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Eco-Centric Financing for Mine Cities: Catalysing Climate Action and Sustainable Development

Salil Seth[1], Mrinal Kanti Mahato[2*], Mohd Irfan Pathan[1], Lokesh Tomar[1] and Parveen Yadav[3]

1. Department of Management Studies, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, Uttar Pradesh, India
2. Department of Business Administration, School of Business and Commerce, Manipal University Jaipur, Jaipur, Rajasthan, India
3. Department of Marketing and Supply Chain Management, School of Business Studies, Central University of Jammu, Jammu & Kashmir, India

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Abstract

This paper explores the role of eco-centric financing in promoting sustainable development and addressing environmental challenges in mine cities. Through qualitative analysis of the case studies from the Pilbara region in Australia, the Visakhapatnam-Chennai Industrial Corridor in India, and the Kapan Mining Complex in Armenia, the work highlights the multifaceted nature of eco-centric financing, and its implications for various stakeholders, including local governments, mining companies, and communities. The findings reveal that eco-centric financing is essential for enhancing climate resilience, fostering sustainable mining practices, and generating socio-economic benefits. However, significant barriers hinder its effective implementation including inadequate regulatory frameworks, limited access to financial resources, and social mistrust among stakeholders. The paper identifies key opportunities for improvement such as strengthening policy frameworks, enhancing stakeholder engagement, and integrating technology and innovation into financing initiatives. Ultimately, this study underscores the importance of a holistic and inclusive approach to eco-centric financing, emphasizing the need for collaboration and transparency to ensure equitable and sustainable outcomes in mine cities.

1. Introduction

Mine cities, often referred to as mining towns, are urban areas that have developed around the extraction of mineral resources [1]. These cities play a significant role in the global mining industry, serving as hubs for labour, commerce, and infrastructure that support mining operations [1, 2]. The development of mine cities, or mining towns, is closely tied to the historical and economic context of mineral extraction [3, 4]. These urban areas typically emerge in response to the discovery of valuable mineral resources, leading to an influx of workers and businesses that support mining operations [1-5]. The origins of mine cities can be traced back to significant mining activities such as those seen during the gold rushes in the United States and Australia, where towns rapidly formed around mines to accommodate labourers, and provide necessary services [2-7].

Historically, mining towns have served as vital hubs for labour, commerce, and infrastructure. As mineral resources were discovered, these towns developed to support the workforce engaged in the extraction activities [8-10]. The establishment of railroads further facilitated this growth by connecting remote mining locations to broader markets, allowing for the efficient transport of both workers and mined materials [3, 4]. Over time, these communities evolved into more complex urban centers, often characterized by unique cultural identities shaped by their mining heritage [7-9]. Mine cities play a crucial role in the local and national economies. They contribute significantly to employment and economic development

Corresponding author: mrinalkantimahato333@gmail.com (M.K. Mahato)

through the direct and indirect jobs created by mining activities [10-12]. However, their reliance on a single industry makes them vulnerable to economic fluctuations associated with global commodity prices. This volatility can lead to socio-economic challenge including community displacement and health risks associated with mining operations [1-7]. Historically, the mining activities and urban development have been closely intertwined, with entire communities, emerging to provide services and support to the mining sector [2-4]. As such, mine cities are pivotal not only for their economic contributions but also for their potential to influence the sustainable development practices within the mining industry [1, 3-4, 12].

However, mine cities face considerable environmental and socio-economic challenges [2, 5]. The extraction processes that underpin mine cities often result in substantial environmental impacts [10-12]. Mining activities can lead to habitat destruction, water pollution, and increased carbon emissions, presenting significant challenges for sustainable development [2, 5-7]. These ecological disturbances are compounded by socio-economic issues such as health risks for local populations and the potential for exacerbating inequalities in developing regions [5, 6]. The extraction of minerals is inherently resource-intensive and often leads to significant ecological disturbances [1, 3], including habitat destruction [4, 6, 7], water pollution [8-11], and increased carbon emissions [7, 11, 12]. These environmental impacts are compounded by socio-economic issues such as community displacement [1-9], health risks associated with mining activities [3-7, 8, 12], and the volatility of local economies that heavily depend on the mining sector [1, 10, 11]. For instance, the mining industry has been linked to large social impacts including the disruption of local communities and the exacerbation of inequalities, particularly in the developing regions [13-15].

In light of these challenges, there is an urgent need for mine cities to adapt to changing global scenarios, particularly concerning Sustainable Development Goals (SDGs) [1-3]. The increasing recognition of sustainable practices has led to concepts like eco-centric financing, which aims to align financial incentives with ecological, and social outcomes [7-9]. This approach seeks to promote the environmentally sustainable practices within the mining sector, while addressing the socio-economic needs of communities affected by mining activities. As the global community pivots towards sustainability, mine cities must evolve from being mere extraction hubs to becoming models of sustainable urban development [7, 11-13]. This transition is essential not only for the mitigating environmental impacts but also for ensuring that these communities can thrive economically, while preserving their unique cultural identities. Mine cities are pivotal in both the historical and contemporary contexts [15-18]. Their evolution reflects broader economic trends and societal changes while highlighting the pressing need for sustainable development practices that can address the complex challenges they face today [19, 20].

As the global community increasingly recognizes the urgent need for sustainable development, the concept of eco-centric financing has emerged as a crucial mechanism to address these challenges [16-20]. Eco-centric financing encompasses various financial instruments and strategies aimed at promoting environmentally sustainable practices in the mining sector [18-21]. Eco-centric financing has the potential to accelerate climate action and facilitate the shift of mine towns onto more sustainable development pathways by coordinating financial incentives with ecological and social consequences [1, 16, 20-24].

1.1. Need for Eco-centric Financing

Degradation of ecosystems and carbon emissions are just two of the major environmental effects that the mining industry has long been linked to [23]. But there has been a notable change in the financial scene in the recent years, with green investment and financing emerging as major forces behind the decarbonisation initiatives in the mining industry [16–20, 23, 25]. Mining businesses are seeking funding to shift to low-carbon technologies and practices as a result of investors placing a higher priority on ecologically friendly projects as the world's attention on sustainability grows [1–5, 9–12, 16–25].

Eco-centric financing provides a solution to the environmental and socio-economic challenges faced by mine cities by incentivizing sustainable practices, and supporting the adoption of eco-friendly technologies [23, 24]. Financial mechanisms such as green bonds [26-27], sustainability-linked loans [28-31], and impact investing are gaining traction in the mining industry [32-36]. These instruments offer mining companies access to capital for sustainable initiatives, while aligning financial terms with the environmental performance targets, encouraging

the integration of eco-friendly practices into their operations [25-36].

1.2. Potential to Drive Climate Action and Sustainable Development

The urgent need for climate action has never been more pronounced, with climate change posing significant threats to ecosystems, economies, and communities worldwide [8, 12, 26]. The Sustainable Development Goal 13 (SDG 13) emphasizes the necessity of taking immediate and effective action to combat climate change and its impacts, recognizing that human activities have significantly contributed to the global warming and environmental degradation [37-44]. The Intergovernmental Panel on Climate Change (IPCC) has highlighted the critical importance of reducing greenhouse gas emissions across all sectors to limit the global temperature rise, and mitigate the adverse effects of climate change, which include extreme weather events, rising sea levels, and increased health risks [12].

With increased access to green financing, mining companies can invest in technologies that reduce energy consumption, improve energy efficiency, and integrate renewable energy sources into their operations [9, 11]. This transition towards low-carbon technologies is crucial for mitigating the industry's carbon footprint and contributing to climate change mitigation efforts [21-27]. Eco-centric financing incentivizes mining companies to adopt sustainable practices such as responsible waste management, water conservation, and ecosystem restoration [18-20, 41, 43-44]. Mine cities can lessen their negative effects on the environment and help to preserve natural resources by encouraging ethical resource extraction [1-5, 9-11, 14-15, 24, 25, 38]. Eco-centric financing can support initiatives that enhance the resilience of mine city communities such as investing in affordable housing, improving access to healthcare and education, and promoting economic diversification [18-20, 41, 43, 46]. Mine cities can become more sustainable overall if eco-centric finance addresses socioeconomic inequities and promotes community well-being [45, 46]. Eco-centric financing requires collaboration among various stakeholders including governments, mining companies, investors, and local communities [41, 43-46]. This collaboration can foster a culture of transparency, accountability, and shared responsibility for sustainable development, ultimately leading to more inclusive and equitable outcomes for mine cities [46]. Furthermore, eco-centric financing aligns with the broader objectives of sustainable development by promoting resilience among vulnerable communities, enhancing their capacity to adapt to climate-related risks, and ensuring that economic growth does not come at the expense of environmental integrity [41, 45, 46]. As mine cities embrace these opportunities, they can contribute to a more sustainable future for the mining industry and the communities it serves.

The aim of this paper is to explore how eco-centric financing can be effectively leveraged in mine cities to promote sustainable development, and address the pressing environmental challenges associated with the mining activities. Through an analysis of diverse financial instruments and tactics including sustainability-linked loans and green bonds, the work aims to underscore the capacity of eco-centric financing to stimulate climate action and promote conscientious resource management in these urban areas. Through a qualitative analysis of the existing literature and case studies, the paper will investigate how eco-centric financing can incentivize mining companies to adopt low-carbon technologies, enhance community resilience, and encourage collaboration among stakeholders. Ultimately, this research work aims to provide insights into the transformative role of eco-centric financing in steering mine cities towards a more sustainable and equitable future.

This paper is structured to provide a comprehensive understanding of mine cities and their role in sustainable development, particularly in the context of the Sustainable Development Goals (SDGs). Following this introduction, the literature review section will delve into the existing research work on mine cities, examining their historical development, socio-economic impacts, and environmental challenges. This review will highlight the key themes and findings from the previous studies, establishing a foundation for understanding the complexities faced by these urban areas. Subsequently, the Methodology section will outline the research approach employed in this work, detailing the data collection methods and the analytical techniques used to assess the current state of mine cities. The findings will be presented in the Results section, where we will explore the implications of eco-centric financing and sustainable practices in mining towns. Finally, the paper will conclude with a Discussion section that synthesizes the insights gained from the research work, offering recommendations for policy-makers and stakeholders to foster sustainable development in

mine cities. By structuring the paper in this manner, we aim to provide readers with a clear roadmap of our exploration into the intersection of mining activities and sustainable urban development.

2. Literature Review

The literature on eco-centric financing has gained considerable attention in the recent years as the global community grapples with the urgent need for sustainable development and climate action. As industries, particularly those with significant environmental footprints such as mining, face increasing scrutiny regarding their ecological impacts, eco-centric financing has emerged as a vital mechanism for promoting sustainable practices and responsible resource management [18-20, 41, 43-46]. This literature review aims to define eco-centric financing, exploring its principles and applications, while highlighting its relevance to a sustainable development. Additionally, it will examine various green financing mechanisms such as green bonds and sustainability-linked loans, which are instrumental in funding the sustainable initiatives. Finally, the review will summarize existing literature on the socio-economic and environmental challenges specific to mine cities including pollution, resource depletion, and community displacement. This section offers a thorough grasp of how eco-centric financing can help with the shift to more sustainable economic models by combining ideas from secondary sources, especially when it comes to mine cities. Through this exploration, the review will underscore the critical role that eco-centric financing plays in aligning financial flows with environmental goals, ultimately contributing to the achievement of broader sustainability objectives.

2.1. Eco-centric Financing

Eco-centric financing, often referred to as green financing, is a financial approach that prioritizes environmental sustainability in investment decisions and capital allocation [18-20]. This concept encompasses a range of financial instruments and strategies designed to support projects and initiatives that have a positive environmental impact [41]. Eco-centric financing is increasingly relevant in the context of sustainable development, as it provides the necessary funding to transition towards more sustainable practices across various sectors including mining [19, 41, 43]. At its core, eco-centric financing aims to align financial flows with environmental objectives, thereby facilitating the shift from traditional, resource-intensive economic models to more sustainable alternatives [41]. According to the European Commission, sustainable finance involves incorporating Environmental, Social, and Governance (ESG) considerations into investment decisions, which leads to long-term investments in the sustainable economic activities and projects [19, 43]. This holistic approach not only addresses a climate change but also promotes bio-diversity preservation [5-9, 26], pollution prevention [8, 12, 37-41], and the circular economy [47]. The principles of eco-centric financing are grounded in the recognition that financial markets can play a pivotal role in addressing environmental challenges [46]. As the industries' environmental impacts become more pronounced, the investors are increasingly seeking opportunities to support companies that prioritize sustainability. Eco-investing, a subset of eco-centric financing, focuses specifically on investments in companies that provide environmentally friendly products and practices, such as renewable energy technologies and sustainable resource management [37-41]. This shift reflects a broader trend where investors are moving beyond merely avoiding the most egregious polluters to actively seeking out transformative investments that contribute to a sustainable future (refer to Table 1).

In the mining sector, eco-centric financing is particularly significant due to the industry's substantial environmental footprint [2, 11, 23]. The mining process often leads to habitat destruction, pollution, and significant carbon emissions, necessitating a transition to more sustainable practices [1-7]. Eco-centric financing can facilitate this transition by providing the capital needed for the adoption of the low-carbon technologies, responsible resource extraction, and community resilience initiatives [12, 37-41]. For example, green bonds and sustainability-linked loans can be utilized to fund projects that enhance energy efficiency, reduce waste, and promote social equity within mining communities. Moreover, eco-centric financing aligns with global sustainability initiatives such as the United Nations SDGs, particularly SDG 13 (Climate Action), and SDGs 11 (Sustainable Cities and Communities). Eco-centric financing addresses the current environmental issues and advances the larger objectives of sustainable development by directing funds towards projects that have a positive environmental impact [48-57]. This promotes

inclusive and environmentally conscious economic growth.

Eco-centric financing represents a transformative approach to capital allocation that prioritizes environmental sustainability and social responsibility. Its relevance to sustainable development is underscored by its potential to drive significant changes in industries with substantial environmental impacts such as mining. Stakeholders may address the urgent issues brought on by resource depletion and climate change by utilising eco-centric funding to work towards a more equitable and sustainable future.

Table 1. Eco-centric Financing Timeline (Source: Authors' extraction).

Year	Event	Description	Impact	References
2015	**Adoption of SDGs**	The United Nations General Assembly adopts the Sustainable Development Goals (SDGs), emphasizing sustainable development.	Establishes a global framework for sustainable practices, including eco-centric financing.	[18-20, 26-41, 43, 46-47]
2016	**Establishment of GCF**	The Green Climate Fund (GCF) is established under the UNFCCC to assist the developing countries in climate change efforts.	Provides financial support for climate adaptation and mitigation projects, promoting eco-centric initiatives.	
2017	**GCF Project Implementation**	The GCF begins implementing projects focusing on both mitigation and adaptation.	Highlights the role of eco-centric financing in addressing climate challenges effectively.	
2018	**GCF Replenishment**	The GCF launches its first replenishment, raising over USD 5 billion for climate projects.	Demonstrates growing commitment and trust in the eco-centric financing mechanisms.	
2020	**EU Sustainable Finance Strategy**	The European Commission releases a renewed sustainable finance strategy.	Reinforces the importance of eco-centric financing in transitioning to a sustainable economy.	
2021	**Legislative Package Publication**	The EU publishes a legislative package to improve financial flows towards sustainable activities.	Embeds eco-centric financing into policy-frameworks, enhancing regulatory support.	
2024	**Reports on Bio-diversity & Climate Risks**	Ongoing studies highlight the need for eco-centric financing mechanisms.	Increases awareness of ecological impacts, driving demand for sustainable financial solutions.	

2.2. Green Financing Mechanisms

Green financing mechanisms have emerged as essential tools for promoting sustainable development, particularly in resource-intensive industries such as mining [21, 24, 26-27, 31, 33-36, 49, 52]. These financial instruments, including green bonds and sustainability-linked loans, provide innovative ways to fund the environmentally friendly projects, while encouraging companies to adopt sustainable practices [33-36, 49, 52] (refer to Table 2).

This section reviews various green financing instruments, highlighting their definitions, applications, and effectiveness in funding the sustainable initiatives, drawing on a range of studies and reports.

2.2.1. Green Bonds

Green bonds are fixed-income financial instruments, specifically earmarked to raise funds for projects with positive environmental impacts [26, 27]. The proceeds from green bonds are typically used to finance initiatives such as renewable energy projects, energy efficiency improvements, sustainable waste management, and pollution prevention [58-60]. The Climate Bonds Initiative defines green bonds as debt instruments that finance projects contributing to climate change mitigation and adaptation, as well as other environmental benefits [61]. The market for green bonds has experienced exponential growth over the past decade. According to the Climate Bonds Initiative, the global green bond market surpassed $1 trillion in cumulative issuance by 2020, with significant contributions from various sectors including energy, transportation, and real estate [61]. In the mining sector, companies are increasingly turning to green bonds to finance the sustainable mining practices. For example, in 2021, the mining company Anglo American issued a $1 billion green bond to fund the projects aimed at reducing carbon emissions and enhancing biodiversity. Several studies have evaluated the effectiveness of green bonds in funding sustainable initiatives [62, 63]. A report by the International Finance Corporation (IFC) highlights that green bonds not only provide access to capital but also enhance the issuer's reputation and credibility among the investors and stakeholders [64]. The report emphasizes that companies issuing green bonds are often perceived as leaders in sustainability, which can lead to increased investor interest and potentially lower borrowing costs.

Furthermore, studies published in the Journal of Sustainable Finance & Investment found that green bonds can lead to a "green premium", where investors are willing to accept lower yields in exchange for supporting environmentally responsible projects [65-68].

Table 2. Green Financing Mechanisms Timeline (Source: Authors' extraction).

Year	Event	Description	Impact	References
1970s	**Emergence of Green Finance Roots**	Environmental awareness leads to early initiatives focused on sustainable investments.	Lays the groundwork for future green finance mechanisms and investments.	[21, 24, 26-27, 31, 33-36, 49, 52]
2008	**First Green Bond Issued by World Bank**	The World Bank issues its first green bond, creating a model for financing the environmentally friendly projects.	Pioneers the green bond market, attracting investors to sustainable projects.	
2015	**Adoption of the Paris Agreement**	The Paris Agreement is adopted to mobilize private investment in the green projects.	Solidifies green finance's role in global climate action efforts.	
2016	**Establishment of TCFD**	The Task Force on Climate-related Financial Disclosures (TCFD) is formed to promote transparency in the climate risk assessment.	Encourages organizations to disclose climate-related risks, enhancing accountability in finance.	
2018	**EU Taxonomy Introduction**	The EU introduces its taxonomy for sustainable activities, defining what constitutes green finance.	Enhances investor confidence and clarity in sustainable investments across Europe.	
2020	**Surge in Social Bonds due to COVID-19 Pandemic**	Governments issue social bonds to address the health and economic challenges, while maintaining sustainability commitments.	Expands the scope of green finance to include social dimensions, fostering holistic approaches to sustainability.	
2021	**Adoption of Sustainability-Linked Bonds by Financial Institutions**	Major financial institutions adopt sustainability-linked bonds that tie performance to sustainability goals.	Integrates Environmental, Social, and Governance (ESG) considerations into mainstream finance practices.	
2023	**Growth of Green Bond Market Projected at USD 2.36 Trillion**	The global market for green bonds is projected to reach USD 2.36 trillion.	Reflects significant growth and interest in green financing mechanisms as essential tools for environmental challenges.	

2.2.2. Sustainability-Linked Loans

Sustainability-linked loans (SLLs) represent another innovative financing mechanism that ties the loan's financial terms to the borrower's performance against specific sustainability targets [28-31]. Unlike green bonds, which are restricted to funding specific projects, SLLs provide a greater flexibility by allowing companies to use the funds for general corporate purposes, provided they meet the agreed-upon sustainability criteria [31]. These criteria can include targets related to greenhouse gas emissions reduction, water conservation, or waste management [1-3, 28]. The effectiveness of sustainability-linked loans has been highlighted in several studies [1-3, 28-31, 69]. According to a report by the UN Environment Programme (UNEP), SLLs encourage the companies to integrate sustainability into their core business strategies, as the financial incentives are directly linked to their performance [69]. For instance, if a mining company successfully reduces its carbon emissions by a pre-determined percentage, it may benefit from a lower interest rate on its loan. This performance-based approach not only motivates companies to improve their sustainability practices but also aligns their financial interests with environmental outcomes [31, 69]. A case study involving the mining company Glencore illustrates the potential of sustainability-linked loans [70]. In 2021, Glencore secured a $1.5 billion sustainability-linked loan that tied the interest rate to specific sustainability performance targets including reducing greenhouse gas emissions and increasing the use of renewable energy [70]. This loan structure incentivizes Glencore to prioritize sustainability in its operations, demonstrating how SLLs can drive positive environmental outcomes, while providing companies with the necessary capital to invest in sustainable initiatives [70].

2.2.3. Effectiveness of Green Financing Mechanisms

The effectiveness of green financing mechanisms including green bonds and sustainability-linked loans, in funding sustainable initiatives is further supported by various studies and reports [16-20, 23, 25, 33, 71]. A comprehensive analysis by the Inter-American Development Bank (IDB) highlights the role of innovative financing instruments in promoting private investment in sustainable energy projects across Latin America and the Caribbean [72]. The

IDB's report emphasizes that green financing can help remove barriers to investment such as high upfront costs and perceived risks associated with sustainable projects [72]. Moreover, the World Bank has identified green financing as a critical component of achieving the SDGs [13]. A report by the World Bank Group indicates that mobilizing private capital through green financing mechanisms is essential for addressing climate change and promoting sustainable development [13, 73]. The report underscores the importance of aligning financial flows with environmental objectives to ensure that investments contribute to both economic growth and ecological sustainability [73]. In conclusion, green financing mechanisms including green bonds and sustainability-linked loans are powerful tools in the pursuit of sustainable development within the mining sector. These instruments provide the companies with access to capital for the environmentally friendly projects, while incentivizing the adoption of sustainable practices. The growing interest in green financing reflects a broader shift in the financial landscape, where investors increasingly prioritize environmental sustainability in their investment decisions. As the global community continues to confront the challenges posed by climate change, the adoption of these green financing mechanisms will be crucial in steering the mining industry towards a more sustainable and responsible future.

2.3. Financing Policies in the Context of Eco-Centric Financing

The role of financing policies in promoting eco-centric financing is critical, particularly in the context of sustainable development and environmental stewardship. Eco-centric financing refers to financial mechanisms that prioritize ecological sustainability while supporting economic growth [70, 71]. This section explores the existing literature on financing policies, highlighting their implications for eco-centric financing initiatives, especially in mine cities.

The financing policies can significantly influence the allocation of resources towards the environmentally friendly projects. As noted by Poghosyan [74-75], green finance has a substantial impact on ecological quality, with policies that support green investments leading to improvements in environmental outcomes. For instance, Alshater, Atayah, & Hamdan [65] emphasizes that green finance serves as a supportive tool for enhancing energy efficiency and promoting renewable energy production, which are essential for transitioning to a sustainable economy. These findings underscore the importance of integrating green finance into national and regional policies to facilitate investments in sustainable practices [75].

Moreover, the literature indicates that effective financing policies can alleviate barriers to accessing capital for the eco-centric projects. For example, the establishment of green bonds and other innovative financial instruments can mobilize private investments towards sustainable initiatives. Zeidan [66] argues that green bonds are among the most effective tools for attracting financial resources for the environmentally sustainable investments. By creating a favorable regulatory environment that encourages the issuance of such financial instruments, the policy-makers can enhance the flow of capital into the eco-centric projects [44-51].

In addition to promoting specific financial instruments, financing policies should also focus on creating an enabling environment for the private sector participation. As highlighted by the G20 principles on financing cities, a conducive investment climate is essential for attracting private investments in urban development, particularly in the developing countries. This involves improving regulatory frameworks, ensuring transparency, and providing incentives for private entities to engage in eco-centric financing initiatives.

2.4. Challenges in Mine Cities

Mine cities are often characterized by their dependence on the extraction of mineral resources, face a myriad of socio-economic and environmental challenges that significantly impact their sustainability and the well-being of their residents [1-5, 9-11]. These challenges are deeply interwoven, creating complex dynamics that require comprehensive understanding and innovative solutions [14-19]; The existing literature highlights several key issues including pollution, resource depletion, community displacement, and governance challenges [1-5, 9-11, 14-19, 60, 71]. This section summarizes the primary challenges faced by mine cities, drawing on a range of secondary sources to provide a detailed overview.

2.4.1. Pollution and Environmental Degradation

One of the most pressing challenges in mine cities is the environmental pollution resulting from mining activities [5-7, 53-55]. The extraction and

processing of minerals often lead to significant ecological disturbances including air and water pollution, soil degradation, and habitat destruction [8, 12, 26, 37-39, 41, 53, 59-64]. According to a report by the World Bank, mining operations are responsible for approximately 4 to 7 percent of global greenhouse gas emissions, contributing to climate change and local environmental degradation [13]. The release of toxic substances such as heavy metals and chemicals used in the extraction process poses serious health risks to local communities and ecosystems [14, 70]. Air pollution is particularly concerning in mine cities, where dust and emissions from mining operations can lead to respiratory issues among residents [10, 41, 59-64]. A study published in the *Journal of Environmental Management* highlights that mining operations frequently result in acid mine drainage, which can severely impact water quality and aquatic life [4, 10]. This phenomenon occurs when sulfide minerals are exposed to air and water, producing sulfuric acid that leaches heavy metals into the nearby water systems. The cumulative effects of pollution not only threaten the environment but also undermine the social fabric of mine cities, leading to conflicts over resource use and environmental justice [74-76]. Moreover, the degradation of land and water resources can have long-term implications for agriculture and food security in mine cities [74, 75]. Contamination of soil and water sources can render agricultural land unproductive, exacerbating food insecurity and economic instability for communities that rely on farming as a primary livelihood. The *Journal of Mining and Environment* emphasizes that the environmental impacts of mining extend beyond the immediate vicinity of mining operations, affecting broader ecosystems and communities downstream [9, 10, 25].

2.4.2. Resource Depletion

Resource depletion represents another significant challenge faced by mine cities [9-10]. As easily accessible mineral deposits are exhausted, mining companies are increasingly required to explore more remote and difficult-to-access areas, often at greater environmental and economic costs [16, 17, 24, 25, 36, 47, 49, 52]. The decline in the availability of high-quality ore deposits has led to increased production costs and longer lead times for the new mining projects [14, 70, 74, 75]. According to a report by the World Economic Forum (WEF), the average cost of producing copper has risen by over 300% in the past 15 years, while the grade of ore has dropped by approximately 30% [77]. This trend not only affects the profitability of mining operations but also raises concerns about the long-term sustainability of mining as a viable economic activity in these regions [14, 70, 77]. The depletion of resources also has socio-economic implications. As mining companies move to less accessible areas, the local workforce may face job losses due to the reduced need for labour in established mines [78-80]. This transition can lead to economic instability in mine cities, where employment opportunities are often heavily reliant on the mining sector. A report by the International Council on Mining and Metals (ICMM) highlights that the decline in mining activity can result in significant economic upheaval, particularly for communities that lack diversification in their economic base [14].

2.4.3. Community Displacement and Socio-economic Disparities

The socio-economic challenges faced by mine cities are compounded by issues of community displacement and inequality [2-5]. The mining operations often require large tracts of land, leading to the displacement of local communities, and disruption of traditional livelihoods [70, 77]. A study by the ICMM emphasizes that mining-induced displacement can result in significant social and economic upheaval, particularly for marginalized groups who may lack the resources to adapt to new circumstances [14]. Displacement can lead to the loss of cultural heritage, social networks, and access to essential resources, further exacerbating inequalities within affected communities [78]. Moreover, reliance on mining as the primary economic driver can create a single-industry economy that is vulnerable to market fluctuations. The decline in the investment activity, and the suspension of mining projects can have drastic consequences for these communities, leading to job losses and economic instability. As highlighted in a report by the United Nations Development Programme (UNDP), the need for a sustainable development in mine cities is urgent, as communities strive to diversify their economies and reduce dependence on mining [6]. The lack of alternative livelihoods can exacerbate poverty and limit opportunities for social mobility, particularly for women and marginalized groups.

2.4.4. Governance and Institutional Challenges

Effective governance and institutional frameworks are crucial for addressing the challenges faced by mine cities [53, 79]. However, many mining regions struggle with weak governance structures, corruption, and lack of transparency, which can exacerbate socio-environmental conflicts [12, 19, 53, 79]. Strong regulatory frameworks that promote the sustainable mining practices and protect the rights of local communities are paramount. A study published in the *Journal of Mining and Environment* underscores the importance of inclusive governance that engages local communities in the decision-making processes related to mining operations [9, 10, 25]. Weak governance can lead to inadequate enforcement of environmental regulations, allowing mining companies to operate without sufficient oversight. This lack of accountability can result in environmental degradation and social injustices, as communities may not have a voice in decisions that affect their lives and livelihoods [12, 19]. Furthermore, corruption can undermine efforts to promote sustainable development, as resources intended for community benefits may be misappropriated or diverted [79].

In conclusion, mine cities face a complex array of socio-economic and environmental challenges that threaten their sustainability and the well-being of their residents. Pollution, resource depletion, community displacement, and governance issues are interrelated challenges that require comprehensive strategies to address. As the global community increasingly prioritizes sustainable development, exploring innovative solutions including eco-centric financing mechanisms will be essential for helping mine cities navigate these challenges and transition towards more sustainable practices. Addressing these issues holistically will empower the stakeholders to create resilient and equitable mine cities that contribute positively to both the local and global sustainability goals. The literature underscores the urgency of tackling these challenges to ensure that mine cities can thrive in an increasingly sustainable and equitable future.

3. Methodology

This study employs a qualitative research approach to explore the role of eco-centric financing in promoting sustainable development in mine cities (refer to Figure 1). Through the integration of data from secondary sources such as academic publications, reports, and case studies, this study seeks to offer a thorough comprehension of the difficulties mine cities confront and the ways in which eco-centric funding might help to resolve these problems. The qualitative analysis framework used in this study is based on thematic analysis, which involves identifying, analysing, and reporting patterns or themes within the data. This approach allows for a rich and detailed exploration of the complex socio-economic and environmental challenges faced by mine cities, as well as the opportunities presented by eco-centric financing. The thematic analysis process includes steps such as data familiarization, initial coding, theme identification, theme review, theme definition, and report writing.

Secondary sources utilized in this work include the academic articles obtained from reputable databases and publishers such as Elsevier, Taylor, Francis, and Routledge. These sources provide in-depth analyses and empirical evidence related to eco-centric financing, sustainable mining practices, and the challenges faced by mine cities. Reports from international organizations including the World Bank, UNDP, and ICMM offer comprehensive assessments of the mining industry's environmental and social impacts, as well as strategies for promoting sustainable development in mine cities. Detailed case studies of specific mine cities and eco-centric financing initiatives such as those from the Pilbara region in Western Australia, the Visakhapatnam-Chennai Industrial Corridor in India, and the Kapan Mining Complex in Armenia provide valuable insights into the practical application and outcomes of eco-centric financing in various contexts. Additionally, industry publications from organizations like the IFC and the WEF offer insights into industry trends, challenges, and best practices related to sustainable mining and eco-centric financing.

This work intends to give a thorough and comprehensive analysis of the possibilities of eco-centric financing to spur sustainable development in mine cities by utilising a wide range of secondary sources. The qualitative approach allows for a nuanced understanding of the complex interplay between environmental, social, and economic factors.

4. Case Studies

This section presents a series of case studies that illustrate the practical application of the eco-centric financing mechanisms in various mine city contexts. This work illustrates how eco-centric financing can effectively address environmental

challenges, promote sustainable development, and support the shift towards more responsible mining practices by looking at specific examples from the Pilbara region in Western Australia, the Visakhapatnam-Chennai Industrial Corridor in India, and the Kapan Mining Complex in Armenia. Each case study provides insights into the unique challenges faced by these regions, the strategies employed to overcome them, and the outcomes achieved through innovative financing solutions. Through this analysis, the case studies underscore the potential for eco-centric financing to drive a positive change in the mining sector, fostering economic growth, while simultaneously prioritizing environmental stewardship and social equity.

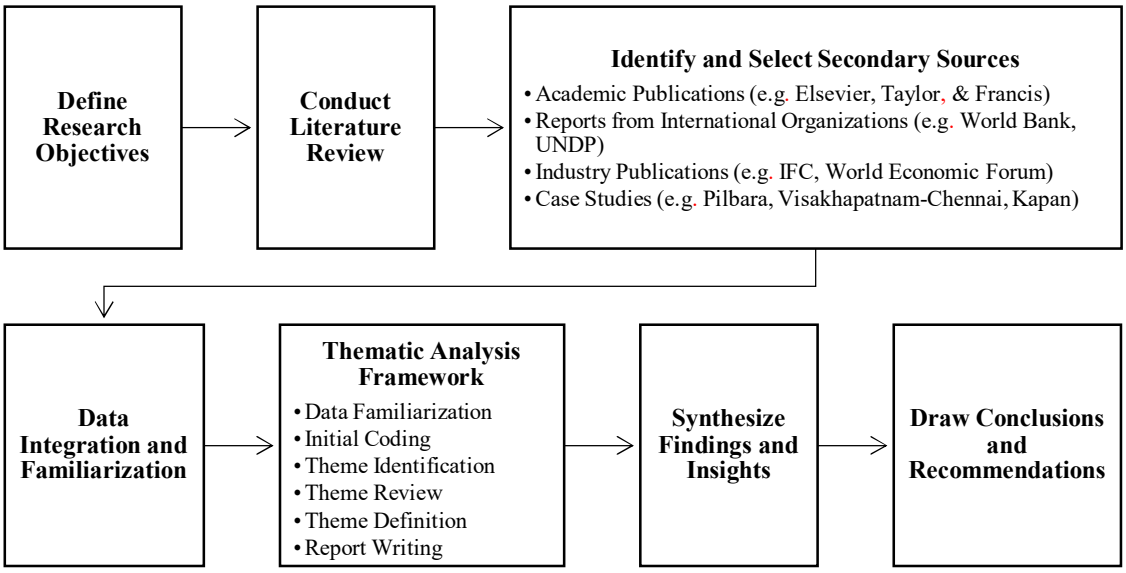

Figure 1. Research Methodology Flowchart (Source: Authors).

4.1. Case Study 1: Pilbara Region, Western Australia

The Pilbara region in Western Australia is renowned for its vast mineral wealth and is a global leader in iron ore production. This region, characterized by a high degree of specialization in mining and extractive activities, has significantly contributed to Australia's economy [81-83]. However, the Pilbara faces numerous challenges including geographic remoteness, environmental degradation, and the need for inclusive and sustainable development models that benefit all stakeholders, particularly indigenous communities [82-90]. The OECD study on the Pilbara provides valuable insights and recommendations aimed at addressing these challenges and promoting a more sustainable future [7]. The Pilbara's remoteness presents logistical challenges for both the mining operations and local communities [84-86]. Many mining sites are located far from urban centres, leading to difficulties in accessing essential services such as healthcare, education, and infrastructure [82, 85-86]. This isolation can exacerbate social inequalities, and limit economic opportunities for local residents, particularly for First Nations peoples who have lived in the region for thousands of years. Environmental impacts are another significant concern. Mining activities contribute to land degradation, water resource depletion, and bio-diversity loss [88, 90]. The extraction processes often result in habitat destruction and pollution, which can have long-term effects on the region's ecosystems [81, 85-86]. Moreover, the carbon footprint associated with mining operations adds to the global challenge of climate change, necessitating a shift towards more sustainable practices [89, 90].

The OECD study outlines several key findings and recommendations aimed at fostering sustainable development in the Pilbara region (refer to Table 3).

Table 3. OECD Study on Sustainable Development in the Pilbara Region (Source: Authors' compilation).

Recommendation	Description	Key Actions	References
Establishing a Networking Platform for Circular Economy Practices	Create a collaborative platform for stakeholders to explore circular economy opportunities in mining. This platform will engage mining companies, First Nations, service providers, and academic institutions to define projects that promote circular practices.	• Facilitate dialogue and cooperation among the stakeholders. • Identify the initiatives such as recycling materials, repurposing waste products, and developing technologies to reduce the environmental impacts. • Engage local communities to incorporate their knowledge and needs into project planning.	[81, 85-86]
Evaluating Regulations and Public-Private Agreements	Develop regulations and agreements that incentivize sustainable practices in mining. This framework aims to mitigate the environmental impacts while promoting economic resilience.	• Establish clear guidelines for the sustainable operations through public-private agreements. • Include provisions for environmental. protection, community engagement, and economic development. • Enhance transparency with public progress reports to track mining operations' adherence to sustainable practices.	[81-83, 85]
Improving Mapping and Geological Information on Abandoned Mines	Enhance geological mapping, and assessments of abandoned mines to identify opportunities for waste mining and resource recovery. This can contribute to sustainable practices and minimize ecological disruption.	• Conduct thorough assessments of abandoned mines to identify recoverable resources. • Use advanced technologies like Geographic. Information Systems (GIS) and remote sensing for improved geological mapping. • Inform future mining operations to ensure they are conducted sustainably and efficiently.	[82, 85-86, 88, 90]

Despite the wealth generated by mining in the Pilbara, many residents experience socio-economic disparities. The benefits of mining have not always been equitably distributed, particularly for Indigenous communities who face challenges related to land rights, cultural preservation, and economic opportunities [82, 85, 86, 88, 90]. The OECD study highlights the need for inclusive development models that prioritize the well-being of all stakeholders, especially First Nations peoples [7]. A more equitable approach could involve creating partnerships between mining companies and Indigenous communities to ensure that local interests are represented and that economic benefits are shared. This could include initiatives such as local employment programs, investment in community infrastructure, and support for the indigenous-led businesses [81-83, 85]. The Pilbara can move towards a more resilient and inclusive economy that values the rights and contributions of its Indigenous peoples by promoting these collaborations. The Pilbara region exemplifies the complexities of balancing economic growth with environmental stewardship and social equity [81, 85]. The findings from the OECD study underscore the importance of collaborative efforts, regulatory frameworks, and innovative practices in promoting sustainable development. The Pilbara can set the stage for a future that is more inclusive and resilient by tackling the issues of remoteness, environmental consequences, and socioeconomic inequities holistically. Ensuring that the benefits of mining extend to all stakeholders involved will be essential for creating a sustainable and equitable mining landscape in the region. Through the implementation of the OECD's recommendations, the Pilbara can position itself as a model for sustainable mining practices that contribute positively to both the local communities and the global economy.

4.2. Case Study 2: Visakhapatnam-Chennai Industrial Corridor, India

The Visakhapatnam-Chennai Industrial Corridor Development Program (VCICDP) represents a significant initiative aimed at bolstering industrial development in the state of Andhra Pradesh, India. This corridor is designed to enhance economic growth, create high-quality jobs, and improve infrastructure through a combination of financing and technical support [91-93]. The eco-centric financing mechanisms play a crucial role in this development, exemplified by the $5 million grant from the Urban Climate

Change Resilience Trust Fund [94]. This case study highlights how such funding is utilized to establish a management corporation, finance basic infrastructure needs, and ensure that policies and reforms are in place to promote sustainable development [95, 96]. The primary objectives of the VCICDP include enhancing industrial growth, creating employment opportunities, and promoting sustainable practices [97-99]. The program aims to stimulate industrial growth in the region by improving infrastructure and creating a conducive environment for businesses to thrive [97, 99]. The corridor aims to improve overall economic conditions by creating high-quality jobs for the local community through the promotion of industrial development. Moreover, the initiative emphasizes the importance of sustainable development, ensuring that industrial growth does not come at the expense of environmental health [97].

The $5 million grant from the Urban Climate Change Resilience Trust Fund is a pivotal component of the VCICDP, aimed at supporting various aspects of the corridor's development [94]. A key area of focus is the establishment of a management corporation responsible for overseeing the implementation of the corridor development. This entity plays a critical role in coordinating efforts among the stakeholders including government agencies, private sector partners, and local communities [100-103]. The management corporation ensures that projects align with SDGs and that resources are allocated efficiently. A significant portion of the funding is directed towards addressing basic infrastructure requirements such as transportation networks, energy supply, and water management systems [91-96]. These investments are essential for facilitating industrial activities and enhancing the overall quality of life for the residents in the corridor [97]. Improved infrastructure not only supports economic growth but also contributes to environmental sustainability by reducing transportation emissions and promoting efficient resource use [98, 99]. Additionally, the grant supports the development of policies, and reforms that promote sustainable practices within the industrial corridor. This includes establishing regulatory frameworks that encourage eco-friendly technologies, waste management practices, and resource conservation [92-94]. The VCICDP seeks to draw investments that place a high priority on environmental stewardship by fostering an environment that is supportive of sustainable development [95, 97]. The implementation of the VCICDP, supported by eco-centric financing, is expected to yield several positive outcomes. The corridor is anticipated to contribute significantly to the economic growth of Andhra Pradesh by attracting investments and fostering the industrial activities [95, 97]. The program aims to create thousands of jobs, particularly in manufacturing and services, thereby improving the livelihoods of the local residents. The VCICDP aims to reduce the environmental consequences, and increase resilience against climate change by incorporating sustainability into the development framework, in line with more general national and international sustainability goals [92-95, 97]. Furthermore, the establishment of a management corporation and the emphasis on the stakeholder collaboration will enhance community engagement in the development process, ensuring that local communities have opportunities to participate in decision-making.

In conclusion, the VCICDP exemplifies how eco-centric financing mechanisms can be effectively utilized to promote a sustainable industrial development. The program's objectives are to improve infrastructure, provide employment, and guarantee that the environmental factors are taken into account during the development process by utilising funds and technical assistance. As the VCICDP progresses, it serves as a model for other regions seeking to balance economic growth with sustainability, demonstrating the potential of collaborative approaches to address complex development challenges. Through the successful implementation of this initiative, the Visakhapatnam-Chennai corridor can emerge as a vital driver of economic transformation in India, setting a precedent for future industrial corridors across the country.

4.3. Case Study 3: Kapan Mining Complex, Armenia

The Kapan Mining Complex, located in the Syunik province of Armenia, represents a unique case study in the context of eco-centric financing and sustainable mining practices. As a state-owned enterprise, the Kapan Mining Complex has been operating at a deficit, necessitating radical restructuring to enable privatization, and the development of a sustainable mining business [104-108]. This case study explores how eco-centric financing mechanisms could support the complex's transition towards more efficient and environmentally responsible operations. The Kapan ore deposit was discovered in the early 19th

century, and the complex has been in operation for around 150 years. It is situated approximately 320 km from the capital, Yerevan, near the border with Azerbaijan [105]. The Kapan Mining Complex is a small to medium-scale deposit, primarily operated through underground mining with comparatively old equipment and machinery. The productivity of the entire mine is very low, and reconstruction is necessary to improve efficiency and sustainability [108]. Despite its long history, the complex faces several challenges that hinder its long-term viability and sustainability including an operating deficit, outdated equipment and machinery, and environmental concerns related to the habitat destruction and water pollution [104-106].

However, the Kapan Mining Complex also presents opportunities for eco-centric financing to catalyse sustainable development. Exploration around the existing polymetallic deposit has indicated potential gold, silver, and copper deposits, which could provide a long-term stable supply of nonferrous metal materials [107]. Additionally, upgrading to more efficient equipment and machinery can improve productivity, reduce operating costs, and minimize environmental impacts [104-106]. Attracting private investment, particularly from foreign sources, can bring in much-needed capital and expertise to drive sustainable development [104]. The Eco-centric financing mechanisms can play a crucial role in supporting the Kapan Mining Complex's transition towards sustainability [108]. Providing the necessary capital for reconstruction and rationalization can enable the adoption of more efficient equipment and machinery, improving productivity, and reducing environmental impacts [106-108]. Funding can also be directed towards exploring prospective areas around the polymetallic deposit, using advanced technologies such as Geographic Information Systems (GIS) and remote sensing to map resources accurately. This will help identify long-term stable supplies of non-ferrous metals. Moreover, eco-centric financing can support the implementation of environmental protection measures such as water treatment facilities, waste management systems, and habitat restoration initiatives [105]. These measures will help mitigate the environmental impacts of mining operations and demonstrate the complex's commitment to sustainable development. Eco-centric financing can also be used to attract private and foreign investment by providing financial incentives for investors to prioritize the environmental and social responsibility [107].

Through focused investments in environmental protection, exploration, privatisation, and rebuilding, eco-centric financing can assist overcome the issues facing the Kapan Mining Complex and turn it into an example of sustainable mining operations. This case study highlights the potential for eco-centric financing to support the transition towards a more efficient, environmentally responsible, and economically viable mining industry in Armenia. As the global community increasingly prioritizes sustainable development, the Kapan Mining Complex can serve as an example of how eco-centr a financing can catalyse positive change in the mining sector, balancing economic growth with environmental stewardship and social responsibility.

4.4. Emerging Themes

The case studies presented in this work provide valuable insights into how eco-centric financing can be applied in different mine city contexts to address environmental challenges, promote sustainable development, and support the transition towards more responsible mining practices. Several key themes emerge from the analysis of these case studies.

4.4.1. Community Engagement

A common thread across all the three case studies is the emphasis on community engagement, and the importance of incorporating local knowledge and needs into project planning. In the Pilbara region, the OECD study recommends establishing a networking platform that actively engages the stakeholders, including First Nations communities, to explore circular economy opportunities [81, 90]. Similarly, the VCICDP highlights the role of the management corporation in facilitating collaboration among the government agencies, private sector partners, and local communities [91-103]. These efforts prioritise inclusive governance in order to guarantee equitable distribution of the advantages of sustainable development, as well as respect for the rights and opinions of local communities.

4.4.2. Environmental Benefits

Eco-centric financing mechanisms are instrumental in driving environmental improvements in mine cities. In the Pilbara region, the OECD study emphasizes the importance of the developing regulations and public-private agreements that incentivize circular practices such as recycling materials, repurposing waste products,

and adopting the eco-friendly technologies [81, 90]. The $5 million grant from the Urban Climate Change Resilience Trust Fund for the Visakhapatnam-Chennai Industrial Corridor is being utilized to finance the basic infrastructure needs including transportation networks and water management systems, which contribute to an environmental sustainability by reducing emissions and promoting efficient resource use [91-103]. The Kapan Mining Complex case study also highlights the potential for eco-centric financing to support the implementation of environmental protection measures such as water treatment facilities and habitat restoration initiatives [104-108].

4.4.3. Socio-economic Impacts

The case studies demonstrate how eco-centric financing can have positive socio-economic impacts in mine cities. The Pilbara region's emphasis on creating partnerships between mining companies, and indigenous communities aim to ensure that the economic benefits are shared equitably [81, 90]. The VCICDP is expected to contribute to economic growth, create thousands of jobs, and improve the livelihoods of the local residents. These programs have the potential to contribute to the development of resilient and sustainable communities by broadening the economic base and lowering reliance on mining [91-103]. The Kapan Mining Complex case study also highlights the potential for eco-centric financing to attract private and foreign investment, bringing in much-needed capital and expertise to drive sustainable development [104-108].

4.4.4. Sustainable Mining Practices

A key theme that emerges from all three case studies is the potential for eco-centric financing to catalyse the adoption of sustainable mining practices. The OECD study on the Pilbara region recommends improving mapping and geological information on abandoned mines to identify opportunities for waste mining and resource recovery [81, 90]. The Visakhapatnam-Chennai Industrial Corridor Development Program emphasizes the importance of establishing policies and reforms that promote sustainable practices within the industrial corridor [91-103]. The Kapan Mining Complex case study demonstrates how eco-centric financing can support the reconstruction of mines through the adoption of more efficient equipment and machinery, improving productivity and reducing environmental impacts [104-108].

4.4.5. Collaboration and Innovation

The case studies underscore the importance of collaboration and innovation in driving a sustainable development in mine cities. The networking platform proposed for the Pilbara region aims to foster dialogue and cooperation among the stakeholders, while the VCICDP highlights the role of the management corporation in coordinating efforts across various sectors [81-103]. The Kapan Mining Complex case study emphasizes the potential for eco-centric financing to support the exploration of prospective areas using advanced technologies such as GIS and remote sensing [104-108]. Mine cities may better handle difficult problems, and seize new opportunities by promoting cooperation and welcoming creative ideas.

The case studies presented in this study demonstrate the transformative potential of eco-centric financing in promoting sustainable development in mine cities. Eco-centric financing can assist in the creation of more resilient and equitable mine cities that positively contribute to the local and global sustainability goals by placing a priority on community engagement, advancing environmental improvements, producing positive socioeconomic impacts, stimulating sustainable mining practices, and encouraging collaboration and innovation.

5. Findings

The findings from the analysis of eco-centric financing in various mine city contexts reveal significant insights into the perceptions and experiences of the key stakeholders including local governments, mining companies, and communities. These insights highlight the complexities and challenges associated with implementing the eco-centric financing mechanisms, while emphasizing the potential benefits for a sustainable development and environmental stewardship. The following sections summarize the key findings derived from the case studies of the Pilbara region, the Visakhapatnam-Chennai Industrial Corridor, and the Kapan Mining Complex.

5.1.1. Stakeholder Perspectives

The stakeholders are individuals or groups that have a vested interest in the activities and outcomes of an organization, project, or initiative. This term

encompasses a wide range of participants including employees, customers, suppliers, local communities, government agencies, and investors [109, 110]. The concept of stakeholders is derived from the combination of two terms: "stake", which refers to an interest or claim in an organization's activities, and "holder", which signifies ownership or involvement. Stakeholders can impact or be impacted by the organization's decisions, both positively and negatively, making their perspectives crucial for effective management and decision-making [109]. The significance of the stakeholders lies in their ability to influence the success or failure of an organization. Engaging with stakeholders can lead to better decision-making, enhanced accountability, and improved transparency [111-113]. For instance, local communities can provide valuable insights into environmental impacts, while employees can offer perspectives on operational efficiencies. Through comprehending and resolving the concerns and interests of diverse stakeholders, entities can reduce risks, promote cooperation, and generate enduring value [109-113].

The stakeholder perspectives refer to the viewpoints, opinions, and attitudes held by different stakeholders regarding an organization, project, or initiative. These perspectives are shaped by the stakeholders' interests, experiences, and the specific contexts in which they operate [109, 110]. For example, local governments may prioritize environmental sustainability and community welfare, while mining companies might focus on profitability and operational efficiency. Communities affected by mining activities may express concerns about environmental degradation and social equity, seeking greater involvement in the decision-making processes [114]. The term "stakeholder perspectives" has gained prominence in the recent years, particularly in discussions surrounding Corporate Social Responsibility (CSR) and sustainable development [19]. As organizations increasingly recognize the importance of balancing the interests of various stakeholders, the need to engage with and understand these perspectives has become paramount. This shift reflects a broader movement towards stakeholder capitalism, where businesses aim to serve the interests of all stakeholders, not just shareholders [109, 115-117]. Organisations can create plans that meet social expectations and promote long-term sustainability by taking into account the various stakeholder views. Stakeholders play a vital role in shaping the direction and success of organizations and initiatives. Their perspectives provide valuable insights that can inform decision-making and drive positive change [110, 115]. Understanding and engaging with stakeholders is essential for fostering collaboration, enhancing accountability, and achieving sustainable outcomes in various contexts, including the mining sector [116, 117].

5.1.1.1. Local Governments

Local governments generally perceive eco-centric financing as a crucial tool for fostering sustainable development and addressing environmental challenges. In the Pilbara region, local authorities recognize the potential of eco-centric financing to enhance infrastructure, promote environmental protection, and stimulate economic growth [81, 90]. For instance, the OECD study emphasizes the importance of establishing a networking platform that actively engages stakeholders including First Nations communities to explore circular economy opportunities [7]. This platform is seen as a means to facilitate collaboration and ensure that local governments can effectively align eco-centric financing initiatives with community needs and priorities [118-120]. Local governments express a strong desire for collaboration and coordination among various stakeholders to ensure that eco-centric financing initiatives are not only environmentally sound but also socially equitable [90, 91, 119]. They highlight the necessity for stronger partnerships with mining companies and communities to effectively implement the sustainable practices [118]. However, they also identify the challenges posed by inadequate regulatory frameworks, and a lack of resources to monitor and enforce compliance with sustainability standards [118-120]. This gap in regulation can hinder the effectiveness of eco-centric financing, as local governments often lack the capacity to oversee complex financing mechanisms and ensure that they deliver on their promises [120].

5.1.1.2. Mining Companies

Mining companies are increasingly acknowledging the economic advantages of adopting eco-centric financing mechanisms. Many companies recognize that the sustainable practices can enhance their competitive edge, and improve their public image [11,15-28]. For example, in the Visakhapatnam-Chennai Industrial Corridor, mining companies see eco-centric financing as an opportunity to invest in infrastructure that supports their operations, while addressing environmental

concerns [91-103]. The $5 million grant from the Urban Climate Change Resilience Trust Fund is a case in point, as it is being utilized to finance the basic infrastructure needs that not only benefit the companies but also the surrounding communities [94]. However, mining companies also face challenges related to the initial costs of transitioning to more sustainable operations and the complexities of navigating regulatory requirements [121]. Many companies express a desire for clearer guidelines and incentives from local governments to facilitate their transition towards eco-friendly practices [118-121]. They argue that while the long-term benefits of sustainability are evident, the upfront investment can be a significant barrier, particularly for smaller operators. This highlights a growing recognition within the industry of the importance of sustainability, coupled with a need for supportive policies to enable effective implementation.

5.1.1.3. Communities

Community perspectives on eco-centric financing are often mixed, reflecting both hope and skepticism. In the Kapan Mining Complex case study, the community members demonstrate a growing awareness of the potential benefits of sustainable practices such as improved environmental quality and economic opportunities [104-108]. They emphasize the need for meaningful engagement in decision-making processes, as their local knowledge and needs are vital for the success of eco-centric financing initiatives [18-20, 44, 46]. For instance, community members in Kapan have expressed a desire to be involved in the planning and implementation of financing projects that directly affect their lives, advocating for transparency and accountability in how funds are allocated and utilized [104-108]. However, there is also a significant skepticism regarding the actual implementation of eco-centric financing schemes, with concerns about whether the promised benefits will materialize [119-123]. Many community members express a strong desire for transparency and accountability in how eco-centric financing is utilized, along with assurances that their rights and interests will be protected throughout the process [124, 125]. This skepticism is often rooted in past experiences, where mining operations have led to environmental degradation and social displacement without adequate compensation or remediation [119-123]. As a result, communities are increasingly demanding that mining companies, and local governments demonstrate a genuine commitment to sustainable practices and community welfare.

5.1.2. Key Themes

Several key themes emerge from the analysis of stakeholder perspectives regarding eco-centric financing (refer to Table 4).

The findings from this study highlight the multifaceted nature of the stakeholder perspectives on eco-centric financing in mine cities. Local governments view it as a necessary tool for a sustainable development but call for stronger collaboration and regulatory support. Mining companies recognize the economic advantages of adopting sustainable practices but seek clearer guidelines and incentives. Communities are hopeful yet cautious, emphasizing the need for engagement, transparency, and accountability. These insights underscore the importance of fostering dialogue among stakeholders to create a cohesive approach to eco-centric financing that effectively addresses environmental challenges, while promoting social equity and economic resilience in mine cities. The case studies illustrate that a successful eco-centric financing requires a collaborative framework that incorporates the diverse perspectives and needs of all stakeholders involved, ultimately leading to more sustainable and responsible mining practices.

6. Discussion

The analysis of eco-centric financing in mine cities reveals significant implications for climate action, sustainable development, and the barriers and opportunities associated with its implementation. This section synthesizes the key findings from the case studies, and secondary sources to provide a comprehensive discussion of these critical aspects.

6.1. Implications for Climate Action

Eco-centric financing plays a pivotal role in enhancing climate resilience and promoting sustainable development in mine cities [11,15-28]. The eco-centric finance methods can dramatically lower greenhouse gas emissions and lessen the effects of climate change by giving priority to investments in clean energy, energy efficiency, and environmentally friendly infrastructure [74-75, 77, 80, 85, 87-89]. For instance, the VCICDP utilizes eco-centric financing to invest in sustainable transportation systems such as electric vehicle infrastructure and efficient public transit options. These initiatives not only reduce emissions from

fossil fuel consumption but also enhance the resilience of local communities to climate-related hazards, such as flooding and heatwaves [82, 85-86, 88, 90]. Moreover, eco-centric financing can support the adoption of sustainable mining practices, which are essential for minimizing environmental degradation and promoting ecosystem restoration [18-20, 44-46]. The Kapan Mining Complex case study highlights how eco-centric financing can facilitate the implementation of environmental protection measures such as water treatment facilities and waste management systems. These measures help mitigate the adverse effects of mining activities on the local ecosystems, and contribute to the restoration of habitats, thereby enhancing biodiversity and ecosystem services [74, 75, 77-80, 85, 87-89]. Eco-centric financing can support my cities in their transition to a more resilient and egalitarian future by placing a high priority on climate action and sustainable development, ultimately helping to achieve global climate targets [109, 115-117]. In addition to direct environmental benefits, eco-centric financing can also stimulate economic growth and job creation in mine cities. Over time, mining businesses can lower costs and increase operational efficiency by using sustainable practices and green technologies. The overarching notion of sustainability includes multifaceted perspectives such as economic, eco-centric, and resource-oriented approaches [81-83, 85,135]. For example, the adoption of energy-efficient machinery, and renewable energy sources can lower operational expenses, while minimizing the environmental impacts. This transition not only benefits the mining companies but also creates new job opportunities in sectors related to sustainability such as renewable energy, waste management, and environmental consulting. Thus eco-centric financing serves as a catalyst for both climate action and economic development in mine cities.

Table 4. Key Themes from Stakeholder Perspectives on Eco-Centric Financing (Source: Authors' compilation).

Theme	Description	Examples	References
Collaboration and Engagement	Effective eco-centric financing requires active collaboration and engagement among local governments, mining companies, and communities. Establishing platforms for dialogue and cooperation can help ensure that all stakeholders' perspectives are considered in the decision-making processes.	The proposed networking platform in the Pilbara region aims to facilitate collaboration, allowing the stakeholders to share knowledge and resources.	[55-58, 90-93, 118-122]
Regulatory Support	Stakeholders emphasize the need for robust regulatory frameworks that support sustainable practices, and provide clear guidelines for implementation. Local governments play a critical role in facilitating this process by developing policies that incentivize eco-friendly practices. The lack of adequate regulations can hinder the effectiveness of eco-centric financing.	Local governments in the Pilbara region are encouraged to strengthen their regulatory capacity to enhance the effectiveness of eco-centric financing initiatives.	[27, 73, 79, 84, 90, 91, 96, 126]
Economic Viability	Mining companies recognize the economic benefits of sustainable practices but seek support in overcoming initial costs and regulatory complexities. Eco-centric financing can provide the necessary capital and incentives to encourage the adoption of sustainable technologies and practices.	The Visakhapatnam-Chennai Industrial Corridor illustrates how targeted investments can lead to an improved infrastructure and economic growth, benefiting both mining companies and local communities.	[16-17, 24, 36, 47, 49, 52, 74, 75, 77-80, 85, 87-89, 94, 115-121]
Transparency and Accountability	Communities demand transparency and accountability in the utilization of eco-centric financing. Ensuring that local voices are heard and that financing initiatives deliver on their promises is essential for building trust and fostering long-term community support.	The Kapan Mining Complex case study highlights the importance of community engagement in ensuring that eco-centric financing aligns with local needs and priorities, advocating for clear communication and reporting on financing outcomes.	[16, 22, 23, 63, 98, 127, 128]

6.2. Barriers to Implementation

Despite the potential benefits of eco-centric financing, several barriers hinder its effective implementation in mine cities. One of the primary obstacles is the lack of adequate regulatory frameworks and enabling environments that support sustainable practices. Many local governments struggle to develop and enforce regulations that incentivize eco-friendly investments, making it challenging for mining companies and communities to access eco-centric financing. For instance, in the Pilbara region, local authorities have expressed concerns about the need for a stronger collaboration with mining companies and communities to create a cohesive regulatory environment that promotes sustainability. Another significant barrier is the limited availability of financial resources, and the complexity of accessing international climate funds [80-93, 118-122]. Many mine cities, particularly those in the developing countries, face substantial financial constraints, and lack the technical expertise to navigate the application processes for these funds.

This challenge is compounded by the long-standing focus of development finance institutions on working with national governments rather than directly with local authorities [27, 73, 79, 84, 90, 91, 96, 126]. As a result, local governments may find it difficult to secure the necessary funding to implement eco-centric financing initiatives effectively. Social barriers also play a critical role in hindering the effective implementation of eco-centric financing [16, 17, 24, 36, 47-49, 52, 74-75, 77-80, 85, 87, 89, 94, 115-121]. Mistrust between mining companies and local communities can create significant obstacles to collaboration and engagement. Communities often express skepticism about the actual benefits of sustainable development projects, fearing that mining companies may prioritize profit over environmental and social responsibility [119-123]. This skepticism is frequently rooted in past experiences where mining operations have led to environmental degradation and social displacement without adequate compensation or remediation [129-134]. Overcoming these social barriers requires meaningful engagement and collaboration among all stakeholders to build trust and ensure that eco-centric financing initiatives align with local needs and priorities.

6.3. Opportunities for Improvement

The literature suggests a number of strategies and recommendations to improve the efficacy of eco-centric funding in mine cities (refer to Table 5).

Table 5. Strategies and Recommendations to Enhance Eco-centric Funding Efficacy in Mine Cities (Source: Authors' extraction).

Strategy	Description	Potential Benefits	Challenges	Examples
Strengthening Regulatory Frameworks and Enabling Environments	Local governments should prioritize the development of policies and regulations that incentivize eco-friendly investments, and support. Sustainable mining practices. This includes implementing building codes, environmental licensing, and payment for ecosystem services. By creating a robust regulatory framework, local governments can facilitate access to eco-centric financing, and ensure that projects align with sustainability goals.	Increased investment in sustainable practices, improved environmental outcomes, and better alignment. With local priorities.	Resistance from industry, lack of capacity for enforcement, and potential unintended consequences.	The European Union's Emissions Trading System (EU ETS), and China's national carbon market.
Improving Access to Financial Resources	International climate funds and development finance institutions should streamline their application processes, and provide targeted support to mine cities seeking eco-centric financing. This could involve simplifying the documentation required for funding applications and offering technical assistance to the local governments. Additionally, bundling small-scale projects into portfolios can help reduce transaction costs and encourage local financial institutions to participate in eco-centric financing initiatives.	Increased availability of funding for sustainable projects, better alignment with international priorities, and leveraging of private sector investment.	Complex application processes, limited capacity of local governments, and lack of coordination among funding institutions.	The Green Climate Fund's Simplified Approval Process (SAP) and the World Bank's Climate Investment Funds (CIF).
Fostering Collaboration and Engagement Among Stakeholders	Establishing platforms for dialogue and cooperation among the local governments, mining companies, and communities can help ensure that eco-centric financing initiatives align with local priorities and needs. Meaningful engagement and transparent communication are essential for building trust and fostering long-term support for sustainable development projects. For example, the proposed networking platform in the Pilbara region aims to facilitate collaboration among stakeholders, allowing them to share knowledge and resources effectively.	Improved trust and cooperation among stakeholders, better alignment of projects with local needs, and increased community support for sustainable development.	Difficulty in reaching consensus, power imbalances among stakeholders, and lack of incentives for participation.	The Extractive Industries Transparency Initiative (EITI) and the ICMM Community Development Toolkit.
Promoting the Integration of Climate Resilience Considerations into Mine Action Planning	Mine action programs should systematically incorporate climate resilience aspects into their decision-making processes including priority-setting and task allocation. This can help ensure that mine action contributes intentionally to the resilience of communities to climate change. By integrating climate considerations into planning, mine cities can better prepare for, and respond to the climate-related challenges.	Improved resilience of mine cities to climate change impacts, better alignment of mine action with broader development goals, and reduced vulnerability of the local communities.	Lack of capacity and expertise in climate resilience planning, difficulty in quantifying climate risks, and potential conflicts with other priorities.	The UNDP's Integrated Climate Change Strategy for the Mining Sector and the World Bank's Climate-Smart Mining Initiative.
Enhancing the Science-Policy Interface	Improving the connection between scientific knowledge and policy decisions can help ensure that eco-centric financing is directed towards addressing the core issues faced by mine cities. For example, in the water sector, international support can help identify vulnerable river basins and develop climate-resilient water projects. Strengthening the science-policy interface can facilitate evidence-based decision-making and enhance the effectiveness of eco-centric financing initiatives.	Improved targeting of eco-centric financing towards critical issues, better alignment of policies with scientific evidence, and enhanced effectiveness of the sustainable development projects.	Difficulty in translating scientific knowledge into policy language, lack of trust between scientists and policy-makers, and competing priorities.	The Intergovernmental Panel on Climate Change (IPCC) and the International Union for Conservation of Nature (IUCN).

Strategy	Description	Potential Benefits	Challenges	Examples
Promoting Transparency and Accountability	Eco-centric financing initiatives should prioritize transparency and accountability to build trust among the stakeholders. This includes establishing clear reporting mechanisms, conducting regular audits, and ensuring that funds are allocated and utilized in alignment with sustainability goals. Regular progress updates and impact assessments can help demonstrate the effectiveness of eco-centric financing to all stakeholders.	Increased trust among stakeholders, better alignment of projects with sustainability goals, and improved effectiveness of eco-centric Financing initiatives.	Resistance from organizations due to concerns about reputational risks or loss of competitive advantage, lack of capacity for Monitoring and evaluation.	The Extractive Industries Transparency Initiative (EITI) and the Global Reporting Initiative (GRI) Standards.
Capacity Building and Knowledge Sharing	Investing in capacity building and knowledge sharing can enhance the effectiveness of eco-centric financing. This includes providing training and technical assistance to the local governments, mining companies, and community organizations on sustainable practices, project management, and accessing eco-centric financing. Establishing knowledge-sharing platforms and facilitating peer-to-peer learning can help disseminate best practices and lessons learned across mine cities.	Improved capacity of the stakeholders to implement sustainable practices and access eco-centric financing, better dissemination of best practices and lessons learned, and enhanced effectiveness of eco-centric financing initiatives.	Limited funding for capacity building, difficulty in reaching all stakeholders, and lack of incentives for knowledge sharing.	The World Bank's Extractives Global Programmatic Support (EGPS) and the International Finance Corporation's (IFC) Sustainable and Responsible Investment in Mining program.
Promoting Innovation and Technological Solutions	Encouraging the adoption of innovative technologies and solutions can significantly improve the outcomes of eco-centric financing. This includes supporting research, and development in areas such as renewable energy, waste management, and resource efficiency. Providing incentives for the mining companies to invest in clean technologies and promoting the use of digital platforms for stakeholder engagement, and project monitoring can help drive innovation in the mining sector.	Improved environmental outcomes, increased. Efficiency and cost-effectiveness of sustainable practices, and better alignment with global trends towards sustainability.	High upfront costs of innovative technologies, resistance to change within the mining industry, and lack of incentives for innovation.	The ICMM' Innovation for Cleaner, Safer Vehicles (ICSV) program and the WEF's Mining and Metals Blockchain Initiative.

Eco-centric funding can be used to promote sustainable development and climate resilience in mine cities more successfully by removing these obstacles and seizing improvement possibilities. The successful implementation of eco-centric financing requires a holistic approach that considers the unique challenges and opportunities of each mine city context, while prioritizing collaboration, innovation, and long-term sustainability. Through concerted efforts to strengthen regulatory frameworks, improve access to financial resources, foster stakeholder engagement, and integrate climate resilience into planning, mine cities can leverage eco-centric financing to create a more sustainable and equitable future.

6.4. Practical Implications

The findings of this study present several practical implications for stakeholders involved in the development and management of mine cities, particularly in the context of sustainable development. First and foremost, there is a pressing need for comprehensive policy frameworks that integrate eco-centric financing mechanisms into mining regulations. Policymakers can play a pivotal role by developing incentives and guidelines that encourage mining companies to adopt sustainable practices and invest in eco-centric projects. This could involve implementing tax credits, subsidies, or preferential access to financing for companies that meet specific sustainability criteria. By creating a supportive policy environment, governments can drive the adoption of eco-centric financing and accelerate the transition toward sustainable mine cities.

In addition to the policy initiatives, effective stakeholder collaboration is essential for the successful implementation of eco-centric financing. The complexities of the mining sector necessitate close cooperation among various stakeholders including mining companies, financial institutions, local governments, and community representatives. Establishing multi-stakeholder platforms can facilitate the development and deployment of tailored financing solutions that address the unique needs and challenges faced by each mine city. These platforms can serve as forums for sharing best practices, identifying barriers to implementation, and co-creating innovative financing mechanisms that align with the sustainable development principles.

Moreover, capacity building is crucial for ensuring that the stakeholders are equipped to implement eco-centric financing effectively. Training programs and workshops should be organized to educate mining companies, financial institutions, and local communities about the benefits and best practices of sustainable financing.

By enhancing knowledge and skills within these groups, capacity-building efforts can help overcome the barriers to implementation and ensure that eco-centric financing initiatives are designed and executed effectively.

Finally, robust monitoring and evaluation frameworks should be established to assess the impact of eco-centric financing initiatives over time. Regular assessments can help identify areas for improvement and ensure that financing mechanisms are effectively addressing environmental and social challenges. These frameworks should incorporate both quantitative and qualitative indicators to capture the multifaceted nature of sustainable development. By regularly evaluating the performance of eco-centric financing initiatives; stakeholders can make informed decisions and adapt their strategies to maximize their impact on the sustainable development in mine cities.

6.5. Limitations

While this study provides valuable insights into the potential of eco-centric financing for promoting sustainable development in mine cities, it is important to acknowledge several limitations that may affect the generalizability and applicability of the findings. One significant limitation is the geographical scope of the research work, which primarily focuses on mine cities in the developing countries. Consequently, the findings may not be directly applicable to mine cities in developed nations, which often face different socio-economic contexts, regulatory environments, and environmental challenges. Another limitation pertains to data availability, as the research work relies heavily on the secondary data sources. The availability and quality of the data can vary significantly across different regions and time periods, which may affect the reliability of the findings. In some cases, limited data may hinder a comprehensive understanding of specific eco-centric financing mechanisms or their impacts on local communities. Additionally, the complexity of the mining sector poses challenges in capturing all relevant nuances associated with eco-centric financing. While this work aims to provide a comprehensive overview, it may not fully account for all specific challenges faced by individual mining companies or regions. Lastly, assessing the long-term impacts of eco-centric financing on sustainable development in mine cities remains a challenge within this study's scope. Longitudinal research work is needed to evaluate how these financing mechanisms perform over time in achieving lasting environmental and social benefits. Future studies could focus on tracking specific case studies or projects to provide deeper insights into the effectiveness of eco-centric financing initiatives over extended periods.

Despite these limitations, this study contributes valuable insights and recommendations for leveraging eco-centric financing to foster sustainable development in mine cities. Addressing these limitations through further research and enhanced stakeholder collaboration will be essential for maximizing the effectiveness of eco-centric financing mechanisms in promoting resilience, equity, and environmental responsibility within mining communities worldwide.

6.6. Summary of Key Findings

The exploration of eco-centric financing in mine cities reveals a multifaceted landscape of opportunities, challenges, and impacts. This section summarizes the key findings of the study, highlighting the various financing mechanisms available, the implementation challenges faced by stakeholders, and the resulting environmental and socio-economic outcomes. By organizing these findings into distinct categories, we aim to provide a clear overview of how eco-centric financing can drive sustainable development in mining regions. Table 6 encapsulates these insights, offering a concise reference for understanding the implications of eco-centric financing in promoting resilience and sustainability within mine cities.

In conclusion, the findings of this study underscore the significant potential of eco-centric financing to drive sustainable development in mine cities. The identified financing mechanisms such as green bonds and impact investment funds, offer innovative ways to channel resources into environmentally beneficial projects. However, the work also highlights critical implementation challenges that must be addressed including awareness gaps and regulatory uncertainties. Ultimately, by overcoming these barriers and leveraging eco-centric financing effectively, mine cities can achieve substantial environmental benefits, and socio-economic improvements. This holistic approach not only enhances community resilience but also contributes to broader sustainability goals, paving the way for a more equitable and environmentally responsible future for mining regions.

Table 6. Summary of Key Findings (Source: Authors).

Category	Findings
Eco-centric Financing Mechanisms.	• Green Bonds: Debt instruments financing environmentally beneficial projects. • Impact Investment Funds: Investments prioritizing social and environmental impact alongside financial returns. • Sustainability-Linked Loans: Loans with interest rates tied to sustainability performance targets. • Eco-Centric Venture Capital: Investments in innovative eco-friendly technologies and business models.
Implementation Challenges	• Lack of Awareness and Capacity: Limited understanding of eco-centric financing among stakeholders. • Perceived Higher Costs: Mining companies may view eco-centric practices as more expensive. • Regulatory Uncertainty: Inconsistent policies regarding environmental regulations hinder investment. • Limited Access to Capital: Small-scale operations face difficulties in securing financing due to perceived risks.
Environmental Impacts	• Reduced Greenhouse Gas Emissions: Investments in renewable energy lower carbon footprints. • Improved Water Management: Development of water treatment facilities and recycling systems. • Habitat Restoration: Initiatives supporting bio-diversity conservation and ecosystem recovery.
Socio-Economic Impacts	• Job Creation in Green Industries: New employment opportunities in eco-friendly sectors. • Enhanced Community Resilience: Diversification of local economies reduces dependence on mining. • Improved Health Outcomes: Better environmental conditions lead to healthier communities. • Reduced Income Inequality: Eco-centric financing can help address socio-economic disparities.

7. Conclusions

The qualitative analysis of eco-centric financing in mine cities has yielded several key insights that underscore its critical role in promoting sustainable development and addressing environmental challenges. Through the examination of case studies from the Pilbara region, the Visakhapatnam-Chennai Industrial Corridor, and the Kapan Mining Complex, this study highlights the multi-faceted nature of eco-centric financing, and its implications for various stakeholders, ultimately emphasizing the need for a holistic and inclusive approach to drive positive change in the mining sector. First and foremost, eco-centric financing is recognized as a vital mechanism for enhancing climate resilience and fostering sustainable practices in mining operations. Eco-centric funding has the potential to drastically cut greenhouse gas emissions and lessen the effects of climate change by giving investments in renewable energy, energy efficiency, and green infrastructure first priority. The case studies illustrate how such financing can support initiatives that not only improve operational efficiency for mining companies but also benefit local communities by creating jobs, enhancing environmental quality, and restoring ecosystem services. This dual focus on environmental protection and socio-economic development underscores the transformative potential of eco-centric financing in creating more resilient and equitable mine cities. Moreover, the analysis reveals the importance of stakeholder perspectives in shaping the effectiveness of eco-centric financing initiatives. Local governments view eco-centric financing as essential for sustainable development but emphasize the need for stronger collaboration and regulatory support to create an enabling environment for sustainable practices. Mining companies increasingly acknowledge the economic benefits of adopting eco-friendly technologies and processes, but they often seek clearer guidelines and incentives from local authorities to facilitate their transition. Communities, while hopeful about the potential benefits of eco-centric financing, express skepticism regarding the actual implementation of projects, and demand transparency and accountability in how funds are utilized, emphasizing the need for meaningful engagement in decision-making processes. However, the work also identifies significant barriers to the effective implementation of eco-centric financing in mine cities. These barriers include inadequate regulatory frameworks, limited access to financial resources, and social mistrust between mining companies, and local communities. The lack of clear policies and regulations that incentivize eco-friendly investments hinders the ability of stakeholders to access eco-centric financing, while the complexity of navigating international climate funds and the focus of development finance institutions on national governments rather than local authorities further exacerbates the challenge. Social barriers such as the mistrust between mining companies and communities can also impede collaboration and engagement, underscoring the importance of building trust through transparent communication and equitable benefit-sharing. Finally, the findings suggest several opportunities for improvement including strengthening regulatory frameworks, enhancing access to financial resources, fostering collaboration among stakeholders, and integrating climate resilience considerations into mine action planning. Mine communities may use eco-centric funding to achieve more equitable and sustainable outcomes by putting these measures into practice, which will ultimately help build a future that is

more resilient to climate change. For instance, the local governments can develop policies and regulations that incentivize eco-friendly investments, while international climate funds, and development of finance institutions can streamline their application processes and provide targeted support to mine cities seeking eco-centric financing. Establishing platforms for dialogue and cooperation among stakeholders can help ensure that eco-centric financing initiatives align with local priorities and needs, while integrating climate resilience into mine action planning can enhance the long-term sustainability of these projects.

The findings from the literature indicate that robust financing policies are integral to advancing eco-centric financing in mine cities. Policy-makers can not only enhance environmental quality but also stimulate economic growth by aligning financial mechanisms with sustainability goals. The integration of green finance into broader economic strategies can lead to a more sustainable resource management approach, particularly in regions heavily dependent on the mining activities. This exploration of financing policies reveals significant opportunities for promoting eco-centric financing through well-designed regulatory frameworks, and innovative financial instruments. As mine cities grapple with the dual challenges of economic development and environmental sustainability, the implementation of effective financing policies will be crucial. These policies can facilitate investments that not only support local economies but also contribute to global sustainability efforts. By prioritizing eco-centric financing within their policy frameworks, governments can ensure that mining activities align with broader environmental objectives, ultimately fostering more resilient and sustainable communities.

In conclusion, eco-centric financing represents a transformative approach to sustainable development in mine cities. Stakeholders may leverage the potential of eco-centric financing to drive good change in the mining industry while promoting social fairness and environmental stewardship by placing a high priority on collaboration, transparency, and innovation. The insights gained from this work underscore the importance of a holistic and inclusive approach to eco-centric financing, ensuring that the benefits of sustainable development are shared equitably among all the stakeholders involved. As mine cities continue to grapple with the challenges of climate change and environmental degradation, eco-centric financing offers a promising pathway towards a more resilient and sustainable future, where economic growth is balanced with environmental protection and social justice.

7.1. Policy Frameworks for Inducing Eco-centric Financing in Mine Cities

As the global community increasingly recognizes the importance of sustainable development, mine cities face unique challenges and opportunities in aligning their economic activities with environmental stewardship. Eco-centric financing presents a viable solution to address these challenges by promoting investments that prioritize ecological sustainability alongside economic growth. To effectively induce eco-centric financing in mine cities, it is essential to establish a robust policy framework that integrates regulatory measures, economic incentives, community engagement strategies, financial instruments, and monitoring mechanisms. Below is a conceptual diagram representing this policy framework, followed by a discussion of specific policies that can be improved or implemented to foster eco-centric financing in mining regions.

7.1.1. Eco-Centric Financing as a Pathway to Sustainable Development

Eco-centric financing emphasizes the need for investments that strike a balance between economic advancement and ecological preservation. This approach not only facilitates the adoption of green technologies but also strengthens local economies through sustainable practices. For mining cities, the shift towards eco-centric financing requires a comprehensive and well-coordinated policy framework that incentivizes eco-friendly practices while holding companies accountable for environmental and social impacts (refer to Figure 2).

To effectively induce eco-centric financing in mining cities, it is essential to develop a robust policy framework that encompasses several key elements: regulatory measures, economic incentives, community engagement strategies, financial instruments, and monitoring mechanisms. Each of these components plays a vital role in creating an enabling environment for sustainable investments in the mining sector. Below is a more detailed exploration of the policies that can be improved or implemented to promote eco-centric financing in mining regions.

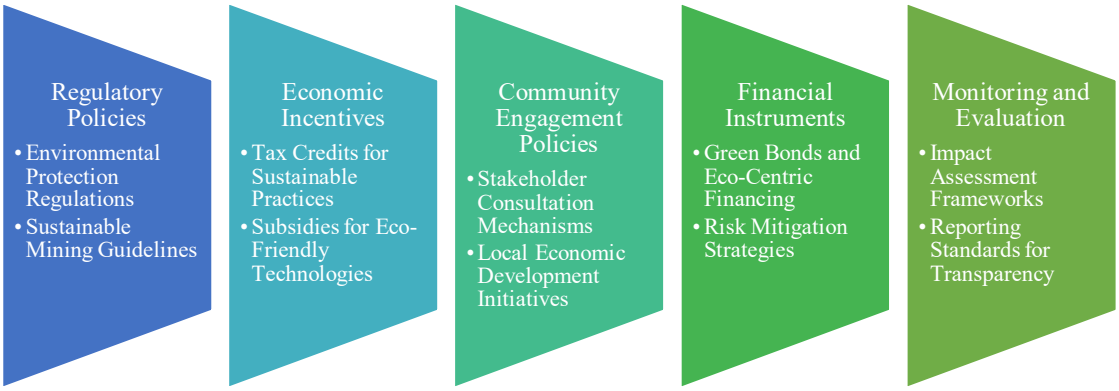

Figure 2. Framework for Promoting Eco-Centric Financing in Mining Cities (Source: Authors).

1. Regulatory Policies for Sustainable Mining:

The foundation of eco-centric financing in mining cities rests upon a strong regulatory framework that ensures mining operations adhere to ecological sustainability principles. Governments should enact stringent environmental protection regulations that mandate comprehensive Environmental Impact Assessments (EIAs) as a prerequisite for project approvals. EIAs ensure that mining projects are evaluated based on their potential to affect ecosystems, bio-diversity, and local communities before any extraction activities commence. This process must include thorough assessments of water, air, and soil quality, as well as the impact on local flora and fauna.

Beyond EIAs, the governments should also develop and enforce comprehensive sustainable mining guidelines. These guidelines would establish best practices for resource extraction, ensuring that environmental considerations are integrated at every stage of mining operations—from exploration to reclamation. This includes the promotion of technologies that minimize waste, reduce greenhouse gas emissions, and conserve natural resources. To further strengthen enforcement, the governments must implement stringent penalties for companies that fail to comply with environmental standards, making violations costly and ensuring accountability.

2. Economic Incentives to Encourage Eco-friendly Practices

Economic incentives play a crucial role in motivating mining companies to adopt eco-centric practices. By providing financial benefits to those who prioritize sustainability, policy-makers can drive change within the industry. One effective approach is the introduction of tax credits or deductions for companies that invest in green technologies and environmentally friendly practices. For instance, companies could receive tax breaks for implementing renewable energy solutions such as solar or wind power or for investing in water recycling technologies to reduce the environmental impact of their operations.

Additionally, the governments can offer subsidies to encourage the adoption of eco-friendly machinery and equipment. This would help lower the initial costs associated with transitioning to more sustainable technologies, making it easier for mining companies to make environmentally conscious investments. Subsidies could also be provided for research and development (R&D) in sustainable mining technologies, fostering innovation in the industry.

3. Community Engagement Policies for Inclusive Development

Sustainable mining practices cannot be fully realized without the active participation and support of local communities. Mining activities often have significant social and economic impacts on the surrounding communities, and policies must be put in place to ensure that local voices are heard in the decision-making process. Governments should develop community engagement mechanisms that promote regular consultations between mining companies, local residents, and other stakeholders. These consultations should provide a platform for discussing the social and environmental impacts of mining activities and allow communities to express their concerns and contribute to the planning and implementation of mining projects.

In addition to consultation, the governments should support local economic development by fostering initiatives that promote small business growth and job creation in mining regions. For

instance, establishing job training programs for local workers in sustainable industries such as eco-tourism or renewable energy can help diversify the local economy and reduce reliance on mining. Furthermore, promoting local entrepreneurship and supporting small businesses can help mitigate the socio-economic impacts of mining, and enhance community resilience in the face of economic fluctuations.

4. Financial Instruments to Expand Green Investment Opportunities

Access to green financing is critical for the success of eco-centric initiatives in mining cities. Governments can facilitate the issuance of green bonds, which are financial instruments specifically designed to fund projects with positive environmental impacts. Green bonds could be earmarked for sustainable mining projects, attracting investors who are interested in supporting environmentally responsible initiatives. These bonds can be used to finance the development of green infrastructure such as renewable energy systems or water treatment facilities, in mining regions.

In addition to green bonds, the governments could develop insurance products that provide risk mitigation for the investors. These insurance products would cover environmental liabilities, offering financial protection to investors who are concerned about the risks associated with eco-centric financing in the mining sector. This added security could make eco-centric projects more attractive to potential investors, thereby increasing the flow of capital into sustainable mining initiatives.

5. Monitoring and Evaluation to Ensure Accountability

A critical component of any eco-centric financing framework is the ability to monitor and evaluate the effectiveness of sustainability initiatives. Governments must establish robust monitoring and evaluation frameworks that assess the environmental and social outcomes of mining projects. This includes setting up standardized reporting requirements for companies to track their progress toward sustainability goals, as well as developing impact assessment frameworks that measure both the short-term and long-term effects on local ecosystems and communities.

These frameworks can help build trust among stakeholders including investors, local communities, and environmental organizations by enhancing transparency and accountability. They also provide a valuable data that can inform future policy decisions, and ensure that eco-centric financing continues to align with broader sustainability objectives.

Eco-centric financing offers a promising pathway to align mining activities with sustainable development goals. By implementing a comprehensive policy framework that includes regulatory policies, economic incentives, community engagement, financial instruments, and monitoring mechanisms, the governments can create an environment that encourages mining companies to prioritize ecological sustainability. This holistic approach not only supports the transition to sustainable mining practices but also fosters economic growth, social well-being, and environmental stewardship in mining cities. Through these efforts, mining regions can become pioneers in sustainable development, contributing to global efforts to combat climate change and protect natural ecosystems.

7.2. Future Research Directions

As the role of eco-centric financing in promoting sustainable development in mine cities continues to gain attention; there is a pressing need for further research work to explore its long-term impacts and effectiveness. While this work has highlighted significant insights into the current state of eco-centric financing, several areas warrant more comprehensive investigation to ensure that these initiatives achieve their intended outcomes. Table 7 illustrates the suggestions which describe potential directions for future research.

As eco-centric financing continues to evolve as a critical tool for a sustainable development in mine cities, further research is essential to fully understand its long-term impacts and effectiveness. Scholars and practitioners can make a valuable contribution to the development of financing mechanisms that are more equitable, sustainable, and effective in addressing the complex challenges faced by mine cities in the context of environmental degradation and climate change by investigating the suggested areas for future research.

Table 7. Potential Future Research Directions for Eco-centric Financing (Source: Authors).

Research Direction	Description	Potential Methodologies	Expected Outcomes
Long-Term Impact Assessments	Future studies should focus on conducting long-term impact assessments of eco-centric financing initiatives in mine cities. This includes evaluating the sustainability of projects over time, examining their economic, social, and environmental outcomes. Research could investigate how eco-centric financing has contributed to climate resilience, job creation, and community well-being in the long run. By utilizing the longitudinal data and case studies, the researchers can identify best practices and lessons learned that can inform future initiatives.	Longitudinal studies, case studies, surveys, and interviews.	Identification of best practices, lessons learned, and measurable impacts on sustainability and community well-being.
Comparative Studies Across Regions	Comparative studies that analyse eco-centric financing initiatives across different mine cities and regions can provide valuable insights into the contextual factors that influence their success. By examining diverse geographical, economic, and cultural contexts, the researchers can identify common challenges and effective strategies for implementing eco-centric financing. Such studies can also explore how local governance structures, stakeholder engagement, and regulatory frameworks impact the effectiveness of financing initiatives.	Comparative analysis, cross-sectional studies, and qualitative interviews.	Insights into effective strategies and common challenges across different contexts, leading to tailored solutions.
Stakeholder Engagement and Perceptions	Research should delve deeper into stakeholder engagement processes and perceptions regarding eco-centric financing. Understanding the motivations, expectations, and concerns of various stakeholders—including the local governments, mining companies, and communities—can help identify barriers to collaboration and trust-building. Qualitative studies such as interviews and focus groups can provide rich insights into the dynamics of stakeholder relationships and the factors that contribute to successful engagement in eco-centric financing initiatives.	Qualitative interviews, focus groups, and participatory action the research.	Enhanced understanding of stakeholder dynamics, barriers to engagement, and recommendations for fostering collaboration.
Integration of Technology and Innovation	Investigating the role of technology and innovation in enhancing the effectiveness of eco-centric financing is another promising area for future research. Studies could explore how advancements in renewable energy, waste management, and resource efficiency can be integrated into financing initiatives to maximize environmental benefits. Additionally, research could assess the potential of digital platforms and data analytics to improve transparency, accountability, and stakeholder engagement in eco-centric financing projects.	Technology assessments, case studies, and pilot projects.	Identification of innovative solutions and technologies that enhance the effectiveness of eco-centric financing.
Policy-frameworks and Regulatory Environments	Future research should also focus on the development of robust policy frameworks and regulatory environments that support eco-centric financing in mine cities. This includes analysing the effectiveness of existing regulations and identifying gaps that may hinder the implementation of sustainable practices. Research could explore how local governments can develop policies that incentivize eco-friendly investments and foster collaboration among stakeholders, ultimately leading to more effective eco-centric financing initiatives.	Policy analysis, stakeholder consultations, and regulatory impact assessments.	Recommendations for policy improvements and regulatory frameworks that support sustainable practices in mine cities.
Socio-Economic Impacts	Finally, there is a need for more comprehensive studies on the socio-economic impacts of eco-centric financing initiatives in mine cities. Research should examine how these initiatives affect local communities, particularly in terms of job creation, income generation, and social equity. Understanding the distribution of benefits and potential trade-offs associated with eco-centric financing can help ensure that initiatives contribute to inclusive and equitable development.	Surveys, economic modelling, and case studies.	Detailed understanding of socio-economic impacts including job creation and income distribution, leading to equitable development.

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تأمین مالی محیط زیست محور برای شهرهای معدنی: کاتالیزور اقدام اقلیمی و توسعه پایدار

سالیل ست[۱]، مرینال کانتی ماهاتو[۲*]، مهد عرفان پاتان[۱]، لوکش تومار[۱] و پروین یاداو[۳]

۱- گروه مطالعات مدیریت، دانشگاه باباساحب بهیمرائو آمبدکار (دانشگاه مرکزی)، لاکنو، اوتار پرادش، هند

۲- گروه مدیریت بازرگانی، دانشکده بازرگانی و بازرگانی، دانشگاه مانیپال جیپور، جیپور، راجستان، هند

۳- گروه بازاریابی و مدیریت زنجیره تأمین، دانشکده مطالعات بازرگانی، دانشگاه مرکزی جامو، جامو و کشمیر، هند

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* نویسنده مسئول مکاتبات: mrinalkantimahato333@gmail.com

چکیده:

این مقاله به بررسی نقش تأمین مالی محیط زیست محور در ارتقای توسعه پایدار و پرداختن به چالش‌های زیست محیطی در شهرهای معدن می‌پردازد. از طریق تجزیه و تحلیل کیفی مطالعات موردی از منطقه پیلبارا در استرالیا، کریدور صنعتی ویساخاپاتنام-چنای در هند و مجتمع معدنی کاپان در ارمنستان، این کار ماهیت چندوجهی تأمین مالی اکو محور و پیامدهای آن را برای سهامداران مختلف برجسته می‌کند. از جمله دولت‌های محلی، شرکت‌های معدنی و جوامع. یافته‌ها نشان می‌دهد که تأمین مالی محیط‌زیست برای افزایش انعطاف‌پذیری آب و هوا، تقویت شیوه‌های استخراج معدنی پایدار و ایجاد مزایای اجتماعی-اقتصادی ضروری است. با این حال، موانع قابل توجهی از جمله چارچوب های نظارتی ناکافی، دسترسی محدود به منابع مالی و بی اعتمادی اجتماعی در بین ذی‌نفعان مانع اجرای مؤثر آن می‌شود. این مقاله فرصت‌های کلیدی برای بهبود مانند تقویت چارچوب‌های سیاست، افزایش مشارکت سهامداران و ادغام فناوری و نوآوری در طرح‌های تأمین مالی را شناسایی می‌کند. در نهایت، این مطالعه بر اهمیت یک رویکرد جامع و فراگیر برای تأمین مالی اکو محور تاکید می‌کند و بر نیاز به همکاری و شفافیت برای اطمینان از نتایج عادلانه و پایدار در شهرهای معدن تاکید می‌کند.

کلمات کلیدی: انعطاف پذیری آب و هوا، تأمین مالی محیط زیست محور، چالش‌های زیست محیطی، شهرهای معدن، مشارکت ذی‌نفعان.