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# Leveraging Green Financing for the Sustainability of the Mining Sector in Emerging Countries. A Meta-Analysis

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**Abstract: Objective:** The study aims to provide strategies on how the mining sector can leverage green financing for the sustainability of the mining environment. The objectives of the study are to establish the role of green financing in sustainability, analyse the challenges of adopting green finance accounting for sustainability, and develop strategies for successful green financing in the mining sector of emerging countries. The study is important in providing information on the effects of leveraging green financial accounting for sustainable development in mining sectors. It adds value to the mining industry by promoting green financing for the sustainability of mining environments and provide strategies to mitigate the impacts of climate change. **Approach:** The research approach involves a bibliometric analysis of literature related to the main theme and objectives of the study. **Results:** Results indicate that full utilisation of green financing can transform the mining environment into a better place to live and help reduce the effects of climate change. **Implications:** The implications of the study are to equip mining companies with knowledge of green financing and to minimise carbon footprints in the surrounding communities. **Value**: This study is valuable in providing green mining knowledge to support sustainability in mining companies within emerging economies.

**Keywords:** collaboration; financial institutions; mitigatory measures; stakeholders

**JEL Classification:** G

## 1. Introduction

Green financing is a topical issue in contemporary society experiencing episodes of environmental problems catalysed by the effects of climate change. The sustainability of the mining sector is important in emerging economies as global demand for minerals and metals rises (Xue, Jiang & Zhang, 2023). Green finance emerges as a pivotal instrument to address the challenges of achieving sustainability in the mining sector of emerging economies. The integration of environmental, economic and social considerations into financial reporting, green financial accounting acts as a catalyst for enhancing responsible resource extraction, promoting ethical mining practices and

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reducing adverse environmental impacts (Frederiksen & Banks, 2022; Dong, Zhang & Zhang, 2023). The mining sector of the emerging economies faces many significant challenges, such as environmental degradation, economic uncertainties, and social conflicts. Green finance offers many opportunities to mitigate the existing challenges by fostering accountability, transparency and allocating finances to sustainable mining projects (Wang & Fan, 2023). The adoption of green financing in the mining sector can lure potential investors, drive innovation initiatives in technologies that can reduce environmental footprints and enhance the mining sector of the emerging economies (An, Zhao & Zhang, 2023). Green financing can act as a transformative force in guiding the mining sector of the emerging economies into a holistic, sustainable and trajectory development (Xue, Jiang & We, 2023). This study focuses on the mining sector of the emerging economies because of their vulnerability to many forms of environmental pollution, land degradation and financial challenges to mitigate the effects of climate change. The study aims to provide more emphasis on how the adoption of green finance in the mining sector of the emerging economies can reduce financial challenges and provide innovative perspectives on the interaction of green finance governance and sustainability (Dong, Zhang, Zhang & Bi, 2023). Thus, the study seeks to provide a diverse and comprehensive examination of the potential transformative impacts that green finance could have for achieving sustainability in the mining sector of the emerging economies (An, Zhao & Zhang, 2023; Wang & Fan, 2023).

The study focused on the emerging economies, as many of these emerging economies are in the process of adopting green financial accounting for sustainable mining development. Additionally, emerging economies experience rapid industrialisation, environmental challenges, regulatory reforms, economic growth, and increasing integration into the global market (Ahmed, Kousar, Pervaiz & Shabbir, 2021). The notable examples of emerging countries that adopted green financing: India in the year 2023 promoted sustainable mining through green finance mechanisms such as green bonds, sustainability-linked loans and government-backed funding schemes, sustainable mining financing, introduced the International Solar Alliance (ISA) and mining sector decomposition. In the year 2023, the government of India invested an amount equivalent to two billion United States dollars for renewable energy and sustainable infrastructure, including the mining sector (Ministry of Finance, India, 2023).

Many researchers and governments of the world are paying attention to the impact of green financing on economic performance (Zakari, 2022). Given the present realities of the adverse effects posed by climate change, the issue of green financing cannot be underestimated (Ahmed, Kousar, Pervaiz & Shabbir, 2021). Mining companies play an important role in the success of the emerging economies worldwide. In Zimbabwe, the mining sector plays a significant role in providing employment, contributing to economic growth and generating large income from foreign exchange earnings (Cheng, Chiem & Lee, 2021). Historically, the mining sector in Zimbabwe was largely characterised by many environmental threats such as environmental degradation, land, water and air pollution due to large amounts of carbon emissions (Ahlstrom & Monciardini, 2021). Despite the existence of large mineral deposits in emerging countries, the mining sector experienced limited sustainable financing and a weak regulatory framework to reduce carbon emissions and environmental degradation (Ahlstrom & Monciardini, 2021; Meng & Shaikh, 2023). The global shift to promote environmentally responsible mechanisms provides many opportunities, such as carbon credits, green bonds and the availability of sustainable related finances (Ofori, Li, Gyamfi, Opoku-Mensah & Zhang, 2023). Green finance guides capital flows into the field of green technology innovation through clear policy orientation and innovative financial instruments (Baloch, Danish, Ulucak, Maherzi & Kayani, 2024). The

Zimbabwean mining sector needs to harness the existence of available sustainable initiatives to align the operation of the mining sector with the Sustainable Development Goals (SDGs). (Li & Wei, 2021). The mining companies are the backbone of many economies, both developing and developed economies. On one hand, mining companies contributed to environmental pollution as well as environmental degradation. The negative effects of mining companies resulted in the increased adverse effects of climate change (Amin, Dogan & Khan, 2020). In the rapidly evolving global landscape, the imperative of sustainable development and the urgent need to combat climate change requires the intervention of mining companies because of their access to large capital investments (Ofori, Li, Gyamfi, Opoku-Mensah & Zhang, 2023). There is a need for every mining company to engage in effective green financing of the environment to enhance business operations for mining and non-mining companies. The main goal of mining companies is to extract mineral resources from the ground. Mineral resources are part of human survival through income generation and as a basic input factor for industrial production that enhances sustainable economic growth by providing raw materials for production (Arfaoui, Naeem, Maherzi & Kayni, 2024).

### 1.1. Problem Statement

The problem of the study is low level of the study is low level of adoption of green finance initiatives by the mining sector in emerging countries. A lack of adequate information and unconsolidated research on green financing for sustainability in the mining sector of the emerging economies. There is a lack of green financing awareness among the mining firms in many emerging economies (Roy, 2023). Additionally, weak stakeholder collaboration amongst major mining stakeholders such as the government, financial institutions, and the mining firms in emerging countries (Ofori, Li, Gyamfi, Opoku-Mensah & Zhang, 2023). There is ignorance of environmental protection, especially by the artisanal small-scale miners who only focus on maximising profits without having an interest on environmental sustainability (Zhang, Song & Zhang, 2023). Mitigatory measures to address escalating threats of environmental pollution and climate change demand urgent strategies on sustainable development (Yan, Yang & Zhang, 2023; Roy, 2023).

### 1.2. Purpose of the Research

The research study aims to investigate the impact of leveraging green finances for the sustainable development of the mining sector. The study aims to provide more emphasis on how the adoption of green finance in the mining sector of the emerging economies can reduce financial challenges and provide innovative perspectives on the interaction of green finance governance and sustainability. Thus, the study seeks to provide a diverse and comprehensive examination of the potential transformative impacts that green finance could have for achieving sustainability in the mining sector of the emerging economies. Additionally, the study seeks to provide policy prescriptions that will guide environmentalists on the best strategies for adopting and implementing green finance initiatives for sustainable development.

### 1.3. Contribution of the Study

The study is important in contributing to the literature and society. The study is important in providing information on the effects of leveraging green financial accounting for sustainable development in the

mining sector in emerging economies. Additionally, the study provides guidelines for policymakers to craft their environmental policies while taking into consideration investing in green financing. By investing in green finance, the mining sector in emerging countries can be able to live in a society free from pollution and other adverse effects of climate change. Investing in green finance can eradicate the effects of climate change and attract potential investors to engage local businesses in the community. Thus, the expansion of the market share of the mining sector in emerging economies is expected as international customers are keen to consume sustainable goods and services. The study is also important in enhancing the green financing for sustainable mining developments to comply with the Sustainable Development Goals, especially SDG 7- focusing on clean energy. SDG 9 focuses on industrial innovation, and SDG 13 focuses on climate action. The readers in the mining sector can adopt and implement the facts raised in this study to comply with the relevant United Nations Sustainable Development Goals (SDGs).

### 1.4. Literature Gap

The noticeable literature gap within the context of leveraging green financial accounting and the sustainability of the mining sector has limited studies conducted in emerging countries. Thus, the study is important in providing information on the benefits enjoyed by the mining sectors in adopting and implementing green finance for sustainable development. Even though there is a lot of literature on the impact of green financing on sustainability globally, there is inadequate literature that provides in-depth information through the utilisation of systematic literature for emerging countries.

### 1.5. Objectives

The main objectives of the study are to:

- Establish the role of green financing on the sustainability of the mining sector in emerging countries.
- Analyse the challenges of adopting green finance accounting for the sustainability of the mining sector of emerging countries.
- Establish strategies for successful green financing for the mining sector of emerging countries.

## 2. Literature

### 2.1. Theoretical Framework

The study is guided by Priority Sustainable Finance Theory by Wilson 2010. The Priority Sustainable Finance theory focuses on how best the financial systems can integrate environmental considerations into successful investment decisions (Bakken, 2021). Sustainable finance refers to money that is harnessed by the business entity to support sustainable development in three combined dimensions which includes the economic dimension, the environmental dimension, and the social dimension (Ahlstrom & Monciardini, 2021; Chiu, 2021). Also, sustainable finance takes into consideration finances that is to be used for investing into Environmental, Social, and Governance (ESG) factors (Ozili, 2021). Priority theory of sustainable finance is important to the study as it advocates for economic agents to make every effort to achieve sustainable finance goals in a region or a country.

The decisions made should be a true reflection of the priority given to the sustainable finance agenda of the region or country (Wilson, 2010). The prioritisation of finances can be assessed from three main dimensions; (a) the coordinated, independent and collaborative efforts combined by economic agents for achieving sustainable financial goals, (b) the time period a consensus on the use of finance is reached, and (c) how slowly or quickly financial actions are taken to achieve sustainable financial goals (Wilson, 2010; Chebly, Ruiz & Shiano, 2018).

Green Financing refers to the financial investments for creating an environment free from all forms of pollution and destructions. Green financing can be any financial model established for protecting the environment (Ahmed, Kousar, Pervaiz & Shabbir, 2021). Green finance could be the market-based financial instruments for curbing environmental pollution and degradation (Li & Wei, 2021). According to the research carried in Organisation for Economic Corporation Development (OECD), twenty-six (26) countries in the OECD have formerly accepted the use of market-based financial instruments to achieve their agenda on environmental protection (OECD, 2022).

Green financing is important for enhancing sustainability development in the mining sector than the traditional methods of environmental protection that lacks effective implementation (Ampofo, Laari, Ware & Shau, 2023). Green financing initiatives promote the flow of financial instruments and other related services and enable the adoption and implementation of sustainable commercial models as well as economic, environmental and social environment projects (Suhrab, Chen & Ullah, 2024). Additionally, green financial institutions like banks include it in their strategic innovations and able to prevent the risks associated to the violation of environmental laws (Zhong, Umar, Mirza & Safi, 2021). According to Zakari (2022) green finance plays a significant role in green carbon as it links the financial institutions, environmental improvement, and economic growth together, which are important factors for fostering long-term sustainable development (Junying, Yang, Shuanglei & Farhad, 2021). Substantial financial support is of significance to realise the ambition of sustainable mineral resource development.

Emerging countries refers to the nations that exhibit rapid industrialisation, economic growth and experiencing increasing integration into global market (OECD, 2024). According to World Bank report (2023) Emerging countries sometimes known as emerging countries or market economies face multiplicity of challenges such as political instability income disparities, and underdeveloped financial systems. There are many emerging worlds that have adopted green financing, these include but not limited to, South Africa, Brazil, India. Indonesia, Chile.

Sustainability refers to the way of extracting mineral resources by mining companies for the benefit of the current generation without compromising the needs of the future generations. Environmental sustainability involves preserving biodiversity, conserving energy and water, and adopting cleaner technologies that does not cause harm to the environment (Ahlstrom & Monciardini, 2021). There is also social sustainability that focuses on fostering positive relationships with local communities, respecting human rights, and prioritising worker safety (World Economic Forum, 2023).

Mining sector refers to the business environment in which the extraction of natural resources is conducted. It is the responsible extraction, management, and processing of solid minerals, while minimising environmental, social, and economic impacts. Mining (Ahlstrom & Monciardini, 2021). In the context of sustainability, the mining sector involves the adoption of practices that ensure the long-term viability of both the mining operation and the surrounding environment and the communities (Dong, Zhang, Zhang & Bi, 2023).

### 2.2. The Role of Green Financing on Sustainable Development

Green financing is an important mechanism that centres around environmentally friendly investments and practices, has emerged as the best alternative in achieving carbon neutrality and greening sustainable economic growth through mining initiatives by mining companies (Houston & Shan, 2022). The adoption of green financing is of significance in raising finances that are important in financing sustainable initiatives through mitigating climate related financial risks, reducing carbon compliance costs, funding renewable energy transition, help to improve Economic, Social, and Governance (ESG) rating thereby enhancing investor confidence (Amin, Dogan & Khan, 2020).

Investing in green financing is important for sustainable finances that can be harnessed for the development of the mining sector environments. The adoption of green financing plays a significant role in mitigating climate financial risks. Many financial institutions in many countries provide green bonds and loans to firms that adapt to climate change initiatives (Zhong, Umar, Mirza & Safi, 2021). By having access to finances companies are in a better position to engage into sustainable projects that raise finances for developing the environments in which production is conducted. Additionally, green financing is of significance in reducing carbon compliance costs through companies complying with the environmental rules and regulations. Companies that comply with environmental regulations are do not incur environmental penalties. A good example is Anglo American used green loans to finance low-carbon technologies. Thus, the company succeeded in avoid being on the wrong side of environmental laws (Anglo American, 2022). Also, the adoption of green financing by the emerging economies is important in boosting operational efficiency of the mining sector through creating clean technology that help to maintain environments free from various forms of pollution and environmental degradation (Ampofo, Laari, Ware & Shau, 2023). Companies that invest in energy efficiency technologies incur lower operating costs. A good example is Vale a Brazilian multinational corporation engaged in metals and mining adopted electric trucks and renewable energy, this enabled the company to cut the fuel costs by almost twenty percent (Vale, 2024).

### 2.3. Challenges of Adopting Green Financing for Sustainability of Mining Sector

There are many challenges faced by emerging countries in adopting and effectively implement green financing. The most notable challenges include limited access to green financing, negative investor perception on the high risks encountered when investing in emerging economies, the existence of high upfront costs, lack of technical expertise, weak regulatory and policy. The success of green financing in emerging economies are hindered by the existence of systematic and unsystematic challenges (Ray & Nedungadi, 2020; Yasar, 2021; Raman, 2020).

Limited access to green funding is one of the most notable challenges faced by emerging countries in adopting and implementing green financing for sustainability. Many emerging economies experience financial challenges as such they opt to finance projects with immediate results (Krastev & Radosveta, 2024). Many financial institutions in many emerging economies do not have arrangements for providing finances for green financing for mining companies, so too some mining companies do not have adequate knowledge on how to obtain green financing for sustainable development of their business operations (Ahlstrom & Monciardini, 2021). The existence of weak financial markets and high financial risks resulted in mining companies having limited access to financial resources needed for green financing. According to World Bank report (2022), Zambian mining companies and other Southern African mining companies failed to have access to green finances from the international

monetary institutions due to lack of due to high debt levels (World Bank, 2022; Wasan, Kumar & Luthra, 2023). It is difficult to access green bonds and sustainability-linked loans when the mining company is operating in a country with huge unpaid debts.

The international monetary institutions do not want to risk their financial resources to the nations or companies without a secured collateral security (Yasar, 2021; Walls, 2024).

Investor perceptions of high risks in emerging countries is one of the major hindrances to green financing for sustainable development in emerging economies (Hunjira, Hassan, Zaied & Managi, 2023). International investors with large capital outlay are the ones with capacity to invest their finances for green financing but many of them are hesitant to risk their finances to long term financial projects in which it is difficult for them to measure the returns of their investments (Walls, 2024). Mining business in emerging economies is often considered as risk by many international investors deterring green investment. Many emerging countries particularly in Africa are usually experienced series of unending wars, as such many investors are not keen to invest their green finances in war torn zones (Yasar, 2021).

High operating costs of mining activities is one of the major challenges that pose challenges for the effective adopting of green financing for sustainability of the mining sector in emerging economies (Hunjira, Hassan, Zaied & Managi, 2023). The transition to sustainability mining demands huge capital investment that may deplete the finances of the mining companies. Additionally, the computation of the payback period for green finance investments does not provide reliable time needed for the green projects to recoup the initial capital outlay (Yasar, 2021). Thus, strategic decision makers of the mining companies are hesitant to venture into green investment in fear of losing their finances (McKibbin, Morris, Wilcoxen & Panton, 2020). Strategic managers fear not only the depletion of their finances but the downfall of their businesses due to lack of future cash flows (Walls, 2024). Many indigenous owners of mining companies in emerging economies do not have adequate capital to cater for both mining operations costs as well as the green financing costs. Thus, the progress of green financing for sustainable mining sector cannot thrive in the present of many financial challenges (World Bank, 2022).

The existence of regulatory and policy gaps contributed to many challenges for the adoption and implementation of effective green financing in the mining sector (Ullah, Majeed & Chishti, 2020). Many emerging economies do not have stable sustainability policies to regulate green financing initiatives as such green financing activities cannot thrive (Razzaq, Wang, Chupradit, Suksatan & Shahzad, 2021). There is policy inconsistent for the adoption and implementation of green financing for sustainable mining development in many emerging countries (Li, Sharif, Razaq & Yu, 2022). Inconsistent enforcement of green financing and sustainability laws discourages mining investors to engage into green initiatives in the mining sector (Taghizadeh-Hesary & Yoshinac, 2020).

Lack of technical expertise in the adoption and implementation of green financing initiatives contributed to the failure of sustainable development of the mining sector in emerging economies (Ernst & Young, 2022). The contemporary mining environment is characterised by high levels of technological development catalysed by the emergency of Artificial Intelligence. Thus, many emerging countries are failing to copy up with the astronomical rise of technological developments (Ullah, Majeed & Chishti, 2020; Agrawal, Agrawal, Samadhiya, Kumar & Vranda, 2024). The shortage of skilled labour force to harness modern green technology resulted in many emerging economies to leggy behind in the adoption of green financing for sustainable development of the

mining sector (Asian Development Bank, 2021). Countries like Zimbabwe and Ghana face encounter shortages of professionals to implement green mining projects for sustainable development of the mining sector (Mining Watch, 2023).

### 2.4. Strategies for the Successful Adoption of Green Financing for Sustainable Development

Mining firms have many alternatives to follow for ensuring successful adoption and implementation of green financing for sustainable development in the emerging countries. The most notable strategies include enforcing policy and regulatory frameworks, mining companies to be involved into Public - Private Partnerships (PPPs), leveraging international climate green climate finances, engage community-based green financing projects, and venture into green bonds and sustainability projects. Mining companies in emerging countries need to optimise their strategies for them to benefit from green financing alternatives (Soundarrajan & Vivek, 2021). The success of the company to adopt and implement green financing is determined by the best alternative foregone in selecting the appropriate strategy that is in tandem with the company's financial resources (Wasan, Kumar & Luthra, 2023).

Enforcing policy and regulatory frameworks for green financing is one of the strategies available for the governments of the emerging countries. Policy and regulatory frameworks need to be publicised to all existing stakeholders so that they get acquainted (Agrawal, Agrawal, Samadhiya, Kumar & Vranda, 2024). Mining companies that violate the green financing policy and regulatory frameworks need to be penalised to make them realise the results of violating the government directives (Meng & Shaikh, 2023). Environmental Management administrators need to be empowered to become effective in making the successful implementation of green financing policy and regulatory frameworks (Meng & Shaikh, 2023). There is need for the responsible authorities to establish clear environmental and green financing policy and incentivising green investments (Aragon & Rud, 2020).

Public-Private Partnership (PPP) is one of the strategy available to the mining companies to adopt for the successful adoption and implementation of green financing for sustainable development of mining companies. Organised collaborations amongst the key stakeholders that include the government, financial institutions, and the mining companies can have more power to ensure successful implementation of green finance for sustainable development of the mining sector (United Nations Development Programme, 2021). A good example for the success story of Public-Private Partnership (PPP) took place in Chile in which the Enel Green Power successfully partnered with large mining companies in the country to supply renewable energy. The supply and use of renewable energies in the operations of the mining companies in Chile helped to reduce carbon emissions thereby creating a cleaner environment free from pollutants (World Bank, 2021).

There is need for the mining companies in emerging countries to leverage international climate finances to boost their financial needs for green projects. Mining companies with a keen interest in green projects can easily get access to international money through international financial institutions such as the International Monetary Fund, World Bank (African Development Bank, 2023). Additionally, mining companies in emerging economies need to issue green bonds to finance eco-friendly initiatives. A success story of leveraging green bonds is the Anglo-American company that managed to raise billions of rands in sustainability-related bonds for its decarbonisation initiatives in South Africa (Green Climate Fund, 2020; Meng & Shaikh, 2023).

Community-based green financing is another alternative available to the mining companies in emerging economies to adopt for the successful implementation of green financing for sustainable development. Working together with the members of the community from the initial planning phase instils a sense of responsibility among the community members; as such, they are motivated to adopt and implement sustainable initiatives within their communities (Aragon & Rud, 2020). The engagement of community members for green financing provides mutual benefits to both the mining companies and the members of the community as each part is held accountable for the implementation of sustainable initiatives (Soundarrajan & Vivek, 2021; Wasan, Kumar & Luthra, 2023).

## 3. Methodology

The study adopted a systematic literature review to arrive to a conclusion in fulfilling the topic entitled, "leveraging green financing on the sustainability of the mining sector in emerging economies. Systematic literature review was relevant to this study as it follows a structured, organised and transparent process for identifying, selecting, and critically appraising relevant research studies to answer specific research questions relating to the study (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow & Moher, 2021). Literature for the study was selected based on each research question of the study. Each research question guided the selection of relevant literature for the study. Keywords from each research question were used to select journal articles from various search engines (Cooke, Smith & Booth, 2021). Systematic reviews were conducted by applying predetermined criteria for selecting studies, assessing the relevance and the quality of each journal article, and finally, the findings were synthesised (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow & Moher, 2021). The research was focused on ensuring reliability and validity by undergoing a rigorous methodology on the available literature relating to the study (Snyder, 2019).

Systematic Literature review was relevant to this study as it was thoroughly conducted to uncover patterns and insights that the original researchers of the journal articles did not notice (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow & Moher, 2021). The study consists of three main research questions in which sixty (60) research journal articles were selected based on key words such as. Green financing, sustainability, mining companies, and emerging economies. From a total of sixty (60) journal articles, only fifteen (15) research journals were considered more relevant and important for the research study. The final selection was based on the journal articles that addressed the specific research questions (Cooke, Smith & Booth, 2021). Systematic literature review was important for the study as it provides a comprehensive textual summary and synthesis of existing research, providing context and background information which is critical to understanding the broader research landscape (Snyder, 2019).

### Ethical Considerations

The researcher observed many ethical considerations. The major ethical consideration for the study is respect for the copyrights and intellectual property of the previous authors. The researcher managed to cite all the authors used for the completion of the study (Higgins, Thomas, Chandler, Cumpston, Page & Welch, 2019). Data accuracy and integrity were observed by reporting the findings of the research faithfully without misrepresenting the information of the original studies adopted by this study (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow & Moher, 2021). The author also avoided harmful

misinterpretation by presenting the findings in context to prevent misleading conclusions of the results of the research (Cooke, Smith & Booth, 2021).

## 4. Results

Evidence from literature selected for the study revealed a significant relationship between green financing and the sustainable development of the mining sector. Additionally, there is a positive correlation between Gross Domestic Product (GDP) growth and the extraction of minerals due to the financing of friendly economic development. Foreign direct investment contributes positively to the mining extraction, hence the creation of a clean mining environment. The literature also indicated a significant correlation between green finance initiatives and enhanced innovation performance in mining companies. The study also shows the pivotal role of environmentally sustainable investments in fostering innovative advancements in the mining sector. A one per cent (1%) increase in the green finance market size is associated with a reduction in carbon dioxide (CO2) emissions from mining. A large green finance market fosters sustainable investments and cleaner mining technologies, thereby decreasing the carbon footprint.

The literature relating to the second objective revealed many challenges faced by the mining sector in leveraging green financing for sustainable development. The most notable challenge is the shortage of finances to adopt and implement green financing in the mining sector in emerging countries. Additionally, inconsistent green financing regulations and policies hinder the smooth adoption of green financing for sustainable development. The study also revealed the absence of green financing regulations and policies in many emerging economies. Also, a lack of awareness and educational campaigns on issues of sustainable development is another drawback to the successful adoption and implementation of green financing for the sustainable development of mining.

Despite many challenges encountered by the mining sector in emerging economies for the adoption of green financing literature relating to objective three provides many strategies available to the mining sector of the emerging economies. The most notable strategies include enforcing policy and regulatory frameworks, involving mining companies to be involved into Public -Private Partnerships (PPPs), leveraging international climate green climate finances, engaging community-based green financing projects, and venturing into green bonds and sustainability projects. Mining companies in emerging countries need to optimise their strategies to benefit from green financing alternatives. The success of the company in adopting and implementing green financing is determined by the best alternative foregone in selecting the appropriate strategy that is in tandem with the company's financial resources.

## 5. Recommendations

The study comes up with many recommendations on successfully leveraging green financing for sustainable development in the mining sector of the emerging economies. The following recommendations were developed based on the rigorous analysis of literature relating to the study.

- There is a need to engage all stakeholders of the mining sector for the adoption and implementation of green financing. The most notable stakeholders include the executives of the mining companies, the government, particularly the department of environmental management, local and international financial institutions, the academic world and the community at large.

- There is a need to establish a clear green finance regulatory framework and policies that are effective in ensuring adherence to create a clean mining environment for sustainable development. The establishment of a regulatory framework and policies need the contribution of all stakeholders to provide their inputs.
- All mining companies in emerging countries are to include in their financial statements the extent to which they adopted and implemented green financing for sustainability accounting.
- The responsible authorities in the Ministry of Environment and organisations responsible for environmental management, to help in conducting training and workshops on issues relating to green financing and sustainability accounting reporting.
- All mining companies to have at least one expert skilled in green financing and sustainability accounting.
- Mining companies to include green financing and sustainability accounting reporting during the annual general meetings. This will enhance a sense of responsibility amongst the mining companies on green financing and sustainability accounting.
- Every mining company should have a green financing and sustainability policy that regulates the way issues of green financing should be handled.
- The government and environmental agents to provide finances to fund research relating to green financing and sustainable development.

## 6. Future Direction

The study recommends the following areas of further research:

- Impact of research funding on climate change in emerging economies.
- Impact of green finance knowledge on climate change.
- Effects of climate change on the profitability of mining companies in emerging economies.

## Declaration of Interests

The authors of this work do not have a conflict of interest in writing this academic work. There is no sponsorship associated with this current research work. This work was written to enhance the academic careers of the authors as well as to contribute to the academic body of knowledge.

# Appendix

**Table 1. Meta-Analysis relating to the research Study**

| Author | Titles | Methods | Findings |
|---|---|---|---|
| Xue, S., Jiang,Y. & Wei, Q. (2024) | Green financial accounting and transition in the mining sector in emerging economies. | The research study investigates the influence of green financial accounting on sustainability within the mining sector across 18 emerging economies from 1995 to 2021. | The study raises sustainability concerns due to insufficient emphasis on green innovation. There is positive correlation between GDP growth and extraction due to environmentally friendly economic development. Foreign direct investment contributes positively to mining extraction. |
| Akhtar, S., Tian, H., Alsedrah, I.T. & Anwar, A. (2024). | Green mining in China: Fintech's contribution to enhancing innovation performance aimed at sustainable and digital transformation in the mining sector. | The study focuses on a sample of 1254 firms listed in the Chines National Green Mining Directory. Data for this study was analysed using the Fisher-type unit root test. Also, Pearson's correlation coefficients, which evaluate the level of association between the independent variable in the study | The findings of the study indicate significant correlation between green finance initiatives and enhanced innovation performance in mining firms. The study also shows the pivotal role of environmentally sustainable investments in fostering innovative advancements in the mining sector. |
| Chu, M., Li, B., Gu, W. & Dai (2023). | Role of Green Finance in Enhancing Sustainability in the Mining Sector in Asia. | 12 mining sectors across Asian economies were studied. Data from 2000 to 2022 was used. Employing the CUP-FM (continuously updated full modified) approach | A 1% increase in the green finance market size is associated with reduction in CO2 emissions from mining. A large green finance market fosters sustainable investments and cleaner mining technologies, thereby decreasing the carbon footprint. The development of ICT shows promise, correlations with a 0.50% reduction in CO2 emissions, highlighting the role of technology in promoting sustainability |
| Hunjira, A. I., Hassan, M. K., Zaieed., Y. B. & Managi, S. (2023) | Nexus between Green Finance, Environmental Degradation, and Sustainable Development. | Panel dataset for 42 developing countries for the 2000-2020 period employing the panel fixed effect estimation. | The analysis of the study revealed a positive significant impact whereas environmental degradation exerts a negative and significant impact on sustainable development in developing countries. |

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|---|---|---|---|
| Raman, R., Ray, D. & Nedungadi (2020). | Innovations and barriers in sustainable and green finance for advancing sustainable development goals. | Mixed methods approach was adopted to investigate the role of sustainable and green finance in advancing UN sustainable development goals. | The study findings indicate that innovations such as green fintech, social impact bonds, and risk models are crucial for facilitating renewable investment and mitigating environmental impacts. |
| Soundarrajan, P. & Vivek, N. (2021). | Green finance for sustainable green economic growth in India. | Systematic review of related literature was used. | Green investment recognises the value of the environment and its natural capital and improve human well-being and social equity |
| Fu, C., Lu, L. & Pirabi, M. (2023) | Advancing green finance: A review of Sustainable development. Springer. | Utilising a narrative review methodology. A range of scholarly articles and publications to identify themes, findings, and future directions in green finance. | - Green investments plays a crucial role to address climate change and promote sustainable economic growth. |
| Junying, D., Yang, L., Shuanglei, X. & Farhad,T. H. (2024) | How does green financing affect the sustainability of mineral resources? Evidence from developing countries. Journal of Cleaner Production[1]. | Systematic generalized method of moments (SYS-GMM) based on panel data for 145 developing countries from 2006 to 2020. | - Green finance can markedly promote sustainable mineral resources (SMR).<br>- Green finance has the most conspicuous improvement on SMR in the Asia-Pacific region.<br>- Green finance indirectly enhances SMR through technological progress and infrastructure construction |
| Meng, X. & Shaikh, G. M. (2023). | Evaluating Environmental, Social, and Green Finance Investments Strategies Using Fuzzy AHP and Fuzzy WASPAS. | The study employed the fuzzy analytical hierarchy process method to assess and rank ESG criteria and sub-criteria and the fuzzy weighted aggregated sum product assessment (WASPAS) | Governance and social factors are secondary to environmental considerations in the creation of green finance. |
| Agrawal, R., Agrawal, S., Samadhiya, A., Kumar, A. & Vranda, J. (2024). | Adoption of green finance and green innovation for achieving circularity: An exploratory review and future directions. | The study adopted network analysis of shortlisting articles to view the overall citation trends. | The study provides the conceptual framework to illustrate how Green Financing can be achieved by the circularity. |
| Zakari, A. (2022). | The Role of Green Finance in Promoting Sustainable Economic and Environmental Development. | 26 OECD countries were studied from 2000 to 2018. Autoregressive with a fixed-effect model was adopted to account for the autocorrelation and unbalanced data settings. | The regression analysis shows that green finance promotes sustainable economic and environmental development. |

[1] Available at www.elsevier.com/locate/jclepro.Elsevier.

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| Krastev, B. & Radosveta. K. (2024). | Challenges and Trends in Green Finance in the Sustainable Development. A Bibliometric Analysis. | The study examines 436 articles published between 2016 and 2024, revealing insights into influential publications, authors, journals, institutions and countries engaged in green finance for sustainability. | Major findings include the pivotal role of green finance in energy efficiency, renewable energy development, and the promotion of sustainable economic growth. |
| Chinyu, L., Ali, S. A., Tan, C., Yin, W., Kouse, R. & Gulza, F. (2022). | The Fiscal Hedging and Green Financing: Sustainability Challenges for Developing World. | The study used TOPSIS and QARDL methodologies on 21-year dataset of South and Southeast Asia economies from 2000 to 2020. | The study results show that fiscal hedging contributes favourably to the environmental degradation of the underlying economy. Research and development in renewables have contributed negatively to ecological degradation and SDGs in the economies South and Southeast Asia. |
| Li, Q., Sharif, A., Razaq, A. & Yu, Y. (2022). | Do climate technology, financialization, and sustainable finance impede environmental challenges? Evidence from G10 economies. | The study employed the Cross-Sectional Augmented ARDL model and find out that climate technologies, financial institutions' access, and green bonds (financial market efficiency) significantly decrease (increase) carbon emissions. | The research findings confirm a long run cointegrating relationship between model variables and highlight the issues of cross-sectional dependence and slope heterogeneity. |
| Wasan, P., Kumar, A. & Luthra, S. (2023). | Green Financing Barriers and Solution Strategies for Emerging Economies: The Case of India. | The study uses a two-phase methodology. In the first phase, an exhaustive literature survey followed by phase 3 round modified Delphi method. | The study revealed the following strategies for successful green financing; clear green policies, and risk assessment frameworks, credit enhancement mechanisms for green developers, low coat refinancing and securitisation markets for green technology and products, combining public finance and private finance. |

*Source: Author compilation from the literature relating to the study (2025)*

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