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Climate risk assessment in petroleum operations: A review of CSR practices for sustainable Resilience in the United States and Africa

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Abstract

Climate risk assessment has emerged as a critical component in the sustainability efforts of petroleum operations, given the increasing frequency and severity of climate-related events. This paper provides a comprehensive review of Corporate Social Responsibility (CSR) practices employed in the United States and Africa to enhance sustainable resilience in the face of climate risks within the petroleum industry. In the United States, where stringent environmental regulations and public scrutiny prevail, petroleum companies have adopted a range of CSR practices to assess and mitigate climate risks. These practices encompass comprehensive environmental impact assessments, carbon footprint reduction initiatives, and the integration of renewable energy sources into their operations. The paper explores how these CSR practices contribute to the overall resilience of petroleum operations in the United States. In contrast, Africa presents a diverse landscape with varying levels of regulatory frameworks and industrial practices. The paper delves into the unique challenges and opportunities faced by petroleum operations on the African continent in managing climate risks. It highlights the role of CSR practices in promoting sustainable development, community engagement, and ecosystem conservation as integral components of climate risk resilience. The review emphasizes the importance of a holistic approach to climate risk assessment, considering both the environmental and social dimensions of petroleum operations. It sheds light on the need for collaboration between industry stakeholders, governments, and local communities to develop effective CSR strategies that enhance resilience while fostering sustainable practices. By synthesizing insights from both the United States and Africa, this paper contributes to the global discourse on climate risk management in the petroleum industry. It underscores the significance of CSR practices as instrumental tools for achieving sustainable resilience and fostering a harmonious coexistence between petroleum operations and the environment in diverse geopolitical contexts.

Keywords: Climate Risk; Risk Assessment; Petroleum; CSR; USA; Africa; Review

1. Introduction

The intersection of climate change and the petroleum industry has ushered in a new era, necessitating a rigorous examination of climate risk assessment methodologies and Corporate Social Responsibility (CSR) practices (Okonkwo, 2020, Kuo & Means, 2021, Smith, 2021). The imperative to address the challenges posed by climate-related factors within petroleum operations is underscored by their profound impact on environmental sustainability, regulatory

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compliance, and societal well-being. As such, this review embarks on a comprehensive analysis of CSR practices for sustainable resilience, focusing on climate risk assessment in both the United States and Africa.

Petroleum operations have long been at the forefront of global industrial activities, supplying the world's energy needs. However, the sector is increasingly grappling with the repercussions of climate change, manifesting in extreme weather events, rising sea levels, and shifting environmental dynamics (Ibn-Mohammed, et. al., 2021, Ozili, 2022). The imperative to assess and address climate risks within petroleum operations stems from the recognition that these risks not only pose a threat to the industry's operational integrity but also have far-reaching consequences for ecosystems and communities. The escalating importance of climate risk assessment is accentuated by stringent environmental regulations, evolving global sustainability targets, and a growing demand for responsible corporate practices (D'Orazio, 2023, George & Schillebeeckx, 2022).

The primary objective of this review is to provide a nuanced understanding of the CSR practices employed in climate risk assessment within the petroleum industry. By exploring the experiences of both the United States and Africa, the review aims to distill insights that can inform global best practices. It seeks to unravel the multifaceted dimensions of CSR strategies, their efficacy in fostering sustainable resilience, and their alignment with the diverse regulatory landscapes and societal contexts in these regions.

This review places a spotlight on CSR practices as integral components of climate risk resilience in petroleum operations. It will investigate the range of CSR initiatives undertaken by industry players, spanning environmental impact assessments, community engagement, sustainable development projects, and carbon footprint reduction strategies. The scope extends beyond the traditional risk management approaches to encompass broader sustainability considerations, emphasizing the interconnectedness of environmental stewardship, social responsibility, and long-term operational viability. By honing in on CSR practices, this review aims to offer practical insights and recommendations for enhancing the sustainable resilience of petroleum operations in the face of climate risks, acknowledging the unique challenges and opportunities presented in both the United States and Africa.

2. Literature Review

Climate risk assessment has become a focal point within the petroleum industry due to the escalating impacts of climate change on global ecosystems. Petroleum operations, with their extensive infrastructure and reliance on stable environmental conditions, are particularly vulnerable to the evolving climate patterns. The assessment of climate risks within the petroleum industry involves a comprehensive examination of potential hazards, vulnerabilities, and the development of strategies to mitigate adverse impacts. Risks range from extreme weather events and sea-level rise to regulatory changes aimed at reducing greenhouse gas emissions (Dong, et. al., 2022, Lee, et. al., 2023, Ukhurebor, et. al., 2021).

The petroleum industry's susceptibility to climate risks has prompted an evolution in risk assessment methodologies. Traditional approaches primarily focused on technical and engineering aspects of risk, such as infrastructure resilience and emergency response plans. However, contemporary climate risk assessments in the industry incorporate broader considerations, including the social and environmental dimensions of operations (Ding, et. al., 2020, George & Renjith, 2021). This holistic approach recognizes the interconnectedness of climate impacts with ecological systems and societal well-being, emphasizing the need for adaptive and sustainable strategies.

Corporate Social Responsibility (CSR) practices have emerged as pivotal tools for enhancing resilience within the petroleum industry amidst the challenges posed by climate change. CSR involves the integration of environmental and social considerations into business operations, acknowledging the industry's responsibility to mitigate negative impacts and contribute positively to the communities it operates in. In the context of climate risk assessment, CSR practices play a crucial role in building adaptive capacity, fostering community engagement, and promoting sustainable development (ElAlfy, et. al., 2020, Osei, 2022).

The significance of CSR practices in enhancing resilience lies in their ability to address both the direct and indirect impacts of climate change on petroleum operations. For instance, companies that actively engage in reducing their carbon footprint contribute to mitigating the broader effects of climate change while simultaneously positioning themselves as environmentally responsible entities. CSR initiatives also extend to community-based adaptation strategies, where petroleum companies collaborate with local communities to enhance their capacity to cope with climate-related challenges (Pinkse & Gasbarro, 2019, Rela, et. al., 2020, Van Zanten & van Tulder, 2021).

Furthermore, CSR practices can improve the industry's social license to operate, enhancing relationships with stakeholders, including governments, local communities, and environmental advocacy groups. By transparently addressing climate risks and proactively implementing sustainable initiatives, petroleum companies can mitigate reputational risks and navigate regulatory landscapes more effectively.

Research on climate risk and CSR practices within the petroleum industry has yielded valuable insights, particularly in the context of the United States and Africa (Agudelo, et. al., 2020, Wang, et. al., 2022). In the United States, a combination of stringent environmental regulations and heightened public awareness has driven petroleum companies to adopt advanced climate risk assessment methodologies and robust CSR practices. Studies have explored the effectiveness of these practices in enhancing the industry's resilience, with a focus on sustainable energy transitions, emission reduction strategies, and community partnerships. In Africa, where the petroleum landscape is characterized by diverse regulatory frameworks and socio-economic conditions, research has delved into the unique challenges and opportunities for climate risk assessment and CSR implementation (Dall-Orsoletta, et. al., 2022, Ng, et. al., 2021). The literature underscores the importance of context-specific approaches, recognizing the need for inclusive and culturally sensitive CSR practices that address the social and economic disparities prevalent in the region.

However, the existing body of research also highlights gaps in understanding the effectiveness of specific CSR practices in different geographical and socio-economic contexts. Further exploration is warranted to assess the transferability of successful initiatives between regions and to identify region-specific challenges that may require tailored solutions. Additionally, research has pointed to the need for standardized frameworks for climate risk assessment and CSR evaluation within the petroleum industry, facilitating comparative analyses and the development of best practices on a global scale.

In conclusion, the literature reviewed emphasizes the evolving landscape of climate risk assessment in the petroleum industry and the integral role of CSR practices in enhancing resilience. The insights gained from previous research in the United States and Africa provides a foundation for the current review, guiding the exploration of effective strategies that contribute to sustainable practices and resilience within petroleum operations.

3. Climate Risk Assessment in Petroleum Operations

Climate change, driven in part by anthropogenic activities, has become a defining challenge of the 21st century. Within the realm of industry, petroleum operations stand out as significant contributors to greenhouse gas emissions, prompting a critical need for comprehensive climate risk assessment (Kemp, et. al., 2022, Overpeck & Udall, 2020). This assessment involves evaluating the environmental impact of petroleum operations, identifying and evaluating climate-related risks, and deploying advanced technologies and methodologies for effective risk assessment.

Petroleum operations, from extraction and processing to transportation and refining, have profound environmental implications that contribute to climate change. The combustion of fossil fuels releases large quantities of carbon dioxide (CO₂) and other greenhouse gases (GHGs) into the atmosphere, intensifying the greenhouse effect and leading to global warming. Additionally, petroleum activities can result in methane emissions, a potent GHG with a higher short-term warming potential. Beyond direct emissions, petroleum operations also impact ecosystems and biodiversity (Jing, et.al., 2020, Manfroni, Bukkens & Giampietro, 2021). Oil spills, a notorious consequence of extraction and transportation, have devastating effects on marine and terrestrial environments. These environmental disturbances exacerbate the overall impact of petroleum operations on climate change, creating a complex web of interconnected challenges that demand thorough assessment and mitigation strategies.

Physical risks in petroleum operations refer to the tangible, direct consequences of climate change on infrastructure, operations, and supply chains. These risks encompass the increased frequency and intensity of extreme weather events, rising sea levels, and temperature extremes. For petroleum infrastructure situated in vulnerable coastal areas, the physical risks include the potential for damage and disruption caused by hurricanes, storm surges, and flooding. Evaluating and addressing these physical risks is crucial for safeguarding the integrity and resilience of petroleum operations (Aroge, 2019, Mahmood, et. al., 2023).

The evolving landscape of climate-related regulations and policies introduces another layer of risk for petroleum operations. Governments and international bodies are increasingly implementing measures to limit carbon emissions, transition to renewable energy sources, and promote sustainable practices. Petroleum companies face regulatory risks related to potential changes in emission standards, carbon pricing mechanisms, and incentives for adopting cleaner technologies. Understanding and staying ahead of these regulatory shifts is vital for mitigating compliance-related risks and positioning petroleum operations for long-term sustainability.

Transition risks arise from the shift towards a low-carbon economy and the global transition away from fossil fuels. As the world moves towards renewable energy sources, petroleum operations face the risk of stranded assets, reduced market demand for traditional fossil fuels, and the need to adapt to new technologies and energy paradigms. The evaluation of transition risks involves assessing the financial implications of changing market dynamics, ensuring that investments align with emerging sustainable trends, and strategically positioning the industry for a carbon-neutral future (Campiglio & van der Ploeg, 2022, Semieniuk, et. al., 2021).

Advancements in technology and methodologies play a pivotal role in enhancing the accuracy and efficiency of climate risk assessment in petroleum operations. Remote sensing technologies, satellite imagery, and Geographic Information System (GIS) tools enable the monitoring and mapping of environmental changes, helping identify vulnerable areas and assess the impact of physical risks. These technologies provide real-time data that can inform emergency response plans and aid in the development of adaptive strategies (Ahmad, et. al., 2021, Mohanta, Nanda & Patnaik, 2020).

Quantitative risk assessment methodologies, such as probabilistic risk modeling, help evaluate the likelihood and consequences of climate-related events. These models incorporate data on climate patterns, infrastructure vulnerabilities, and operational dependencies to generate risk profiles. By quantifying the potential impacts of physical, regulatory, and transition risks, petroleum companies can prioritize mitigation measures and allocate resources effectively (Sillmann, et. al., 2021, Ye, et. al., 2021).

Furthermore, scenario analysis has gained prominence as a strategic tool for evaluating different future trajectories and their associated risks. This involves simulating various scenarios, including different climate outcomes, regulatory landscapes, and market dynamics, to assess the resilience of petroleum operations under diverse conditions. Scenario analysis aids in identifying flexible and adaptive strategies that can withstand uncertainties and contribute to long-term sustainability.

In conclusion, climate risk assessment in petroleum operations is an imperative undertaking to address the environmental impact of the industry, identify and evaluate climate-related risks, and deploy advanced technologies and methodologies for effective risk management. Understanding the intricate interplay between physical, regulatory, and transition risks allows petroleum companies to proactively adapt to the evolving climate landscape, contribute to global climate goals, and ensure the sustainability of their operations in an era of unprecedented environmental challenges.

4. CSR Practices for Sustainable Resilience

The conceptual framework of Corporate Social Responsibility (CSR) in the petroleum sector extends beyond mere compliance with regulations, emphasizing the industry's commitment to environmental stewardship, social responsibility, and sustainable practices (Akpaka, 2020, Bagheri, 2023, Sowa, 2019). CSR in this context entails integrating ethical, environmental, and social considerations into the core business strategies of petroleum companies. It involves a proactive approach to addressing the industry's impact on climate change, fostering resilience, and contributing to sustainable development.

Key elements of the conceptual framework include the acknowledgment of the petroleum sector's role in climate change mitigation, the promotion of transparency and accountability, and the recognition of the interconnectedness between environmental conservation, community well-being, and the industry's long-term viability. This framework sets the stage for CSR initiatives that go beyond mitigating negative impacts to actively contributing to the resilience of petroleum operations in the face of climate-related challenges.

One of the central pillars of CSR initiatives for climate resilience in the petroleum sector is the adoption of emission reduction strategies. Recognizing their contribution to greenhouse gas emissions, leading companies are investing in technologies and practices that mitigate their carbon footprint (Bandeira, et. al., 2023, Bathrinath, et. al., 2021, Okeke, 2021). This includes the implementation of cleaner extraction and refining processes, the integration of carbon capture and storage technologies, and the development of carbon offset programs. Emission reduction strategies not only align with global climate goals but also enhance the industry's capacity to adapt to evolving regulatory landscapes and market demands for cleaner energy sources.

CSR practices for sustainable resilience in the petroleum sector extend beyond internal emission reduction measures to include substantial investments in sustainable energy alternatives. Diversifying energy portfolios by investing in renewable energy sources, such as solar, wind, and bioenergy, enables petroleum companies to contribute positively to the global transition towards a low-carbon economy (Agudelo, Johannsdottir & Davidsdottir, 2020, Bagheri, 2023).

These investments not only bolster the long-term sustainability of the industry but also position companies as leaders in the broader energy transition. By aligning CSR initiatives with the development and implementation of sustainable energy projects, petroleum companies can proactively adapt to changing market dynamics and future-proof their operations.

Effective CSR practices for climate resilience involve active engagement with local communities and collaboration with diverse stakeholders. Community engagement goes beyond philanthropy and involves establishing meaningful partnerships that address the specific needs and concerns of the communities in which petroleum operations are situated. This can include initiatives such as job creation, skills development, and community-led environmental conservation projects. Collaborating with stakeholders, including governments, non-governmental organizations, and local communities, allows petroleum companies to leverage collective expertise and resources in developing comprehensive climate resilience strategies. By fostering a sense of shared responsibility and inclusivity, these CSR initiatives contribute to the industry's social license to operate and enhance its overall resilience.

ExxonMobil, a major player in the petroleum industry, has embarked on the Low Carbon Solutions initiative, a comprehensive CSR strategy aimed at reducing greenhouse gas emissions. The initiative focuses on the development and deployment of carbon capture and storage (CCS) technologies to capture CO₂ emissions from industrial facilities. By investing in CCS infrastructure and collaborating with governments and industry partners, ExxonMobil aims to play a pivotal role in mitigating climate change while ensuring the sustainability of its operations.

Shell, recognizing the need for diversification in the energy sector, established the New Energies division, dedicated to investing in renewable and low-carbon energy sources. This CSR initiative represents a strategic move towards sustainable energy investments, including wind and solar projects, electric vehicle infrastructure, and bioenergy. By aligning its business model with the global transition to cleaner energy, Shell aims to navigate the challenges posed by climate change, contribute to sustainable development, and ensure the resilience of its operations in a rapidly evolving energy landscape.

TotalEnergies, operating extensively in Africa, has implemented CSR initiatives that prioritize sustainable development and community engagement. In regions where petroleum activities coexist with vulnerable ecosystems and communities, TotalEnergies has initiated projects focused on education, health, and environmental conservation. By fostering strong partnerships with local stakeholders and aligning CSR practices with the specific needs of each community, TotalEnergies enhances the social and environmental resilience of its operations in the African context.

In conclusion, CSR practices for sustainable resilience in the petroleum sector are essential for addressing the environmental impact of the industry, enhancing climate resilience, and contributing to broader sustainable development goals. The conceptual framework emphasizes the integration of ethical, environmental, and social considerations into core business strategies. Through initiatives such as emission reduction strategies, sustainable energy investments, and community engagement, petroleum companies can proactively adapt to the challenges posed by climate change, ensuring the long-term viability of their operations while positively impacting the communities and environments in which they operate. Case studies demonstrate the effectiveness of these CSR practices in real-world contexts, showcasing the potential for industry-wide transformation towards greater sustainability.

5. Regional Variations: United States and Africa

The United States, as a major player in the global petroleum industry, is characterized by a complex regulatory landscape that significantly influences climate risk assessment in petroleum operations. Federal agencies, such as the Environmental Protection Agency (EPA) and the Department of Energy, set overarching environmental standards, while individual states have the autonomy to enact additional regulations. The Clean Air Act, Clean Water Act, and the National Environmental Policy Act (NEPA) are key federal legislations that shape climate risk assessment practices (Ruple, Pleune & Heiny, 2022, Ulibarri, Figueroa & Grant, 2022).

In the U.S., climate risk assessment in the petroleum sector is intricately linked to compliance with emissions standards, spill response planning, and adherence to environmental impact assessment requirements. The regulatory framework places a strong emphasis on transparency, disclosure, and accountability, pushing companies to adopt rigorous risk assessment methodologies. The regulatory landscape has evolved over time, with increasing emphasis on addressing climate change and transitioning towards cleaner energy sources. This dynamic environment necessitates adaptive risk assessment strategies to navigate evolving regulatory expectations (Adekoya, et. al., 2023, Masudin, et. al., 2023).

In contrast, African nations exhibit a diverse range of regulatory frameworks with varying levels of stringency and enforcement. The regulatory landscape in many African countries is shaped by factors such as economic development priorities, political stability, and resource availability. While some nations have established comprehensive environmental regulations, enforcement can be challenging due to capacity constraints and competing developmental priorities (Chu & Tran, 2022, Greyling, Rossouw & Adhikari, 2021).

African countries often grapple with the delicate balance between fostering economic growth through natural resource exploitation, including petroleum operations, and addressing environmental concerns. The lack of uniformity in regulatory standards across the continent poses challenges for multinational petroleum companies operating in multiple jurisdictions. Climate risk assessment in African nations requires a nuanced understanding of regional regulatory variations, emphasizing the need for flexible and context-specific approaches.

In the United States, a developed and diversified economy allows for a more mature approach to CSR practices in the petroleum sector. Companies often invest in advanced technologies and sustainable practices to enhance resilience and align with evolving societal expectations. Economic diversification and robust regulatory frameworks provide a conducive environment for petroleum companies to integrate CSR initiatives seamlessly into their operations.

In Africa, where economic development varies significantly among nations, CSR practices face unique challenges and opportunities. Some African nations heavily depend on revenue from natural resource extraction, including petroleum, to fund essential development projects. This economic dependence can influence the extent to which CSR practices are prioritized. While there is a growing awareness of the importance of sustainable practices, economic considerations often play a central role in shaping the CSR landscape. Companies operating in Africa must navigate the delicate balance between economic development goals and the imperative to adopt socially and environmentally responsible practices.

Environmental considerations and community impact are central to CSR practices in both the United States and Africa, but the nature of challenges and responses varies. In the U.S., environmental concerns are often closely tied to regulatory compliance and public scrutiny. Petroleum companies implement CSR initiatives that focus on reducing environmental impact, engaging in habitat restoration, and investing in technologies that minimize ecological harm. Community engagement involves transparent communication, stakeholder consultations, and partnerships with local organizations.

In Africa, where many petroleum operations are situated in ecologically sensitive areas, CSR practices often center on addressing the immediate needs of local communities. Companies may invest in infrastructure development, education, and healthcare to mitigate the social impact of their operations. Environmental conservation efforts are critical, given the rich biodiversity in some regions, and CSR initiatives may include reforestation, wildlife protection, and water resource management.

Despite regional variations, a common thread in both the United States and Africa is the recognition that CSR practices must be tailored to the specific needs of local communities and ecosystems. Effective CSR strategies involve genuine engagement with stakeholders, acknowledging cultural nuances, and fostering inclusive development that goes beyond mere philanthropy.

In conclusion, regional variations in the United States and Africa shape the landscape of climate risk assessment and CSR practices within the petroleum sector. The regulatory frameworks, economic dynamics, and environmental considerations unique to each region underscore the importance of context-specific approaches. As the global community grapples with the challenges of climate change and sustainable development, understanding and navigating these regional variations will be crucial for the petroleum industry to contribute positively to both environmental resilience and social well-being.

6. Comparative Analysis

Both the United States and Africa recognize the imperative of climate risk assessment in petroleum operations, given the industry's susceptibility to climate-related challenges. Common elements include the evaluation of physical risks (extreme weather events, sea-level rise), regulatory and policy risks, and transition risks associated with the global shift towards a low-carbon economy (Jaffe, et. al., 2019, Van Benthem, et. al., 2022).

The United States has a well-established and stringent regulatory framework, resulting in a more standardized approach to climate risk assessment. In Africa, variations in regulatory standards and enforcement contribute to a more diverse landscape of risk assessment practices. The scale and sophistication of climate risk assessment technologies and

methodologies may differ, with the U.S. often utilizing advanced tools, while some African nations may face capacity constraints in adopting comparable technologies.

Both regions acknowledge the importance of CSR practices in enhancing sustainability and resilience within the petroleum sector. CSR initiatives in both regions often focus on emission reduction strategies, sustainable energy investments, and community engagement to address social and environmental concerns.

CSR practices in the United States are often driven by a combination of regulatory requirements, market expectations, and a strong civil society. In Africa, CSR initiatives may be influenced by economic dependence on natural resources and the need to balance development goals with environmental and social responsibility. The scale and scope of CSR projects may vary, with U.S. companies having greater resources to invest in advanced technologies and comprehensive community development initiatives compared to some African counterparts (Halkos & Nomikos, 2021, Mbilima, 2021, Singh & Misra, 2022).

Regional disparities in regulatory frameworks influence the depth and rigor of climate risk assessment and CSR practices. The U.S., with a more robust regulatory environment, may experience greater standardization and transparency, fostering a culture of compliance. In Africa, variations in regulatory stringency and enforcement capacities contribute to a more heterogeneous landscape, requiring companies to navigate diverse regulatory expectations.

Economic considerations significantly influence CSR practices in both regions. In the U.S., diversified economies and strong regulatory oversight enable petroleum companies to integrate sustainability seamlessly into their operations. In Africa, economic dependence on natural resource extraction can lead to a delicate balance between economic development goals and CSR initiatives. The impact of CSR practices on local communities and the environment may be more pronounced in Africa, where social and environmental considerations play a crucial role in sustainable resilience (Deb, Rahman, & Haseeb, 2023, Sun, et. al., 2021).

Environmental challenges and community impacts differ based on regional contexts. While both regions emphasize environmental conservation and community engagement, the nature and scale of these efforts may vary. In the U.S., CSR initiatives often align with stringent environmental standards and include advanced technologies for reducing ecological harm. In Africa, CSR practices may focus on immediate community needs and unique environmental challenges, such as biodiversity preservation.

The U.S. demonstrates the efficacy of a comprehensive regulatory framework in shaping industry practices. African nations can draw lessons from adaptive approaches, tailoring regulations to their specific developmental stages and environmental contexts. Developing standardized regional frameworks, where feasible, could enhance the effectiveness of climate risk assessment and CSR practices. The U.S. showcases the successful integration of economic development with sustainable practices. African nations can learn to balance economic imperatives with environmental and social responsibility. Strategic investments in sustainable energy alternatives can mitigate economic risks associated with the global transition away from fossil fuels. Both regions highlight the importance of community engagement in CSR practices. African nations can benefit from the U.S. emphasis on transparent communication, stakeholder consultations, and partnerships with local organizations. U.S. companies, in turn, can learn from the community-centric focus of African CSR initiatives, ensuring that interventions align closely with the specific needs of local communities (Domenech & Bahn-Walkowiak, 2019, Mazzucato, Kattel & Ryan-Collins, 2020).

In conclusion, the comparative analysis of climate risk assessment and CSR practices in the United States and Africa illuminates the shared challenges and distinct approaches within the petroleum sector. The impact of regional disparities on sustainable resilience underscores the need for adaptive strategies that consider both regulatory and economic contexts. Lessons learned from these regions can inform global best practices, emphasizing the importance of balancing economic development with environmental stewardship and fostering inclusive, community-centric CSR initiatives for long-term sustainability.

7. Challenges and Opportunities

Petroleum companies, both in the United States and Africa, face the challenge of navigating a complex and evolving regulatory landscape. The intricacies of climate regulations, varying standards across jurisdictions, and frequent policy changes can pose difficulties in ensuring consistent compliance and effective climate risk assessment.

The implementation of robust climate risk assessment methodologies requires advanced technologies and comprehensive data. Petroleum companies may encounter challenges in adopting and integrating these technologies, particularly in regions with limited technological infrastructure. Obtaining accurate and up-to-date data for risk assessment can also be challenging, impacting the precision of the assessments (Dhali, Hassan & Subramaniam, 2023, Krause & Pullman, 2021, Obi, 2019).

Economic pressures, particularly in regions heavily dependent on petroleum revenue, may limit the resources available for climate risk assessment and comprehensive CSR initiatives. The balancing act between economic viability and sustainable practices is a persistent challenge faced by companies, impacting their ability to invest in innovative technologies and community development projects.

Public perception and stakeholder engagement are crucial elements of CSR practices. Petroleum companies often face challenges in building and maintaining public trust due to historical environmental incidents and concerns. Engaging with diverse stakeholders, including local communities, non-governmental organizations, and governments, requires a delicate and continuous effort to address concerns and foster transparency.

The transition towards a low-carbon economy poses challenges for petroleum companies. Adapting to changing market dynamics, potential stranded assets, and the need for upskilling and retraining the workforce are complex issues that impact the long-term resilience of the industry. Companies must navigate this transition while balancing economic imperatives and social responsibilities (Jackson, 2022, Linde, et. al., 2022, Tankajev, 2023).

One of the significant opportunities for petroleum companies lies in investing in renewable energy sources. CSR initiatives can include substantial investments in solar, wind, and other clean energy projects. By diversifying their energy portfolios, companies not only contribute to sustainability goals but also position themselves as leaders in the transition towards a low-carbon future. CSR initiatives that focus on community capacity building can enhance sustainable resilience. By investing in education, skills development, and healthcare, petroleum companies contribute to the long-term well-being of local communities. Empowered communities are better positioned to adapt to changing economic landscapes and contribute positively to the industry's social license to operate.

Collaborative efforts and partnerships with governments, non-governmental organizations, and local communities present significant opportunities for CSR initiatives. By leveraging collective expertise and resources, petroleum companies can implement more impactful projects that address both environmental and social concerns. Such collaborations enhance the effectiveness of CSR strategies and contribute to the broader sustainability agenda.

Embracing innovation in climate risk assessment methodologies presents an opportunity for petroleum companies to enhance their resilience. Advanced technologies, such as artificial intelligence, machine learning, and remote sensing, can provide more accurate and real-time data for risk assessment. Investing in these technologies improves the industry's ability to proactively identify and address climate-related challenges (Nguyen, Gosine & Warriar, 2022, Urquiza, et. al., 2021).

Transparent communication and proactive stakeholder engagement are key components of effective CSR practices. By fostering open communication channels with the public, local communities, and other stakeholders, petroleum companies can build trust and enhance their social license to operate. Engaged stakeholders are more likely to support and collaborate on sustainability initiatives (Gromis di Trana, Fiandrino & Yahiaoui, 2022, Wadesango, 2023).

Recognizing the long-term transition challenges, petroleum companies have an opportunity to develop adaptive management strategies. These strategies involve scenario planning, flexible business models, and continuous evaluation of market dynamics. Proactively adapting to the changing landscape positions companies for sustained success in a rapidly evolving energy sector.

In conclusion, while petroleum companies face formidable challenges in climate risk assessment and CSR practices, there are significant opportunities to enhance sustainable resilience. By embracing innovative technologies, investing in renewable energy, fostering transparent communication, and collaborating with stakeholders, companies can navigate the complexities of the industry while contributing positively to environmental and social goals. Balancing economic imperatives with responsible practices is at the core of building resilience and ensuring the long-term viability of the petroleum sector.

8. Recommendation

The review of climate risk assessment and Corporate Social Responsibility (CSR) practices in the petroleum sector across the United States and Africa has yielded key insights into the complex dynamics of the industry. In the United States, a well-established regulatory framework and advanced technologies drive comprehensive climate risk assessment and CSR practices, emphasizing emission reduction, sustainable energy investments, and community engagement. In Africa, the diverse regulatory landscape, economic dependencies, and unique environmental challenges contribute to variations in risk assessment and CSR initiatives, often centered on community development and biodiversity preservation. The implications of the review extend beyond the individual practices of petroleum companies to the broader industry and its role in global sustainability. The United States serves as a benchmark for stringent regulatory environments and technologically advanced risk assessment, setting a precedent for transparency and accountability. Africa, with its regional variations, highlights the importance of context-specific CSR practices that balance economic development with social and environmental responsibilities.

The petroleum industry, as a whole, faces the dual challenge of adapting to a rapidly changing climate landscape and contributing to global efforts to mitigate climate change. The implications underscore the need for a paradigm shift in industry practices, where climate risk assessment and CSR initiatives are integral components of business strategies rather than mere compliance measures.

Develop standardized frameworks for climate risk assessment and CSR practices within the petroleum industry. This can facilitate knowledge-sharing, benchmarking, and the establishment of best practices on a global scale. Collaborative efforts between industry stakeholders, governments, and research institutions can contribute to the development of these frameworks. They should encourage the creation of platforms that facilitate enhanced data accessibility and transparency in climate risk assessment. This can be achieved through industry-wide initiatives that promote the sharing of environmental data, risk assessments, and CSR performance metrics. Such transparency enhances public trust and facilitates informed decision-making. Recognize the capacity constraints in developing regions, particularly in Africa, and invest in capacity-building initiatives. Collaborative efforts between governments, international organizations, and the private sector can support the adoption of advanced technologies and methodologies for climate risk assessment. This enhances the resilience of petroleum operations in diverse global contexts. Encourage innovative financing models to facilitate sustainable energy investments in the petroleum sector. Public-private partnerships, green financing, and incentive programs can incentivize petroleum companies to diversify their energy portfolios and accelerate the transition to renewable sources, contributing to long-term industry resilience. Develop long-term workforce planning strategies that address the transition challenges associated with the shift towards a low-carbon economy. Investments in employee training, reskilling programs, and collaboration with educational institutions can ensure a skilled workforce capable of navigating the evolving energy landscape.

Prioritize community-centric CSR strategies that align with the unique needs and aspirations of local communities. Engage in meaningful partnerships with local organizations, promote inclusive development projects, and ensure that CSR initiatives contribute directly to the well-being and empowerment of communities impacted by petroleum operations. Embrace scenario analysis as a tool for developing adaptive strategies. Conducting comprehensive scenario analysis allows petroleum companies to anticipate and plan for different future trajectories, including regulatory changes, market shifts, and technological advancements. This proactive approach enhances the industry's ability to navigate uncertainties and build resilience.

9. Conclusion

In conclusion, the review underscores the importance of proactive climate risk assessment and CSR practices for sustainable resilience in the petroleum industry. The recommendations provided aim to guide future research endeavors and corporate practices, fostering a transition towards a more sustainable, transparent, and resilient petroleum sector that contributes positively to global environmental and social goals. By embracing these recommendations, the industry can position itself as a responsible steward of the environment while ensuring its long-term viability in a rapidly changing world.

Compliance with ethical standards

Disclosure of conflict of interest

The author has no conflict of interest in this research.

References

- [1] Adekoya, O. O., Tula, O. A., Adefemi, A., & Abatan, A. (2023). Health, Safety and Environmental (HSE) practices in the LNG industry: A review.
- [2] Agudelo, M. A. L., Johannsdottir, L., & Davidsdottir, B. (2020). Drivers that motivate energy companies to be responsible. A systematic literature review of Corporate Social Responsibility in the energy sector. *Journal of cleaner production*, 247, 119094.
- [3] Ahmad, T., Zhang, D., Huang, C., Zhang, H., Dai, N., Song, Y., & Chen, H. (2021). Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities. *Journal of Cleaner Production*, 289, 125834.
- [4] Akpaka, A. (2020). Collaboration in Corporate Social Responsibility Programs in Nigeria's Oil Industry (Doctoral dissertation, Walden University).
- [5] Aroge, O. O. (2019). Assessment Of Disruption Risk In Supply Chain The Case Of Nigeria's Oil Industry (Doctoral dissertation, University of Bradford).
- [6] Bagheri, B. (2023). Corporate Social Responsibility Reporting and Performance: Will the Oil and Gas Sector Join the Energy Transition? (Doctoral dissertation, The University of Texas at San Antonio).
- [7] Bandeira, G. L., Trindade, D. N., Sodario, M., & Ferronato, G. (2023, October). Creating Sustainable Value: An ESG Framework for the Petroleum Industry. In *Offshore Technology Conference Brasil* (p. D021S019R006). OTC.
- [8] Bathrinath, S., Abuthakir, N., Koppiahraj, K., Saravanasankar, S., Rajpradeesh, T., & Manikandan, R. (2021). An initiative towards sustainability in the petroleum industry: A review. *Materials Today: Proceedings*, 46, 7798-7802.
- [9] Campiglio, E., & van der Ploeg, F. (2022). Macrofinancial risks of the transition to a low-carbon economy. *Review of Environmental Economics and Policy*, 16(2), 173-195.
- [10] Chu, L. K., & Tran, T. H. (2022). The nexus between environmental regulation and ecological footprint in OECD countries: empirical evidence using panel quantile regression. *Environmental Science and Pollution Research*, 29(33), 49700-49723.
- [11] D'Orazio, P. (2023). Navigating financial stability through the dual challenges of climate change and pandemics. *Current Opinion in Environmental Sustainability*, 65, 101386.
- [12] Dall-Orsoletta, A., Cunha, J., Araújo, M., & Ferreira, P. (2022). A systematic review of social innovation and community energy transitions. *Energy Research & Social Science*, 88, 102625.
- [13] Deb, B. C., Rahman, M. M., & Haseeb, M. (2023). Unveiling the impact on corporate social responsibility through green tax and green financing: a PLS-SEM approach. *Environmental Science and Pollution Research*, 1-19.
- [14] Dhali, M., Hassan, S., & Subramaniam, U. (2023). Comparative analysis of oil and gas legal frameworks in Bangladesh and Nigeria: a pathway towards achieving sustainable energy through policy. *Sustainability*, 15(21), 15228.
- [15] Ding, G., Xin, L., Guo, Q., Wei, Y., Li, M., & Liu, X. (2020). Environmental risk assessment approaches for industry park and their applications. *Resources, Conservation and Recycling*, 159, 104844.
- [16] Domenech, T., & Bahn-Walkowiak, B. (2019). Transition towards a resource efficient circular economy in Europe: policy lessons from the EU and the member states. *Ecological Economics*, 155, 7-19.
- [17] Dong, H., Feng, Z., Yang, Y., Li, P., You, Z., & Xiao, C. (2022). Sub-national climate change risk assessment: A case analysis for Tibet and its prefecture-level cities. *Science of the Total Environment*, 807, 151045.
- [18] ElAlfy, A., Palaschuk, N., El-Bassiouny, D., Wilson, J., & Weber, O. (2020). Scoping the evolution of corporate social responsibility (CSR) research in the sustainable development goals (SDGs) era. *Sustainability*, 12(14), 5544.
- [19] George, G., & Schillebeeckx, S. J. (2022). Digital transformation, sustainability, and purpose in the multinational enterprise. *Journal of World Business*, 57(3), 101326.
- [20] George, P. G., & Renjith, V. R. (2021). Evolution of safety and security risk assessment methodologies towards the use of bayesian networks in process industries. *Process Safety and Environmental Protection*, 149, 758-775.
- [21] Greyling, T., Rossouw, S., & Adhikari, T. (2021). A Tale of Three Countries: What is the Relationship Between COVID-19, Lockdown and Happiness?. *South African Journal of Economics*, 89(1), 25-43.

- [22] Gromis di Trana, M., Fiandrino, S., & Yahiaoui, D. (2022). Stakeholder engagement, flexible proactiveness and democratic durability as CSR strategic postures to overcome periods of crisis. *Management Decision*, 60(10), 2719-2742.
- [23] Halkos, G. E., & Nomikos, S. N. (2021). Reviewing the status of corporate social responsibility (CSR) legal framework. *Management of Environmental Quality: An International Journal*, 32(4), 700-716.
- [24] Ibn-Mohammed, T., Mustapha, K. B., Godsell, J., Adamu, Z., Babatunde, K. A., Akintade, D. D., ... & Koh, S. C. L. (2021). A critical analysis of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies. *Resources, Conservation and Recycling*, 164, 105169.
- [25] Jackson, S. (2022). *A Blueprint for Better, Cleaner Jobs*.
- [26] Jaffe, A. M., Busby, J., Blackburn, J., Copeland, C., Law, S., Ogden, J. M., & Griffin, P. A. (2019). *Impact of Climate Risk on the Energy System*. Council on Foreign Relations, 1-87.
- [27] Jing, L., El-Houjeiri, H. M., Monfort, J. C., Brandt, A. R., Masnadi, M. S., Gordon, D., & Bergerson, J. A. (2020). Carbon intensity of global crude oil refining and mitigation potential. *Nature climate change*, 10(6), 526-532.
- [28] Kemp, L., Xu, C., Depledge, J., Ebi, K. L., Gibbins, G., Kohler, T. A., ... & Lenton, T. M. (2022). Climate Endgame: Exploring catastrophic climate change scenarios. *Proceedings of the National Academy of Sciences*, 119(34), e2108146119.
- [29] Krause, D., & Pullman, M. (2021). Fighting to survive: how supply chain managers navigate the emerging legal cannabis industry. *Journal of Supply Chain Management*, 57(3), 50-71.
- [30] Kuo, S. S., & Means, B. (2021). Climate Change Compliance. *Iowa L. Rev.*, 107, 2135.
- [31] Lee, H., Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P., ... & Park, Y. (2023). *IPCC, 2023: Climate Change 2023: Synthesis Report, Summary for Policymakers*. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland.
- [32] Linde, L., Sanchez, F., Mete, G., & Lindberg, A. (2022). North Sea oil and gas transition from a regional and global perspective.
- [33] Mahmood, Y., Afrin, T., Huang, Y., & Yodo, N. (2023). Sustainable Development for Oil and Gas Infrastructure from Risk, Reliability, and Resilience Perspectives. *Sustainability*, 15(6), 4953.
- [34] Manfroni, M., Bukkens, S. G., & Giampietro, M. (2021). The declining performance of the oil sector: Implications for global climate change mitigation. *Applied Energy*, 298, 117210.
- [35] Masudin, I., Tsamarah, N., Restuputri, D. P., Trireksani, T., & Djajadikerta, H. G. (2023). The impact of safety climate on human-technology interaction and sustainable development: Evidence from Indonesian oil and gas industry. *Journal of Cleaner Production*, 140211.
- [36] Mazzucato, M., Kattel, R., & Ryan-Collins, J. (2020). Challenge-driven innovation policy: towards a new policy toolkit. *Journal of industry, competition and trade*, 20, 421-437.
- [37] Mbilima, F. (2021). Extractive industries and local sustainable development in Zambia: The case of corporate social responsibility of selected metal mines. *Resources policy*, 74, 101441.
- [38] Mohanta, B., Nanda, P., & Patnaik, S. (2020). Management of VUCA (Volatility, Uncertainty, Complexity and Ambiguity) Using machine learning techniques in industry 4.0 paradigm. *New Paradigm of Industry 4.0: Internet of Things, Big Data & Cyber Physical Systems*, 1-24.
- [39] Ng, A. W., Nathwani, J., Fu, J., & Zhou, H. (2021). Green financing for global energy sustainability: prospecting transformational adaptation beyond Industry 4.0. *Sustainability: Science, Practice and Policy*, 17(1), 377-390.
- [40] Nguyen, T., Gosine, R., & Warriar, P. (2022). A review of the role of digitalization in health risk management in extractive industries—a study motivated by COVID-19. *Journal of Engineering, Design and Technology*, 20(2), 475-496.
- [41] Obi, C. (2019). *The Changing Dynamics of Chinese Oil and Gas Engagements in Africa*. Praise for the book, 173.
- [42] Okeke, A. (2021). Towards sustainability in the global oil and gas industry: Identifying where the emphasis lies. *Environmental and Sustainability Indicators*, 12, 100145.

- [43] Okonkwo, E. (2020). The Oil Industry CSR and School Climate Protest in Norway (Master's thesis, University of Stavanger, Norway).
- [44] Osei, G. K. (2022). Challenges in Implementing Environmental Sustainability Practices in Ghana's Downstream Petroleum Sector: A Mixed-Method Study (Master's thesis).
- [45] Overpeck, J. T., & Udall, B. (2020). Climate change and the aridification of North America. *Proceedings of the national academy of sciences*, 117(22), 11856-11858.
- [46] Ozili, P. K. (2022). Global economic consequence of Russian invasion of Ukraine. Available at SSRN 4064770.
- [47] Pinkse, J., & Gasbarro, F. (2019). Managing physical impacts of climate change: An attentional perspective on corporate adaptation. *Business & Society*, 58(2), 333-368.
- [48] Rela, I. Z., Awang, A. H., Ramli, Z., Md Sum, S., & Meisanti, M. (2020). Effects of environmental corporate social responsibility on environmental well-being perception and the mediation role of community resilience. *Corporate Social Responsibility and Environmental Management*, 27(5), 2176-2187.
- [49] Ruple, J. C., Pleune, J., & Heiny, E. (2022). Evidence-based recommendations for improving National Environmental Policy Act implementation. *Colum. J. Env't L.*, 47, 273.
- [50] Semieniuk, G., Campiglio, E., Mercure, J. F., Volz, U., & Edwards, N. R. (2021). Low-carbon transition risks for finance. *Wiley Interdisciplinary Reviews: Climate Change*, 12(1), e678.
- [51] Sillmann, J., Shepherd, T. G., van den Hurk, B., Hazeleger, W., Martius, O., Slingo, J., & Zscheischler, J. (2021). Event-based storylines to address climate risk. *Earth's Future*, 9(2), e2020EF001783.
- [52] Singh, K., & Misra, M. (2022). The evolving path of CSR: toward business and society relationship. *Journal of Economic and Administrative Sciences*, 38(2), 304-332.
- [53] Smith, J. M. (2021). *Extracting accountability: Engineers and corporate social responsibility*. Mit Press.
- [54] Sowa, D. M. A. (2019). Exploring the nexus between corporate environmental responsibility and regulatory oversight in Ghana's upstream petroleum industry (Doctoral dissertation).
- [55] Sun, P., Doh, J. P., Rajwani, T., & Siegel, D. (2021). Navigating cross-border institutional complexity: A review and assessment of multinational nonmarket strategy research. *Journal of International Business Studies*, 52(9), 1818-1853.
- [56] Tankajev, R. (2023). Oil Companies in Transition: A Comparative Case Study of Norwegian, Dutch, and Danish Oil Companies in the Context of Sustainable Energy Transitions (Master's thesis, uis).
- [57] Ukhurebor, K. E., Athar, H., Adetunji, C. O., Aigbe, U. O., Onyancha, R. B., & Abifarin, O. (2021). Environmental implications of petroleum spillages in the Niger Delta region of Nigeria: a review. *Journal of Environmental Management*, 293, 112872.
- [58] Ulibarri, N., Figueroa, O. P., & Grant, A. (2022). Barriers and opportunities to incorporating environmental justice in the National Environmental Policy act. *Environmental Impact Assessment Review*, 97, 106880.
- [59] Urquiza, A., Amigo, C., Billi, M., Calvo, R., Gallardo, L., Neira, C. I., & Rojas, M. (2021). An integrated framework to streamline resilience in the context of urban climate risk assessment. *Earth's Future*, 9(9), e2020EF001508.
- [60] Van Benthem, A. A., Crooks, E., Giglio, S., Schwob, E., & Stroebel, J. (2022). The effect of climate risks on the interactions between financial markets and energy companies. *Nature Energy*, 7(8), 690-697.
- [61] Van Zanten, J. A., & van Tulder, R. (2021). Improving companies' impacts on sustainable development: A nexus approach to the SDGs. *Business Strategy and the Environment*, 30(8), 3703-3720.
- [62] Wadesango, O. (2023). Proactive approaches to stakeholder engagement.
- [63] Wang, X., Zhao, X., Wang, Y., & Li, S. (2022). A Comparison of CSR Image Construction between Chinese and American Petroleum Companies in the Context of Ecological Transition. *Sustainability*, 14(21), 14490.
- [64] Ye, B., Jiang, J., Liu, J., Zheng, Y., & Zhou, N. (2021). Research on quantitative assessment of climate change risk at an urban scale: Review of recent progress and outlook of future direction. *Renewable and Sustainable Energy Reviews*, 135, 110415