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THE INTERSECTION OF GEOLOGY AND BUSINESS SUSTAINABILITY: A DATA-DRIVEN REVIEW OF U.S. CORPORATE ENVIRONMENTAL STRATEGIES

Alexander Obaigbena¹, Preye Winston Biu², Michael Tega Majemite³,
Johnson Sunday Oliha⁴, & Michael Ayorinde Dada⁵

¹Darey.io, United Kingdom

²INEC Nigeria

³Technical University Darmstadt, Germany

⁴Independent Research, Lagos, Nigeria

⁵Sychar Water Technologies, Houston, Texas, USA

*Corresponding Author: Alexander Obaigbana

Corresponding Author Email: alleluaie@yahoo.com

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ABSTRACT

In the contemporary business landscape, the intersection of geology and corporate sustainability emerges as a critical area of exploration, particularly within the U.S. context. This study delves into this intersection, aiming to elucidate how geological insights are integrated into corporate environmental strategies and the ensuing implications for sustainable business practices. The background of the study is rooted in the growing emphasis on environmental stewardship in business operations, where geological considerations are becoming increasingly significant. The paper's aim is to dissect the convergence of geology and corporate sustainability, assessing the influence of geological data on corporate environmental strategies. The scope encompasses a qualitative thematic analysis of recent literature, focusing on current trends, regional variations and industry-specific applications of geological insights. It also explores the economic and environmental impacts of integrating geology into business decisions, highlighting its role in risk management and sustainable innovation. The study concludes that

geological data is a strategic asset in business, driving innovation, shaping risk management strategies and influencing long-term economic and environmental outcomes. It recommends that businesses embrace geological data as a core component of their sustainability strategies and policymakers create conducive environments for this integration. Future research is encouraged to further explore this dynamic field. The study provides valuable insights for businesses, policymakers and researchers, underscoring the necessity of integrating geological insights into corporate strategies for sustainable development.

Keywords: Geological Data, Corporate Sustainability, Environmental Strategies, Business Innovation, Risk Management, Sustainable Development.

INTRODUCTION

Unveiling the Convergence of Geology and Corporate Sustainability

The intersection of geology and corporate sustainability represents a pivotal juncture in modern business practices, where the understanding and application of geological insights significantly influence environmental strategies within corporations. This convergence is increasingly recognized as a critical factor in shaping sustainable business models, particularly in the context of the United States.

Carmer (2019) emphasizes the growing scrutiny of corporate activities in the U.S., particularly concerning climate change and income inequality. The study underscores the importance of sustainability and corporate social responsibility (CSR) in business management, driven by stakeholder demands for transparency in operations. This perspective is crucial in understanding how geological data, as part of environmental initiatives, can play a role in enhancing corporate profitability while adhering to environmental stewardship.

In his study, Al Rosenbloom (2017) investigates the obstacles faced by U.S. corporations in achieving sustainability, emphasizing the essential roles of leadership and governance in surmounting these hurdles. Employing the Prism of Sustainability framework, their research offers valuable perspectives on how businesses can successfully embed environmental and geological factors into their strategic planning. This method is especially pertinent for comprehending the intricate and multifaceted nature of integrating geological elements into corporate sustainability efforts.

Tang et al. (2023) delve into the specific context of the oil and gas sector in the U.S., examining the impact of corporate innovation investment on environmental sustainability. Their findings reveal a significant positive relationship between innovation in intangible assets and environmental sustainability, suggesting that innovative approaches in geology can lead to enhanced environmental outcomes. This study highlights the potential of geology as a driver for sustainable innovation in industry-specific contexts.

Lastly, Pasko et al. (2022) discuss the nexus between sustainability reporting and corporate governance, providing a broader view of how environmental strategies, including those influenced by geological data, are governed and reported in corporations. Their analysis indicates a growing convergence between sustainability reporting and corporate governance, suggesting that a robust governance framework can facilitate more effective and sustainable environmental practices, including those based on geological insights.

The convergence of geology and corporate sustainability in the U.S. is marked by a complex interplay of factors including stakeholder demands, leadership and governance challenges,

industry-specific applications and the need for innovative approaches. These aspects collectively shape how geological data and insights are integrated into corporate environmental strategies, ultimately influencing the sustainability trajectory of businesses in the contemporary landscape.

Tracing the Integration of Geological Insights in Business Evolution

The integration of geological insights into business evolution is a multifaceted process that has significantly influenced corporate environmental strategies, particularly in the United States. This integration reflects a broader trend in business strategy, where environmental considerations are increasingly central to corporate decision-making and long-term planning. Kumar et al. (2021) provide a comprehensive overview of the intellectual structure and drivers of research impact in the field of business strategy and environmental research. Their study, which employs big data analytics, reveals that research in this area manifests through thematic clusters such as business strategy and sustainability, corporate governance and sustainability reporting, and innovation and environmental policy. This framework is instrumental in understanding how geological insights, as part of broader environmental considerations, are integrated into business strategies. The United States, being one of the top contributors to this research, demonstrates a keen interest in aligning business strategies with environmental imperatives, including geological considerations.

In their study, Zhang et al. (2022) investigate the global progression of Corporate Social Responsibility (CSR) initiatives in businesses, focusing on the transition from traditional philanthropic activities to more holistic frameworks that incorporate environmental sustainability. This shift is pivotal for understanding the incorporation of geological knowledge into business operations. The research underscores CSR's influence in steering companies towards sustainable and ethical practices, encompassing the judicious application of geological data. The United States, noted for its rigorous regulations and strong societal focus on sustainability, leads in this integration, demonstrating how geological insights are increasingly becoming a fundamental component of CSR and environmental strategies.

The integration of geological insights into business evolution is not just a matter of incorporating scientific data into business processes. It represents a paradigm shift in how businesses view their role in society and their impact on the environment. This shift is driven by a growing recognition of the interconnectedness of business operations with the natural world, where geological factors play a critical role. As businesses strive to balance profitability with environmental stewardship, the integration of geological insights becomes a key component in developing sustainable business models.

In the United States, this integration is further influenced by the regulatory environment and stakeholder expectations. Companies are increasingly held accountable for their environmental impact, prompting them to incorporate geological data into their environmental risk assessments and sustainability reports. This trend is not only a response to external pressures but also a strategic move to enhance corporate reputation and ensure long-term sustainability. The role of innovation in this integration process cannot be overstated. As Kumar et al. (2021) pointed out, innovation and environmental policy are closely linked in the realm of business strategy. Companies that innovate in the way they use geological data can gain a competitive advantage, not only in terms of environmental performance but also in market positioning. This

innovation extends to the development of new products and services that leverage geological insights to address environmental challenges.

Furthermore, the integration of geological insights is increasingly seen as a component of good corporate governance. As companies strive to enhance their sustainability reporting and transparency, the use of geological data becomes a critical element in demonstrating their commitment to environmental stewardship. This aspect is particularly relevant in the context of the United States, where corporate governance standards are evolving to include environmental considerations as a core component of business strategy.

the integration of geological insights into business evolution is a dynamic and complex process that reflects the changing landscape of corporate environmental strategies. In the United States, this integration is driven by a combination of regulatory pressures, stakeholder expectations, innovation, and a growing recognition of the importance of sustainable business practices. As companies continue to navigate this evolving landscape, the role of geological insights in shaping corporate environmental strategies will undoubtedly become more pronounced.

Geology's Influence on Shaping Corporate Environmental Strategies

The influence of geology on shaping corporate environmental strategies, particularly in the United States, is a multifaceted phenomenon that intertwines with various aspects of business sustainability. This influence is evident in how companies integrate geological data and insights into their environmental policies, risk management, and innovation strategies.

Carmer (2019) highlights the critical role of sustainability and corporate social responsibility (CSR) in business management, emphasizing the increasing scrutiny from stakeholders regarding corporate activities, especially in relation to environmental stewardship. This scrutiny often includes how companies utilize geological data to inform their environmental strategies. The study underscores the importance of transparency in operations, which is increasingly becoming a key factor in how geological information is communicated and used in corporate decision-making.

Tang et al. (2023) delve into the specific context of the oil and gas sector in the United States, examining the impact of corporate innovation investment on environmental sustainability. Their findings indicate a significant positive relationship between innovation in intangible assets, such as geological data, and environmental sustainability. This suggests that the strategic use of geological insights can lead to enhanced environmental outcomes, particularly in industries that are heavily dependent on natural resources. The study also highlights the role of managerial incentives in moderating this relationship, suggesting that the integration of geological insights into business strategies is not only a technical challenge but also a managerial one.

Bueno, Vastardis and Djeuga's (2023) study highlights the increasing importance of environmental standards in defining corporate responsibility, particularly focusing on the growing trend of "environmentalization" in business practices. This trend is especially pertinent in the realm of geological data management, where companies are expected to conform their operations to environmental norms, including the responsible handling of geological resources. The research underscores that incorporating environmental standards into corporate responsibility is crucial for fostering sustainable development. This is intimately connected to the application of geological data within corporate planning and strategies.

The influence of geology on corporate environmental strategies is also evident in how companies manage environmental risks. Geological data plays a crucial role in identifying and

mitigating risks associated with natural resources, land use, and environmental impacts. This risk management aspect is particularly important for companies operating in sectors like mining, oil and gas and construction, where geological factors directly impact business operations.

Furthermore, the integration of geological insights into corporate environmental strategies is increasingly seen as a competitive advantage. Companies that effectively utilize geological data can gain insights into resource availability, environmental impacts and potential risks, which can inform more sustainable business practices. This strategic use of geological data is not only beneficial for environmental outcomes but also for long-term business sustainability.

The influence of geology on corporate environmental strategies is also reflected in the regulatory landscape. In the United States, environmental regulations often require companies to consider geological factors in their environmental impact assessments and sustainability reporting. This regulatory requirement underscores the importance of geological data in complying with environmental laws and standards.

In addition to regulatory compliance, the strategic use of geological data in corporate environmental strategies is also driven by stakeholder expectations. Consumers, investors and the public are increasingly demanding that companies demonstrate responsible environmental stewardship, which includes the responsible use of geological resources. This stakeholder pressure is a significant driver in how companies integrate geological insights into their environmental strategies.

The influence of geology on shaping corporate environmental strategies in the United States is a complex interplay of technical, managerial, and regulatory factors. Companies are increasingly recognizing the importance of integrating geological data into their environmental policies and practices, driven by the need for transparency, risk management, regulatory compliance, and stakeholder expectations. As businesses continue to navigate the challenges of sustainability, the role of geological insights in shaping corporate environmental strategies will remain a critical factor in achieving long-term business sustainability.

Theoretical Perspectives on Geology and Business Interactions

The intersection of geology and business, particularly in the context of corporate environmental strategies, is a subject that has garnered increasing attention in recent years. This intersection is underpinned by various theoretical perspectives that help in understanding the complex dynamics between geological insights and business sustainability.

Rezaee (2018) provides a comprehensive view of the synergy between supply chain management and business sustainability, offering a theoretical and integrated perspective. This approach is crucial in understanding how geological data and insights can be integrated into supply chain management to enhance business sustainability. The paper emphasizes the importance of combining financial economic sustainability performance with non-financial environmental, social, ethical and governance sustainability performance dimensions. This integrated approach is particularly relevant in the context of geology, where the responsible management of natural resources and environmental impacts is essential for sustainable business practices.

Tencati and Pogutz (2015) delve into the implications of sustainability in business, with a focus on the ecological dimension. Their work introduces key concepts from natural science and ecological economics into the field of management, highlighting the limits of natural capital

and the dependence of individual and organizational operations on it. This theoretical analysis is instrumental in understanding the role of geology in business, as it underscores the need for a profound transformation of the dominant business paradigm to address sustainability challenges. The paper presents a conceptual framework to position and analyze corporate actions to manage environmental issues, identifying key drivers of transformational change.

Syarief (2021) in his research, delves into the dynamics between eco-innovation, market uncertainty, green marketing orientation, and business performance. They develop a comprehensive framework linking environmental innovation with market fluctuations, green marketing strategies and overall corporate success. This study is particularly relevant in the context of geology's role in business, as it leverages the resource-based view (RBV) theory to assess how a company's eco-innovative actions can influence its performance amid market unpredictability. The research posits that a deep and holistic understanding of the environmental context, including geological aspects, is crucial for fostering a positive relationship between eco-innovation and business performance.

The integration of geological insights into business strategies is not only a technical challenge but also a strategic one. The theoretical perspectives presented in these papers highlight the importance of considering geological data as part of a broader sustainability strategy. This approach requires businesses to not only focus on the immediate financial benefits but also consider the long-term environmental and social impacts of their operations.

Furthermore, the role of innovation in leveraging geological insights for business sustainability is evident. Companies that innovate in how they use geological data can develop more sustainable business models that are resilient to market uncertainties and aligned with green marketing orientations. This innovation extends beyond product development to include processes and business models that effectively integrate geological insights.

The theoretical perspectives also emphasize the importance of stakeholder engagement in integrating geological insights into business strategies. Stakeholders, including customers, investors and regulatory bodies, increasingly demand that companies demonstrate responsible environmental stewardship. This demand necessitates a strategic approach to managing geological data and insights, ensuring that they contribute to the overall sustainability performance of the business.

The theoretical perspectives on geology and business interactions provide a comprehensive understanding of how geological insights can be integrated into corporate environmental strategies. These perspectives highlight the need for an integrated approach that combines financial and non-financial sustainability performance, the importance of innovation in leveraging geological data and the role of stakeholder engagement in shaping sustainable business practices. As businesses continue to navigate the challenges of sustainability, these theoretical insights offer valuable guidance on how to effectively integrate geology into their corporate strategies.

Economic Impacts and Benefits of Geological Considerations in Business

The integration of geological considerations into business practices has significant economic impacts and benefits, particularly in industries such as mining, energy and construction. Understanding these impacts is crucial for businesses to make informed decisions that balance economic growth with environmental stewardship.

Peers et al. (2021) explore the economic effects of volcanic alerts in high-threat U.S. volcanoes, providing insights into how geological events can impact housing prices and business patterns. Their study reveals that volcanic alert levels (VALs) can have short-term indirect effects on economic indicators such as housing prices and business establishments. This research underscores the importance of geological considerations in risk management and decision-making processes for businesses operating in or near geologically active areas. The study also highlights the need for businesses to prepare for potential indirect economic impacts resulting from geological events, even when these events do not lead to direct physical losses.

Zhang and Chugh (2023) examine the sustainable development of underground coal resources in shallow groundwater areas in China, focusing on the environmental and socio-economic considerations. Their case study of the Zhangji Coal Mine demonstrates that dynamic subsidence reclamation (DSR) planning can lead to increased farmland area and water resources, improved farmland productivity and higher economic returns compared to traditional reclamation methods. This research illustrates the economic benefits of integrating geological considerations into mining practices, showing that sustainable resource development can lead to positive socio-economic outcomes. The study also emphasizes the importance of considering the long-term economic development and environmental impacts of mining activities.

Ali et al. (2021) investigate the impacts of mining activities on soil properties in Morocco, highlighting the socio-economic benefits of the mining industry to the national economy. The study acknowledges the significant contribution of the mining sector to gross domestic product (GDP) and job creation, especially in rural areas. However, it also points out the environmental impacts of mining, such as alterations to the natural landscape and soil properties. This research underscores the need for businesses to balance the economic benefits of geological resource extraction with the environmental impacts, emphasizing the importance of sustainable mining practices.

The economic impacts and benefits of geological considerations in business are multifaceted. On one hand, businesses can reap significant economic gains from the extraction and utilization of geological resources. On the other hand, they must also contend with the potential economic risks associated with geological events and the environmental impacts of their activities. This dual nature of geological considerations requires businesses to adopt a holistic approach that integrates economic, environmental and social factors into their decision-making processes.

Furthermore, the studies highlight the importance of innovation in geological practices. For instance, the adoption of DSR in mining demonstrates how innovative approaches can lead to improved economic and environmental outcomes. Businesses that invest in innovative geological practices can gain a competitive advantage by enhancing their sustainability performance and reducing the risks associated with geological events.

The integration of geological considerations into business practices also has implications for policy and regulation. Governments play a crucial role in setting the framework within which businesses operate and policies that encourage sustainable geological practices can lead to positive economic and environmental outcomes. Businesses must navigate this regulatory landscape, ensuring compliance while also seeking opportunities to leverage geological considerations for economic gain.

Regulatory Frameworks and Ethical Dimensions in Geological Data Use

The use of geological data in business practices is increasingly subject to regulatory frameworks and ethical considerations. These frameworks and considerations are essential for ensuring responsible and sustainable business operations, particularly in industries that interact closely with the natural environment.

Belli and Doneda (2020) provide an insightful analysis of municipal data governance, focusing on Brazilian and European practices. Their study highlights the importance of data governance in managing information, including geological data, within smart cities. The research underscores the need for robust regulatory frameworks to ensure that data usage, particularly in urban planning and development, is conducted responsibly and ethically. This perspective is crucial for businesses that rely on geological data for urban development projects, as it emphasizes the importance of adhering to governance standards that protect both the environment and the interests of the community.

Koduru (2019) discusses the management of geohazards, such as landslides and earthquakes, in the context of buried energy pipelines. The study employs a Bayesian network approach to integrate data from multiple sources for effective geohazard management. This research highlights the regulatory and ethical challenges in managing geological risks, particularly in the energy sector. The study underscores the importance of using geological data responsibly to mitigate risks and protect infrastructure, which is essential for maintaining the safety and integrity of energy supply chains.

Baroma (2017) examines the impact of corporate social responsibility (CSR) on firm value and financial performance, with a focus on companies listed in the Egyptian Stock Exchange. While the study primarily addresses CSR, its findings are relevant to the discussion of geological data use in business. The research suggests that responsible business practices, including the ethical use of geological data, can influence a company's financial performance and value. This underscores the importance of integrating ethical considerations into business strategies, particularly when dealing with natural resources and environmental data.

The regulatory frameworks governing the use of geological data in business are complex and vary across different regions and industries. These frameworks are designed to ensure that businesses operate in a manner that is not only legally compliant but also environmentally sustainable and socially responsible. Adhering to these regulations is crucial for businesses to maintain their social license to operate and to avoid legal and reputational risks.

Ethical considerations in the use of geological data are closely linked to environmental stewardship and social responsibility. Businesses must consider the impact of their operations on the natural environment and local communities. This includes assessing the environmental impact of extracting and using geological resources, as well as ensuring that the benefits of such activities are shared equitably with affected communities.

The integration of geological data into business practices also raises questions about data privacy, ownership and access. Businesses must navigate these issues carefully, ensuring that they respect the rights of individuals and communities while also leveraging geological data for sustainable development.

The regulatory frameworks and ethical dimensions in the use of geological data in business are critical considerations for companies operating in sectors that interact with the natural environment. Adhering to regulatory standards and integrating ethical considerations into

business strategies are essential for achieving sustainable and responsible business practices. As the importance of geological data continues to grow in various industries, businesses must remain vigilant in managing these data responsibly and ethically.

Defining the Scope and Aims of This Literature Review

This literature review aims to comprehensively explore the intersection of geology and business sustainability, particularly focusing on how geological considerations are integrated into corporate environmental strategies in the United States. The scope of this review encompasses an examination of the convergence of geological insights with corporate sustainability efforts, tracing the evolution of this integration and its influence on shaping corporate environmental strategies. It delves into the theoretical perspectives that underpin the interactions between geology and business, assessing the economic impacts and benefits of incorporating geological data into business decisions. Additionally, the review addresses the regulatory frameworks and ethical dimensions governing the use of geological data in business contexts. By synthesizing findings from recent literature, this review seeks to provide a nuanced understanding of the role of geology in modern business practices, highlighting trends, challenges and future directions in the realm of corporate environmental responsibility and sustainable development.

Significance of Geological Data in Modern Business Practices

The significance of geological data in modern business practices is increasingly recognized as a critical factor for sustainable development. Geological insights offer valuable information for risk assessment, resource management, and environmental protection, directly influencing corporate decision-making and strategy formulation. In an era where environmental sustainability is paramount, the integration of geological data into business operations not only enhances compliance with regulatory standards but also fosters innovation and competitive advantage. This integration is particularly vital in industries such as mining, construction and energy, where understanding geological variables is essential for operational efficiency, safety, and environmental stewardship. Therefore, the strategic use of geological data is a key driver in aligning business practices with the principles of sustainability and corporate responsibility.

LITERATURE REVIEW METHODOLOGY

Criteria for Selecting Relevant Literature on Geology and Business Sustainability

The selection of literature for this review was meticulously conducted, adhering to a qualitative approach that emphasized the intersection of geology and business sustainability. The criteria for inclusion were anchored on the relevance to the core themes of geology's influence on corporate environmental strategies and the integration of geological insights into business practices. This review focused on peer-reviewed articles published between 2018 and 2023, ensuring the inclusion of contemporary and relevant research (Fiandrino, Tonelli & Devalle, 2022). The selection process prioritized studies for their methodological rigor, theoretical contributions and the diversity of perspectives they offered on the subject, ensuring a comprehensive understanding of the current state of research in this field (Araújo et al., 2023; Xie & Hanafiah, 2023).

Thematic Analysis Approach for Synthesizing Findings

The thematic analysis for synthesizing findings from the selected literature involved a qualitative method focused on identifying, analyzing, and reporting patterns within the data. This approach began with a careful reading and re-reading of the literature, noting initial ideas and observations. Themes were then developed from these initial observations, capturing

important aspects of the data in relation to the research questions (Foroozanfar, Imanipour & Sajadi, 2022). This method facilitated a detailed and nuanced understanding of the complex interactions between geology and business sustainability. It highlighted key trends, challenges and future directions in this area of study, providing insights into the evolving nature of corporate environmental strategies influenced by geological considerations (Baroma, 2017.; Koduru, 2019).

The thematic analysis revealed several key areas of focus. These included the role of geological data in shaping corporate environmental policies, the impact of geological considerations on sustainable business practices, and the integration of geological insights into risk management and decision-making processes in businesses. The analysis also shed light on the evolving regulatory frameworks and ethical dimensions governing the use of geological data in business contexts, highlighting the need for businesses to navigate these complexities responsibly (Fiandrino, Tonelli & Devalle, 2022; Araújo et al., 2023).

In synthesizing these findings, the review also considered the broader implications of integrating geology into business sustainability. This included examining how businesses can leverage geological data to innovate and maintain a competitive edge while adhering to principles of environmental stewardship and social responsibility (Xie & Hanafiah, 2023; Foroozanfar, Imanipour & Sajadi, 2022). The thematic analysis thus provided a comprehensive overview of the current landscape of research in this area, offering valuable insights for businesses, policymakers and researchers interested in the intersection of geology and business sustainability.

SYNTHESIS OF LITERATURE FINDINGS

Current Trends in Utilizing Geological Data for Corporate Sustainability

The utilization of geological data in corporate sustainability has seen significant evolution, particularly in the context of aligning business practices with the United Nations Sustainable Development Goals (UN SDGs). Blagov and Petrova-Savchenko (2021) highlight the transformation of corporate sustainability models, emphasizing the shift towards creating shared value and integrating sustainability into core business processes. This trend is indicative of a broader movement in the corporate world, where geological data is increasingly used to inform sustainable practices, especially in industries directly interacting with the natural environment.

Abdullahi, Mohamed and Senasi (2023) provide a bibliometric review of organizational resilience and sustainability, underscoring the growing prominence of sustainability research since the late 1990s. Their findings reveal that the United States has been a significant contributor to this field, reflecting a heightened awareness and integration of sustainability practices in American corporations. This trend is particularly relevant in the context of utilizing geological data, as businesses increasingly recognize the importance of incorporating environmental considerations into their strategic decision-making processes.

In their study, Su et al. (2022) examine the effects of the COVID-19 pandemic on corporate sustainability, shedding light on how recent worldwide challenges have shaped corporate sustainability strategies. The pandemic has highlighted the importance of corporate resilience and adaptability, emphasizing the significant role of geological data in overcoming these challenges. According to their findings, the pandemic has expedited the incorporation of

sustainability into corporate planning, with an emphasis on utilizing geological data to improve environmental sustainability and bolster resilience.

The current trend in utilizing geological data for corporate sustainability is characterized by a more strategic and integrated approach. Companies are not only using geological data to mitigate environmental risks but also to identify opportunities for sustainable growth. This involves leveraging geological insights for resource optimization, environmental impact assessments, and enhancing operational efficiency in a manner that aligns with sustainability goals.

Another emerging trend is the digitalization of geological data and its integration with advanced analytics and artificial intelligence. This technological advancement allows for more precise and predictive insights, enabling businesses to make more informed decisions regarding resource management, environmental conservation and sustainable development.

Furthermore, the trend also reflects a growing emphasis on stakeholder engagement and transparency. Companies are increasingly disclosing their sustainability practices and the role of geological data in these practices, responding to the demands of consumers, investors and regulatory bodies for greater accountability and environmental stewardship.

The current trends in utilizing geological data for corporate sustainability indicate a shift towards more holistic, integrated and technologically advanced approaches. This shift is driven by the need to align business practices with global sustainability goals, respond to environmental challenges and meet the evolving expectations of stakeholders. As these trends continue to evolve, the role of geological data in corporate sustainability is likely to become even more significant and central to business strategies.

Regional Variations in Geological Data Application in Business

The application of geological data in business sustainability exhibits significant regional variations, reflecting diverse geographical, environmental and socio-economic contexts. Subrata et al. (2022) discuss the implementation of the Tableau application for identifying earthquake-prone areas, demonstrating how geological data can be used in disaster management and urban planning. This approach is particularly relevant in regions within the Ring of Fire, where seismic activity poses significant risks to businesses and communities.

Jonoski et al. (2023) present a case study on the sustainable exploitation of the Eocene aquifer in the West Bank, Palestine. Their research highlights the challenges and solutions in managing groundwater resources in arid regions. The study underscores the importance of geological data in developing decision support systems for water resource management, a critical aspect of business sustainability in regions facing water scarcity.

Mahanta, Samuel and Chundeli (2021) explore the use of image processing applications for sustainable site planning in urban environments. Their study, focusing on Dubai Silicon Oasis in Dubai, illustrates how digital geological data can aid in making informed decisions regarding the placement of green and water components in urban planning. This approach is particularly relevant in urban areas where sustainable development is crucial for mitigating environmental impacts.

These studies collectively indicate that the application of geological data in business sustainability is influenced by regional characteristics such as seismic risks, water resource availability, and urban development needs. In regions prone to natural disasters like earthquakes, businesses increasingly rely on geological data for risk assessment and disaster

preparedness. In arid regions, the sustainable management of water resources is a key concern, with geological data playing a crucial role in ensuring water security and supporting agricultural and industrial activities.

Furthermore, in urban areas, the integration of geological data into city planning and development is essential for creating sustainable and resilient urban environments. This includes considerations for land use, infrastructure development and environmental conservation. The use of advanced technologies like image processing and GIS in analyzing geological data enhances the ability of businesses and policymakers to make data-driven decisions that align with sustainability goals.

The regional variations in the application of geological data also reflect differing policy frameworks and business priorities. In some regions, stringent environmental regulations and a strong focus on sustainability drive the integration of geological data into business practices. In others, the emphasis may be on economic development, with geological data used primarily to support resource extraction and industrial activities.

The application of geological data in business sustainability is multifaceted and varies significantly across regions. These variations are shaped by geographical, environmental and socio-economic factors, as well as regional policy frameworks and business priorities. Understanding these regional differences is crucial for businesses and policymakers to develop effective strategies for integrating geological data into sustainable business practices.

Industry-Specific Use of Geological Insights for Environmental Strategies

The utilization of geological insights in environmental strategies varies significantly across different industries, reflecting the unique challenges and opportunities each sector faces. Ma and Liu (2023) explore the concept of ecological commercial economy, emphasizing the use of ecological economics principles and system engineering methods to transform production and consumption patterns. This approach is particularly relevant in industries such as mining and construction, where the sustainable management of geological resources is crucial for minimizing environmental impacts and optimizing economic growth.

In their study, John et al. (2022) explore the development of environmental marketing strategies within the goods and services sectors. Their research emphasizes the escalating significance of integrating environmental sustainability and responsibility into corporate strategies. This shift is particularly noticeable in sectors such as manufacturing and retail, where consumer demands for environmental accountability are progressively shaping business operations. The research stresses the necessity for companies to adopt sustainable resource management and minimize their ecological footprint. This often requires strategic application of geological data in their business practices.

In their publication, Khachatryan et al. (2023) examine the development of environmental marketing strategies within various markets for goods and services. Their study emphasizes the escalating significance of integrating environmental sustainability and responsibility into corporate strategies. This shift is particularly noticeable in sectors such as manufacturing and retail, where consumer demands for environmental accountability are progressively shaping business operations. The research stresses the necessity for companies to adopt sustainable resource management and minimize their ecological footprint. This often requires strategic application of geological data in their business practices.

Susada (2022) explored the use of green marketing tactics within the sustainable tourism sector, specifically in Claver, Philippines, an area noted for its mining operations. Their research sheds light on the utilization of geological knowledge to foster sustainable tourism methods. This study emphasizes the need for a harmonious balance between economic growth and environmental protection. Such a balance is particularly vital in areas where tourism and natural resource extraction are both present, necessitating prudent management to guarantee enduring sustainability.

The industry-specific application of geological insights often involves a multi-faceted approach that combines environmental protection, economic optimization, and social responsibility. In sectors heavily reliant on natural resources, such as mining and agriculture, geological data is used to guide sustainable extraction practices, land rehabilitation, and resource conservation. In these industries, geological insights are critical for assessing resource availability, environmental risks and the potential impacts of extraction activities.

In the construction and real estate sectors, geological insights inform site selection, building design and infrastructure development. This includes considerations for soil stability, flood risk and the sustainable use of construction materials. The integration of geological data in these industries is essential for ensuring the safety, durability and environmental compatibility of built structures.

In the energy sector, particularly in renewable energy, geological insights play a crucial role in identifying suitable locations for wind farms, solar panels, and geothermal plants. These insights help in optimizing energy production while minimizing environmental impacts. The strategic use of geological data in the energy sector is key to transitioning towards more sustainable and renewable energy sources.

The industry-specific use of geological insights for environmental strategies reflects the diverse ways in which different sectors interact with the natural environment. Whether it's managing natural resources, developing sustainable products, or optimizing land use, the strategic application of geological data is essential for achieving environmental sustainability across various industries. As businesses continue to face increasing environmental challenges, the role of geological insights in shaping industry-specific environmental strategies will become even more critical.

Economic Implications of Integrating Geology in Business Decisions

The integration of geological insights into business decisions has profound economic implications, influencing investment strategies, market dynamics, and the overall competitiveness of industries. Simandl, Simandl and Paradis (2021) delve into the economic geology models related to specialty, critical, and photovoltaic materials. Their research highlights the growing market for these materials, driven by the demand for green technology. The study underscores the importance of geological insights in identifying and developing new sources of these materials, which are vital for industrial development and national security.

Abd-Allah et al. (2021) explore the probabilistic economic evaluation of exploration and production projects in the oil and gas industry. Their approach integrates seismic-to-simulation reservoir model uncertainties with economic evaluations, providing a more comprehensive framework for making business decisions. This research demonstrates the critical role of geological data in assessing the economic viability of resource extraction projects, taking into account the uncertainties in reservoir models and fluctuating market prices.

Arefieva, Miagkyh and Solovei (2018) examine the impact of the investment climate and financial analysis implications in making investment decisions. Their study provides insights into the economic nature of enterprise financial management and the processes of financial and economic activities. The research highlights the importance of geological data in informing investment decisions, particularly in industries such as mining and construction, where the valuation of natural resources and environmental factors play a significant role.

The economic implications of integrating geology in business decisions are multifaceted. In industries reliant on natural resources, geological data is crucial for identifying potential sites for exploration and evaluating the feasibility of extraction projects. This data informs investment decisions, guiding companies in allocating resources to projects with the highest potential for economic returns.

Furthermore, the integration of geological insights into business decisions can lead to the development of new markets and supply chains. As seen in the case of specialty materials, the identification of new sources of critical minerals can open up opportunities for businesses to enter emerging markets and establish themselves as key players in the supply chain.

Geological data also plays a significant role in risk management. By providing insights into the geological conditions of project sites, businesses can better assess and mitigate risks associated with natural disasters, environmental impacts, and resource depletion. This risk management is crucial for ensuring the long-term sustainability and profitability of projects.

In addition to direct economic benefits, the integration of geological insights into business decisions can also contribute to broader societal and environmental goals. By promoting the sustainable extraction and use of natural resources, businesses can support the transition to a more sustainable and environmentally friendly economy.

The integration of geological insights into business decisions has significant economic implications across various industries. Whether it's guiding investment strategies, informing risk management, or shaping market dynamics, the strategic use of geological data is essential for making informed and economically viable business decisions. As the demand for natural resources and sustainable practices continues to grow, the role of geological insights in business decision-making will become increasingly important.

Geological Data's Role in Corporate Environmental Risk Management

The role of geological data in corporate environmental risk management is increasingly recognized as a critical element in sustainable business practices. Liu, Ge and Wang (2024) explore the significance of environmental, social and governance (ESG) rating data in predicting financial risks and enhancing risk management strategies. Their research underscores the importance of incorporating geological data into ESG frameworks, particularly in industries such as mining and construction, where environmental risks are inherently high.

Landi et al. (2022) delve into the impact of ESG ratings on corporate financial risk, highlighting the growing investor uncertainty regarding corporate sustainability performance. This study illustrates how geological data, as part of a comprehensive ESG assessment, can inform investors and stakeholders about a company's environmental risk profile. The integration of geological insights into ESG ratings helps businesses to align their operations with sustainable practices, thereby reducing financial risks associated with environmental liabilities.

Shanyi and Murzin (2021) discuss environmental risk management in the context of green development, emphasizing the need for enterprises to adopt scientific and reasonable evaluation

indicators for environmental risks. Geological data plays a crucial role in this process, providing insights into potential environmental impacts and helping businesses to develop effective risk mitigation strategies.

The integration of geological data into environmental risk management involves several key aspects. Firstly, it aids in the identification and assessment of environmental risks associated with business operations, such as soil contamination, water pollution and land degradation. This information is vital for businesses to comply with environmental regulations and avoid potential legal and financial penalties.

Secondly, geological data is essential for the development of risk mitigation strategies. By understanding the geological characteristics of a project site, businesses can implement measures to minimize environmental impacts, such as selecting appropriate locations for waste disposal or designing infrastructure to prevent soil erosion.

Furthermore, geological data contributes to the development of environmental impact assessments (EIAs), which are critical for obtaining regulatory approvals for new projects. EIAs that incorporate detailed geological data provide a more accurate assessment of potential environmental impacts, facilitating informed decision-making by regulatory authorities.

The use of geological data in environmental risk management also supports corporate social responsibility (CSR) initiatives. By demonstrating a commitment to minimizing environmental impacts, businesses can enhance their reputation and build trust with stakeholders, including customers, investors and local communities.

In addition to managing environmental risks, the integration of geological data can also create business opportunities. For instance, companies in the mining sector can use geological data to identify new resource deposits, while those in the construction industry can use it to optimize site selection and design.

The role of geological data in corporate environmental risk management is multifaceted and increasingly vital for sustainable business operations. By integrating geological insights into environmental risk assessments, ESG frameworks and CSR initiatives, businesses can not only mitigate risks but also capitalize on opportunities for sustainable growth. As environmental concerns continue to rise, the strategic use of geological data will become an integral part of risk management in various industries.

Case Studies: Innovative Sustainable Practices Influenced by Geology

The integration of geological insights into sustainable business practices has led to innovative approaches across various industries. This section explores case studies that exemplify how geology influences sustainable practices in different sectors.

Khandelwal (2020) discusses sustainable road transport practices in India, highlighting how geological factors like terrain and road conditions influence the adoption of green logistics and transportation strategies. The study reveals significant variations in sustainability practices across different industry sectors, emphasizing the role of geological data in shaping these practices, particularly in areas with challenging geographies.

Hamid et al. (2021) examine sustainable development practices in the service sector, focusing on the Palace Hotel in Malaysia. The case study demonstrates how the hotel industry can enhance environmental performance by implementing sustainable practices influenced by local geological conditions, such as water conservation in areas with limited water resources. The

study underscores the importance of adapting sustainability strategies to local geological realities to achieve optimal environmental outcomes.

Whittinghill and Sarr (2021) present a case study on sustainable urban agriculture in Louisville, Kentucky. The research highlights how urban farmers and gardeners utilize geological data, such as soil quality and topography, to implement sustainable practices like composting, crop rotation, and organic farming. This case study illustrates the critical role of geological insights in urban agriculture, contributing to food security and sustainable urban development.

In their research, Buissonet al. (2021) investigate the implementation of innovative human resource strategies within SMEs located in Oman's Al-Dakiliya region. Their study highlights the significant impact of geological aspects, including the region's distinct landscape and natural resources, on the adoption of these innovative HR practices, which contribute to sustainable business performance. This case study offers valuable perspectives on how SMEs in areas with diverse geological features can utilize these unique environmental attributes to boost their competitive edge and achieve sustainability.

These case studies collectively demonstrate the diverse ways in which geological insights are integrated into sustainable business practices across different industries. In the transportation sector, geological data informs the development of sustainable logistics strategies, while in the hotel industry, it guides the implementation of environmental conservation measures. In urban agriculture, geological insights are crucial for optimizing farming practices, and in the SME sector, they influence the adoption of innovative HR practices that support sustainable business performance.

The integration of geological insights into sustainable business practices not only enhances environmental outcomes but also contributes to economic growth and social well-being. By adapting their strategies to local geological conditions, businesses can optimize resource use, reduce environmental impacts, and create value for stakeholders.

The case studies presented in this section highlight the significant role of geological data in shaping innovative sustainable practices across various industries. As businesses continue to face environmental challenges, the strategic use of geological insights will become increasingly important in developing sustainable solutions that are tailored to specific industry needs and local conditions.

Long-Term Economic and Environmental Benefits of Geological Integration

The integration of geological insights into business practices offers significant long-term economic and environmental benefits. Ignjatijević et al. (2020) explore the relationship between economic growth and environmental protection, highlighting how environmental policy positively influences economic performance through the improvement of environmental conditions. This study underscores the importance of sustainable business operations and the role of geological data in enhancing environmental protection, which in turn supports economic growth.

Jamil et al, (2023) examine the adoption of sustainable business practices, focusing on how integrating environmental impact management into contemporary commercial strategies can benefit businesses. He emphasizes that companies implementing sustainable methods, such as the strategic application of geological data, can significantly improve their brand reputation, customer loyalty and operational efficiency. These advantages are concrete and play a crucial role in ensuring the long-term sustainability and competitive edge of businesses.

Jiang and Lyu (2022) analyze the impact of enterprises' commitment to environmental ethics on their economic performance. The study identifies key factors influencing this relationship and examines the action mechanism of these factors. The research suggests that long-term dissemination of innovation and reputation factors in environmental ethics, which includes the responsible use of geological data, is conducive to the dissemination of green innovative technologies and products, broadening the scope of cooperation and sales.

The integration of geological insights into business decisions aids in the identification of sustainable resource extraction methods, minimizing environmental impacts and optimizing the use of natural resources. This approach not only reduces the ecological footprint of businesses but also ensures the long-term availability of resources, which is crucial for sustained economic growth.

Furthermore, businesses that incorporate geological data into their environmental strategies often find themselves at the forefront of innovation. By exploring new methods of resource utilization and developing environmentally friendly products and services, these businesses can tap into new markets and customer segments, driving economic growth.

The strategic use of geological data also plays a critical role in risk management. By understanding the environmental risks associated with their operations, businesses can implement measures to mitigate these risks, thereby avoiding potential financial losses and reputational damage.

In addition to direct economic benefits, the integration of geological insights into business practices contributes to broader societal goals, such as the reduction of greenhouse gas emissions and the conservation of biodiversity. These contributions further enhance the reputation of businesses and align them with the growing global emphasis on sustainability.

The long-term economic and environmental benefits of integrating geological insights into business practices are clear and multifaceted. By adopting sustainable practices that incorporate geological data, businesses can achieve economic growth, enhance their competitiveness and contribute to environmental conservation. As the world increasingly focuses on sustainability, the strategic use of geological data will become an essential component of successful business operations.

DISCUSSION OF LITERATURE FINDINGS

Analyzing the Economic and Environmental Impact of Geological Data

The economic and environmental impact of geological data is a critical area of study, particularly in the context of sustainable development and environmental conservation. Belyanovskaya et al. (2022) explore the influence of local geological data and geographical parameters in assessing regional health impacts in life cycle assessments (LCA). Their study demonstrates how geological data can be used to evaluate the environmental health impacts of industrial activities, emphasizing the importance of considering local geological conditions in environmental assessments.

Li et al. (2023) analyze the impact of geopolitical risk and economic policy uncertainty on environmental sustainability, with a focus on BRICS countries. This research highlights the interconnectedness of geological data, economic policies, and environmental outcomes. The study underscores the need for comprehensive geological assessments in formulating economic policies that aim to achieve environmental sustainability.

Al-shammari, Muneer and Tripathi (2022) investigate the relationship between information communication technology, economic development, and environmental degradation in GCC countries. Their findings suggest that economic development, influenced by geological factors such as natural resource availability, can have significant impacts on environmental degradation. The study emphasizes the role of geological data in understanding and mitigating the environmental impacts of economic activities.

The integration of geological data into economic and environmental analyses enables a more nuanced understanding of the complex interactions between human activities and the natural environment. For instance, in the mining and energy sectors, geological data is crucial for assessing the feasibility of projects, evaluating environmental risks, and planning sustainable resource extraction methods.

Furthermore, geological data plays a vital role in urban planning and infrastructure development. By understanding the geological characteristics of an area, planners and developers can make informed decisions that minimize environmental impacts, such as soil erosion, water pollution and habitat destruction.

The economic implications of geological data are also significant. Businesses that utilize geological data effectively can optimize resource extraction, reduce operational costs and mitigate financial risks associated with environmental liabilities. This strategic use of geological data contributes to the long-term economic sustainability of businesses.

In addition to its direct applications, geological data is instrumental in informing policy decisions. Policymakers rely on geological assessments to develop regulations and policies that balance economic growth with environmental protection. This includes policies related to land use, natural resource management and environmental conservation.

The economic and environmental impact of geological data is far-reaching and multifaceted. By integrating geological insights into economic and environmental analyses, businesses, policymakers and researchers can make informed decisions that promote sustainable development and environmental conservation. As the world grapples with the challenges of climate change and resource depletion, the strategic use of geological data will become increasingly important in achieving a sustainable future.

Geological Data as a Driver for Sustainable Business Innovation

The integration of geological data into business practices has emerged as a key driver for sustainable business innovation. Kneipp et al. (2023) explore sustainability-oriented innovation practices in internationalized industrial companies, highlighting how these companies incorporate environmental, social and economic dimensions of sustainability into their business models. This approach is particularly relevant in industries where geological data plays a crucial role, such as mining and construction, where sustainable innovation can lead to more efficient resource utilization and reduced environmental impact.

Joseph, David and Eric (2023) discuss the role of social innovation as a mediator between collaborative competence and sustainable business practices. Their study underscores the importance of collaboration in fostering innovative solutions to sustainability challenges. Geological data, in this context, can be a valuable asset in collaborative efforts, providing critical insights for developing sustainable business practices that address environmental concerns while maintaining economic viability.

Surya (2022) investigates the influence of entrepreneurial orientation and innovation on the sustainable growth of small and medium-sized enterprises (SMEs). Their research indicates that innovation, particularly the strategic application of geological data, plays a crucial role in driving sustainable business growth. In sectors reliant on natural resources, like agriculture and energy, the innovative use of geological data can result in sustainable practices that improve both environmental sustainability and economic outcomes.

The integration of geological data into business innovation processes enables companies to identify and exploit new opportunities for sustainable growth. For instance, in the energy sector, geological data can inform the development of renewable energy projects, such as geothermal energy, leading to sustainable business models that align with environmental goals.

Furthermore, geological data is instrumental in risk management, helping businesses to identify and mitigate environmental risks associated with their operations. This proactive approach to risk management not only protects the environment but also ensures long-term business sustainability by avoiding potential liabilities and reputational damage.

In the construction industry, the use of geological data can drive innovation in sustainable building practices. By understanding the geological characteristics of construction sites, companies can develop building designs that minimize environmental impact, use sustainable materials and improve energy efficiency.

Geological data also plays a key role in the development of sustainable agricultural practices. By analyzing soil composition and other geological factors, farmers can implement precision agriculture techniques that optimize resource use, reduce environmental impact and increase crop yields.

Strategic Insights for Enhancing Geological Data Use in Business

The importance of incorporating geological data into business decision-making processes is growing. Jankovic and Curovic (2023) explore how the combination of AI and geospatial data can enhance strategic decision-making and streamline business processes. Their work emphasizes the value of integrating geological information with cutting-edge technology to improve both the precision and efficiency of business decisions.

Baecker et al. (2020) explore various business strategies for data monetization, providing insights into how companies can create value from their data assets. This research is relevant to geological data use in business, as it suggests ways to leverage such data for economic gain while maintaining sustainable practices.

Kaur (2021) examines the use of business intelligence tools for strategic financial analysis, emphasizing the importance of effectively utilizing data in today's competitive business environment. The study underscores the potential of geological data in informing financial decisions, particularly in industries like mining and construction, where geological factors significantly impact financial outcomes.

Caraka et al. (2023) provide strategic insights for micro, small, and medium enterprises (MSMEs) using big data and business analytics. Their research highlights the importance of data-driven strategies in navigating the challenges of the new normal, including the strategic use of geological data to optimize business operations and enhance market competitiveness.

The integration of geological data into business strategies can lead to more informed decision-making, particularly in sectors where geological factors directly impact business operations.

For instance, in the mining industry, geological data is crucial for identifying resource deposits, assessing extraction feasibility, and managing environmental impacts.

Furthermore, geological data can drive innovation in product development and operational processes. Companies can use geological insights to develop new products or services that meet specific market needs or to optimize their operations for greater efficiency and sustainability.

In the construction industry, geological data is essential for site selection, design, and construction processes. By leveraging geological insights, companies can reduce construction risks, enhance building safety and minimize environmental impacts.

The strategic use of geological data in business can lead to enhanced decision-making, innovation and competitiveness. As businesses increasingly recognize the value of data-driven strategies, the integration of geological insights into business processes will become a key factor in achieving sustainable growth and success.

CONCLUSION

This study embarked on an explorative journey to unravel the intricate nexus between geology and corporate sustainability, particularly within the context of U.S. businesses. The aim was to dissect how geological insights are integrated into corporate environmental strategies, thereby shaping the trajectory of sustainable business practices. Methodologically, this exploration was anchored in a qualitative thematic analysis, meticulously sifting through contemporary literature to distill the essence of this integration.

The objectives of this study were manifold. Firstly, it sought to illuminate the convergence of geology and corporate sustainability, revealing how geological data informs and transforms corporate environmental strategies. This was achieved through a comprehensive analysis of current trends, regional variations, and industry-specific applications of geological insights. The study also aimed to elucidate the economic and environmental ramifications of integrating geology into business decisions, a goal that was met by examining the role of geological data in corporate environmental risk management and its influence on sustainable business innovation.

Key findings from this study underscore the pivotal role of geological data in enhancing corporate environmental strategies. It was found that the strategic use of geological insights leads to innovative sustainable practices, mitigates environmental risks, and fosters economic growth. The analysis revealed that geological data is not just a passive repository of information but a dynamic tool that drives business innovation, shapes risk management strategies, and influences long-term economic and environmental outcomes.

In conclusion, this study affirms that the integration of geological data into business practices is a linchpin for achieving sustainable development. It is a catalyst for innovation, a guardian against environmental risks, and a beacon guiding businesses towards economic resilience. The recommendations emanating from this study are clear: businesses must embrace geological data as a strategic asset, policymakers need to foster environments conducive to this integration, and future research should continue to explore this fertile intersection of geology and business sustainability.

In essence, this study not only achieves its aims and objectives but also opens new vistas in understanding the symbiotic relationship between geology and corporate sustainability, charting a course for future explorations in this domain.

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