS into blue hydrogen production and include supply chain emissions for ensuring sustainable development. The study offers a unique contribution by providing a structured environmental risk map prior to conducting a full Life Cycle Assessment (LCA), enabling early-stage decision-making for researchers, policymakers, and industry stakeholders. It serves as a valuable screening tool for overall safety and sustainability of CCUS operations as a key climate mitigation strategy. The methodology used in the current study can be extended to other high-risk systems in CCUS infrastructure, supporting global carbon control strategies that are safe and more effective.

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Biographies

Maham Sohail is a PhD student of Industrial Engineering at the University of Regina. She holds a Bachelor of Science degree in Sustainable and Renewable Energy Engineering from University of Sharjah, United Arab Emirates and a Master's degree in Environmental, Sustainability, and Green Technology from Keele University, United Kingdom. She is working as a Researcher at the the Petroleum Technology Research Centre (PTRC). Her current research focuses on the environmental assessment of Carbon Capture, Utilization, and Storage (CCUS) technologies, highlighting blue hydrogen and life cycle sustainability. Her research interests include sustainability analysis, nanotechnology, and advanced modeling and assessment tools. She has contributed to several peer-reviewed journals including *Journal of Cleaner Production*, *Applied Thermal Engineering, and Journal of Molecular Liquids.* conference papers and five book chapters. She has a certification of Carbon Literate.

Shabana Kamal is currently a Postdoctoral Fellow at the University of Regina, Saskatchewan, Canada. She holds a PhD in Finance from Victoria University of Wellington, New Zealand, where her doctoral research focused on the economic and financial impacts of droughts on agricultural sectors and financial markets. Prior to her current role, Dr. Kamal served as a Senior Analyst in the Financial Stability Assessment and Strategy division at the Reserve Bank of New Zealand, where she led thematic reviews on governance, risk management, and financial inclusion across regulated financial institutions. Dr. Kamal brings over 17 years of experience across academia, central banking, and commercial finance. She has held managerial roles in multiple financial institutions and worked as a financial accountant in an international development organization. Her research interests include financial stability, climate-related financial risk, agricultural finance, and risk governance. Her work has been published in *Weather, Climate, and Society* and presented at several international conferences, including NZAE, IDRiM, and the CEF Group Climate Finance Symposium. She holds the Canadian Risk Management (CRM) designation and has completed specialized training in financial supervision through the IMF and Seneca Polytechnic. Proficient in tools such as R, STATA, SQL, and Excel (VBA), Dr. Kamal continues to contribute to research and policy efforts aimed at enhancing financial resilience in the face of environmental and systemic risks.

Sharfuddin Ahmed Khan is currently an Associate Professor and Associate Program Chair of Industrial Systems Engineering at the University of Regina, Saskatchewan, Canada. Prior to this role, he served as a Lecturer (September 2009 – August 2019) and later as an Assistant Professor (September 2019 – December 2021) at the University of Sharjah, United Arab Emirates. He then joined the University of Regina as an Assistant Professor (January 2022 – June 2025) before being promoted to his current position. Dr. Khan has contributed extensively to top-tier academic journals and Scopus-indexed conferences in areas such as supply chain management, sustainability, and engineering management. His research has been published in renowned journals, including *Business Strategy and the Environment*, *Supply Chain Management: An International Journal*, *IEEE Transactions on Engineering Management*, *Production Planning and Control*, *International Journal of Production Research*, and *Operations Management Research*, among others. He has also authored book chapters and published books with leading academic publishers such as Taylor & Francis and Emerald Publishing. Dr. Khan has successfully secured significant research funding and has supervised and co-supervised numerous graduate students at the master's and doctoral levels. His research continues to make a strong academic impact. A detailed overview of his scholarly work is available on his Sharfuddin Ahmed Khan - Google Scholar

Dr. Saqib Khan has been associated with the University of Regina since 2007. He is an Associate Professor of Finance and served as Interim Dean, Associate Dean - Academic, Associate Dean - Faculty Relations and Development, and Program Lead-International, at the Hill and Levene Schools of Business. Dr. Khan holds a MSc. Chemistry degree from Karachi University, MSc. Engineering from Pakistan Institute of Engineering and Applied Sciences, MBA from Institute of Business Administration-Karachi, and PhD in Finance from Ivey Business School, University of Western Ontario. Prior to joining academia, Dr. Khan has experience working in both public and private sector organizations. In addition to the University of Regina, Dr. Khan has taught at the Ivey Business School, Brescia University College, and Institute of Business Administration-Karachi. He has also been involved in executive education through the Center for Experiential and Executive Learning at the Hill and Levene Schools of Business. Dr. Khan's research interests are in the areas of Derivatives and Risk Management, Corporate Finance, and Agricultural Finance. He is the holder of Agribusiness Research Scholar. He has co-authored several papers in top tier finance journals. He has also coauthored several business cases. Dr. Khan has demonstrated leadership in a wide range of service areas within the University as well as the business and broader community of Regina. He has served on the Labour Market Council and Investment and Growth Committee of the Saskatchewan Chamber of Commerce, and on the board of several community organizations.

Noha Razek received her PhD in Economics (specializing in energy and international economics) from the University of Alberta in 2012 and a Galileo Master Certificate in Hydrogen Energy from the Renewable Energy Institute in the UK in 2022. Currently, she is an Associate Professor at the University of Regina. Previously, she held various positions in government, academia, and international research institutes in Canada and overseas, including Saudi Arabia. Her research has been at the intersection between commodity, energy and financial markets; international macroeconomics; geopolitics of energy markets; energy security; and energy transition risks, tackling emerging and developing economies (Russia, Saudi Arabia, China, Egypt, and Ethiopia) as well as advanced economies (Canada and the United States). She has published high-quality peer-reviewed journal papers, policy papers, and scholarly articles; and has presented at national and international conferences, including the International Association for Energy Economics (IAEE). She is a reviewer for several well-regarded peer-reviewed journals and a liaison for the American Economic Association's (AEA) Committee on the Status of Women in the Economics Profession (CSWEP).

Sama Hosseini Androod is a PhD student in Industrial Systems Engineering at the University of Regina, Canada. She holds a Master's degree in Industrial Engineering with a focus on Financial Systems and a Bachelor's degree in Industrial Engineering, both from Azad University in Tehran, Iran. Her research focuses on the economic implications of Carbon Capture, Utilization, and Storage (CCUS) and blue hydrogen on supply chain operations in Canada. She also examines sustainable supply chain management, with recent works presented at the International Conference on Industrial Management and Production (ICIMP) 2024. Sama has extensive experience working with industry professionals and academic experts on various industrial engineering topics. She has a solid background in Enterprise Resource Planning (ERP) systems, having worked as an ERP Specialist at System Group in Tehran, Iran for 4 years. Additionally, Sama has earned several certifications in supply chain management, data analysis, and optimization, further enhancing her expertise in logistics and ERP systems. She currently works as a researcher at the Petroleum Technology Research Centre (PTRC), where she contributes to research on CCUS and blue hydrogen's impact on supply chains.