# Environmental sustainability in mining industry: A systematic review of economy perspective for achieving sustainability development goals

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**Abstract:** The mining industry plays a significant role in the global economy but also has a considerable impact on the environment. This research aims to systematically review the economic perspective on environmental sustainability within the mining industry, particularly in the context of achieving the Sustainable Development Goals (SDGs). Using the Systematic Literature Review (SLR) method following the PRISMA protocol, this study analyzed 17 publications from the Scopus database published between 2019 and 2024. The main focus areas include five economic perspectives: productivity, diversification, resilience, innovation, and efficiency. The review's results indicate a growing academic interest in environmental sustainability in the mining sector, with an increase in publications in 2023 and 2024. The resilience perspective dominates scientific discussions, followed by innovation, efficiency, and productivity. However, a significant research gap exists in the area of diversification, which is crucial for reducing economic dependence on a single commodity or market. The implications of this study highlight the importance of a multidimensional approach in the sustainability policies and practices of the mining industry. Diversification strategies, technological innovation, energy efficiency, and social resilience are vital pillars for achieving economically and environmentally sustainable mining. Further research is necessary to explore how diversification strategies can be effectively implemented to enhance economic resilience and support the attainment of the SDGs.

**Keywords:** Environmental Sustainability, Economy Perspective, Mining Industry, SDG, Systematic Literature.

## 1. Introduction

Environmental sustainability is an aspect that is the main concern in the mining industry today. The mining industry refers to the group of industries involved in mining-related activities, including the extraction and refining of minerals and resources [1].

This industry is a very important sector for many countries, especially for those that are heavily dependent on mining resources.

Despite its relatively small size compared to other industrial sectors, the mining industry produces significant hazardous materials as by-products and wastes, highlighting the importance of this industry in both economic and environmental contexts.

Because it provides vital raw materials for manufacturing, electricity, and infrastructure, the mining sector is fundamental to the growth of the world economy. But mining operations are also linked to serious environmental harm, such as ecosystem disruption, greenhouse gas emissions, groundwater contamination, and deforestation. Given these environmental costs, the industry must undergo a long-term transition to meet international agendas, especially the Sustainable Development Goals (SDGs) set forth by the United Nations (UN).

In addition to playing an important role in the growth of the world economy, the mining sector causes significant environmental damage. Currently, it is seen that carbon emissions, water pollution,

and deforestation are increasing as a result of unsustainable mining operations. Groundwater pollution comes from more than 10,000 active and abandoned tailings sites. Instead, the industry faces pressure to adopt environmentally sound practices to support the achievement of the Sustainable Development Goals (SDGs) [2].

Mining is especially affected by several of the 17 Sustainable Development Goals (SDGs), including SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 12 (Responsible Consumption and Production).

In the past, environmental and social aspects have dominated mining sustainability initiatives. But little is known about the economic viewpoint—how operational, structural, and financial tactics might support long-term environmental sustainability.

Although various studies have addressed sustainability in the mining sector, most still focus on environmental and social aspects. Research highlights the potential of the circular economy [3] while other research reviews the local economic impact of mining in Africa [4]. However, economic aspects such as diversification in the context of sustainability are still poorly researched.

These limitations show that environmental sustainability in the mining sector requires a systematic approach that incorporates economic perspectives. Perspectives such as productivity, resilience, efficiency, innovation, and, most importantly, diversification have great potential to improve the industry's adaptability to emerging challenges around the world. Therefore, it is important to fill this gap by reviewing the latest research and looking at how the economy contributes to the achievement of sustainable development goals.

Research conducted by Mohsin, et al. [2] looking at the economic and environmental impacts of the mining industry, but the study did not specifically pay attention to sustainable economic strategies. Research [3] talk about circular economies, but they do not include diversification in the context of economic resilience. Research [4] assess the impact on the local economy, but does not consider sustainability from various aspects. These three studies show that, especially in terms of diversification, efficiency, and innovation strategies related to achieving the SDGs, the economic aspects of environmental sustainability of the mining industry are still limited.

The ability of the sector to adjust to global pressures, such as market volatility, climate change, and regulatory changes, can be greatly influenced by economic resilience, diversity, innovation, efficiency, and productivity. Developing sustainable development policies and practices in the mining sector requires a thorough grasp of these economic viewpoints. By performing a thorough analysis of current research, this paper fills this vacuum by concentrating on the relationship between mining's environmental sustainability and economic strategy.

In this study, economic perspectives such as efficiency, diversification, resilience, innovation, and productivity are systematically studied. These perspectives have not been studied integratively in the context of the sustainability of the mining sector so far. There are significant research opportunities, especially since very little research has been done on diversification strategies as an economic way to reduce dependence on a single market or commodity. This study broadens the understanding of the contribution of economies to the achievement of the Sustainable Development Goals (SDGs) by emphasizing how the economic dimension can strengthen the resilience of industries to global challenges.

Environmental sustainability is defined as the practice of preserving natural resources to meet the needs of today without sacrificing the ability of future generations to meet their own needs [5]. This includes collaborative efforts between businesses, individuals, and governments to engage in activities such as water treatment, waste reduction, pollution control, and resource conservation through renewable methods. The ultimate goal is to move from unmonitored growth and consumption to a model that drives monitored use and sustainability.

Environmental sustainability in the mining industry is regulated in the United Nations campaign, namely the Sustainable Development Goals (SDGs). The Sustainable Development Goals (SDGs) are a set of universal goals promoted by the United Nations, designed to address global challenges while

ensuring that development is inclusive and sustainable [6]. The SDGs emphasize interconnectedness and can be applied in all countries, regardless of their development status. The SDGs aim to meet the basic needs of underprivileged communities and recognize environmental limitations in meeting current and future needs, in line with the principles of sustainable development.

This research is important because it provides a thorough understanding of how economic perspectives contribute to environmental sustainability in the mining sector. This study shows how economic strategies can improve the mining industry's resilience to global pressures by looking at elements such as productivity, diversification, resilience, innovation, and efficiency. To achieve the Sustainable Development Goals (SDGs), the application of economic principles in mining practices is essential, especially in terms of economic sustainability and environmental conservation.

This study uses a systematic literature review (SLR) methodology to facilitate a careful and thorough analysis of the existing knowledge pool.

Through the examination of previous research, the SLR methodology makes it possible to look at patterns, deficiencies, and trends in the literature, thus establishing a strong foundation for further investigation and pragmatic implementation in the field of the mining industry. Through this evaluative process, researchers aim to enhance scientific dialogue and practical initiatives undertaken by companies and policymakers striving for a more sustainable future.

## 2. Research Method

This study follows the protocol of the PRISMA statement. The PRISMA protocol itself refers to the guidelines set by the PRISMA statement, which aims to improve the quality of systematic review reporting and meta-analysis. In Figure 1 the protocol includes a checklist and flowchart outlining the important matters that must be reported, to ensure clarity and transparency in the review process [7].

This study's theoretical underpinnings combine several frameworks. The idea of environmental sustainability highlights the necessity of satisfying present needs without endangering those of future generations. In the mining industry, this entails implementing methods that maintain economic viability while minimizing environmental damage.The expansion of economic activity across several goods, markets, or industries is known as economic diversification.

Diversification promotes economic resilience and reduces the risks brought on by changes in commodity prices in resource-dependent nations. Diversification promotes sustainable growth and flexibility. Its precise function in mining sustainability hasn't been fully explored, though.

Another important idea is economic resilience, which describes a system's ability to withstand shocks and continue operating. Resilience in the mining industry includes strategic company transformation, policy reaction, and community adaptation. Mining companies can align with sustainability goals through innovation and efficiency, especially green innovation and resource optimization.
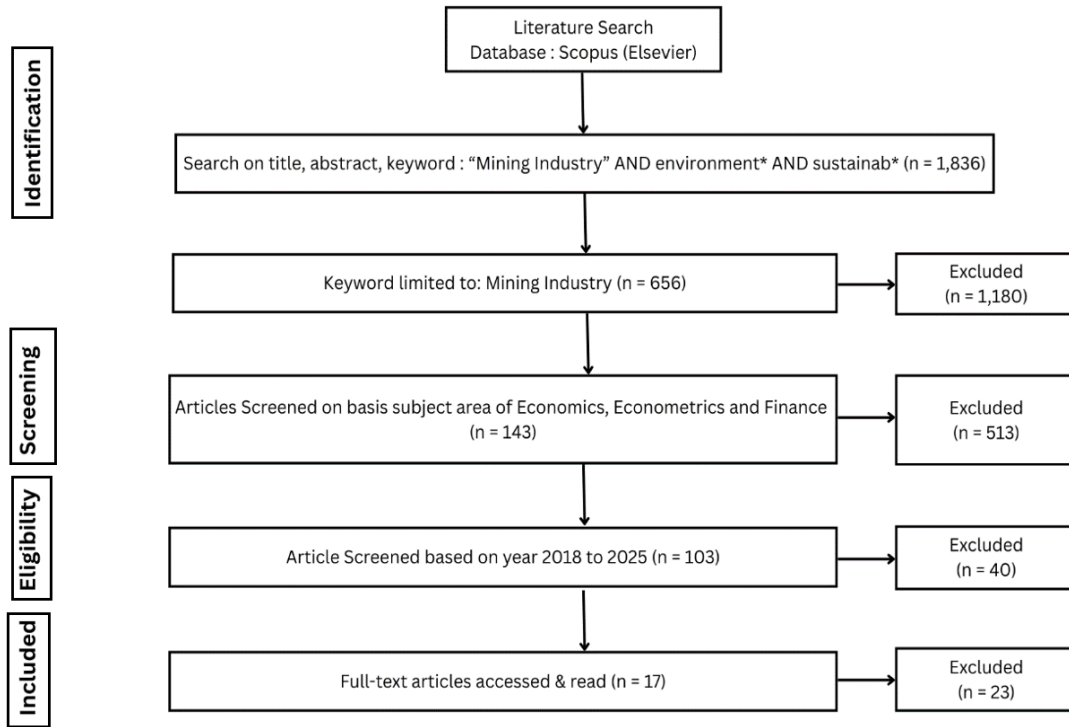
**Figure 1.**
PRISMA Protocols.
**Source:** Moher, et al. [7].

The keywords used in this analysis are "Mining Industry" and environment* and sustainab* in the author data from the Scopus database using titles, abstracts, and keywords as shown in Figure 1. Seventeen documents were reviewed and met the inclusion criteria for environmental sustainability in mining industry, article based on year 2018 to 2024, basis subject area of economics, econometrics, and finance, as seen in Figure 1. The search query option used in data mining was as follows ( TITLE-ABS-KEY ( "mining industry" ) AND TITLE-ABS-KEY ( environment* ) AND TITLE-ABS-KEY ( sustainab* ) ) AND PUBYEAR > 2018 AND PUBYEAR < 2025 AND ( LIMIT-TO ( OA , "all" ) ) AND ( LIMIT-TO ( SUBJAREA , "ECON" ) ) AND ( LIMIT-TO ( EXACTKEYWORD , "Mining Industry" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) as of May 2025.

The literature still lacks an integrated method that combines various perspectives, despite increased interest. The majority of research only focus on one or two elements, which results in fragmented insights. Furthermore, there aren't many studies that provide specific policy proposals or workable implementation frameworks. Through a comprehensive synthesis of actual data and theoretical discussion, this work aims to close these gaps.

The Systematic Literature Review uses a variety of analytical methodologies to synthesize and explain the research evidence well. This includes qualitative analysis techniques, such as content analysis, which look at patterns and themes that exist in the literature, as well as quantitative methodologies such as meta-analysis, which systematically combine the results of various studies to arrive at more comprehensive conclusions [8]. The study uses five economics perspectives analyses that include Productivity [2]. Diversification [3]. Resilience [4] innovation [9] innovation [2].

## 3. Result and Discussion

Within this sector, the results of the research will be discussed which include the status of existing and circulating literature, based on quantitative analysis, annual literature analysis, and economic perspective analysis. This research presents five important economic perspectives in the context of the sustainability of the mining industry, namely productivity, resilience, innovation, efficiency, and diversification. Sustainable productivity emphasizes the balance between increased output and environmental sustainability [10]. Meanwhile, resilience is defined as adaptation to market, social, and policy turmoil [11]. Green innovation [10] and resource efficiency [12] identified as the key to the transformation of this sector. The perspective of diversification, which is still relatively underexplored [13] is an important strategy to increase economic resilience and open up new opportunities, in addition to that sustainable economic development is an effort by human beings to improve the quality of life while still trying not to go beyond the ecosystem that supports their lives [14, 15].

The study expands the theoretical understanding of sustainable mining economics through the integration of five perspectives and provides practical direction for policymakers. The main implications are to support the SDGs, especially SDG 8, SDG 9, and SDG 12. By encouraging the adoption of green technology, energy efficiency, and economic diversification as strategic pillars in sustainable development.

### 3.1. Environmental Sustainability in Mining Industry's Yearly Research

Figure 2 shows 17 studies that have been released annually from 2019 to 2024. In Figure 2, the data shows an increase and decrease in the number of research that has been released related to environmental sustainability in the mining industry as well as the economic aspect. The graph in Figure 2 shows the research figures related to the 5-year period before 2025, starting from 2019 to 2024. The documents used have been scopus indexed and all data have been finalized so that they can provide reliable insights without any distortion of the research used. The level of publication growth in 2019 shows that there are 3 publications. In 2020 there was a significant decline until there were no publications at all that year. Then in 2021 there were 2 publications released related to the scope of topics taken by researchers. In 2022 there was a decrease to only 1 publication that year. Then in 2023 there was a significant surge in the number of publications from the previous year, namely 5 publications released in 2023. In 2024, there will be another increase in the number of publications related to environmental sustainability in the mining industry, namely 6 research publications.
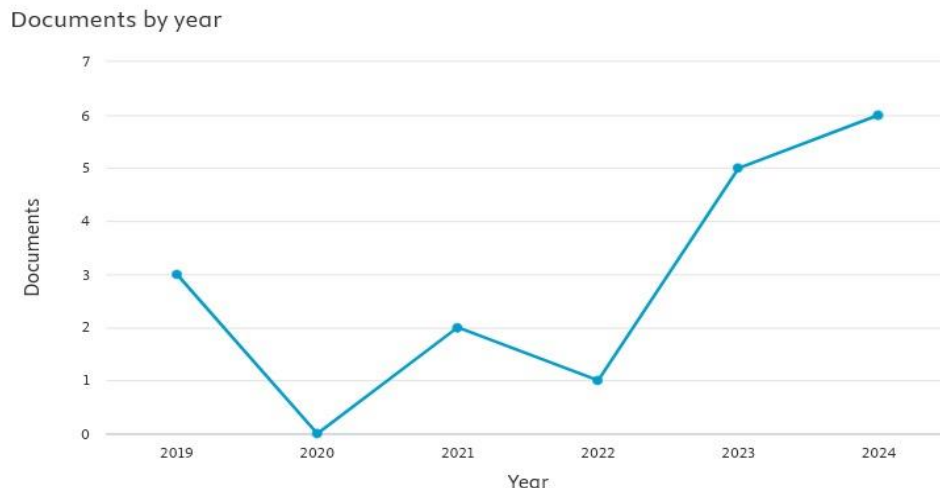


**Figure 2.**
Environmental sustainability in mining industry's Yearly Publications.

*3.2. Perspective Analysis of Environmental Sustainability in Mining Industry on Economy Perspectives*

**Table 1.**
Analysis of Perspective.

| Analysis of Perspective | References |
|---|---|
| Productivity | Gagnon, et al. [16] |
| Diversification | |
| Resilience | Tomassi and Kinyondo [17]; Pouresmaieli, et al. [18]; Chipangamate, et al. [19]; Rey-Martí, et al. [20]; Pouresmaieli, et al. [21]; Lesnikov, et al. [22]; Alves, et al. [23]; Olubukola, et al. [24]; Lacey, et al. [25] and Jones, et al. [26] |
| Innovation | Tahir, et al. [27]; Pietrobelli, et al. [28]; Adomako and Nguyen [29] and Alvarenga, et al. [30] |
| Efficiency | Gholami, et al. [31] and Sobczyk, et al. [32] |

**Source:** Research Results by the author, 2025.

In Table 1 explain the analysis of economic perspective of the environmental sustainability in mining industry explains the economic aspects related to productivity, diversification, resilience, innovation and efficiency. In terms of productivity, operational efficiency and productivity are important aspects of the sustainability of the mining economy.

The implementation of environmentally friendly technology and production process innovation can improve efficiency and reduce operational costs [33, 34]. Regarding diversification, the dependence on one type of commodity can increase economic risk.

Product and market diversification is a strategy to increase the economic resilience of mining companies. Regarding economic resilience, it refers to the ability of the mining industry to survive and adapt to market and environmental changes.

Then about innovation, especially in technology and processes, plays a key role in improving economic sustainability. And finally about efficiency. Efficiency in the use of resources and energy can reduce costs and environmental impacts.

- Productivity

  Seventeen articles and books were reviewed in perspective analysis to find out what perspective was used in each of the studies reviewed. One article focuses on the level of perspective analysis of the economic aspects of productivity. This study discusses a systematic review of research on innovation in the mining sector in the aspect of technological innovation, the factors that drive and inhibit innovation, the sector's preference for process innovation over product innovation, and the role of AI, IoT, and knowledge management suppliers in supporting innovation [16]. Productivity, which balances resource output with environmental limits, is still a major challenge. To maximize output, digital monitoring systems, automation, and technological advancements have been implemented. To save waste and boost operational throughput, for example, prioritize process innovation and the combination of AI and IoT.

- Resistance

  Ten articles used in the level of analysis of resilience economic perspectives . In the first study, the researcher discussed the adaptive ability of small-scale mining communities in the face of technological change and international policy pressures [17]. The most talked-about viewpoint is resilience. Research emphasizes the significance of infrastructure, community, and institutional resilience. For instance, highlight how gender-inclusive sustainability reporting contributes to societal resilience while highlighting the flexibility of technology and policy. The second research highlights the strategic role of CSR in strengthening the resilience of industrial systems to sustainability challenges [18]. The third study frames the ability to withstand social, technological, and political pressures as the main challenges [19]. The fourth paper discusses

understanding the minimum social conditions so that people can survive and feel benefited from the existence of mines, despite environmental damage [20]. The fifth study highlights the importance of resilience in the face of ongoing challenges in the open mining sector [21]. The sixth research shows that the sustainability of the mining sector is highly dependent on the social resilience of companies and communities, especially in responding to gender issues [22]. The seventh paper emphasizes the importance of resilience in Brazil's mining sector through reducing environmental impacts and increasing community engagement [23].

The eighth study discusses the inability of mining institutions and companies to survive sustainably, both due to internal and external factors [24]. The ninth research illustrates how the mining sector maintains its existence in complex and changing social contexts [25]. This tenth paper discusses the strategic response to uncertainty and external pressures to maintain long-term sustainability [26].

- Innovation
  Then, four publications have been analyzed at the level of innovation perspective. The first article discusses blockchain technology innovation as the main solution to economic and environmental challenges in mining projects [27].
  The second study highlights innovation in the context of entry and position enhancement in the global value chain of mining [28]. The third research emphasizes on how a combination of resilience factors and institutional pressures drive and strengthen sustainable innovation in the extractive industry [29].
  Using circular economy concepts, recycling, and renewable energy sources are examples of green innovation. Digital twins and blockchain have become popular instruments for risk management and traceability. Additionally, innovation makes it easier to join global value chains, which boosts competitiveness. The third paper discusses new innovation-based strategies, approaches and methodologies to improve the sustainability of the metals and mining sector from upstream to downstream [30].

- Efficiency
  There are two articles that are analyzed at the level of efficiency perspective. Reducing ecological footprints requires material optimization and energy efficiency. efficiency throughout the mining life cycle, supporting eco-efficiency measures and lean operations. Effective procedures can enhance cost structures, bringing financial and environmental objectives into line. In the first study, researchers discussed the achievement of energy, material, and process efficiency in response to climate change [31]. In the last research, the researcher discussed the strategic decision of mine exploitation as a multi-dimensional efficiency issue [32].

### 3.3. Research Gap Analysis of Environmental Sustainability in Mining Industry on Economy Perspective

In the literature analysis carried out, it was found that there are significant shortcomings related to the diversification perspective in the mining industry. Diversification is underrepresented in spite of its strategic significance. By reducing reliance on certain commodities and markets, diversification can improve economic stability and flexibility in response to environmental and regulatory shifts. This perspective is fundamentally important because it is closely related to the reduction of economic risks due to dependence on a single commodity or market.

Unfortunately, there has not been enough in-depth research on how diversification strategies can be applied in the mining context, especially in the face of the challenges of climate change, global policies, and market volatility. In fact, diversification of products, technologies, or markets is crucial to maintain the long-term economic sustainability of mining companies.

The absence of studies that focus on diversification indicates that there is a research gap that needs to be filled immediately. This opens up opportunities for researchers to further investigate how mining companies can develop diversification strategies—for example, through the development of by-products, the use of mine waste as a new commodity, or expansion into the renewable energy sector—to improve

financial resilience and reduce environmental impact. By closing this gap, future research will be better able to provide practical recommendations that are relevant to the mining industry and support the achievement of the Sustainable Development Goals (SDGs).

*3.4. Perspective for Achieving Sustainable Development Goals in the Indonesian Mining Sector*

As one of the most mineral-rich nations in the world, Indonesia must balance the need to maintain social and environmental sustainability with the goal of optimizing mining's economic benefits.

The mining industry can be brought into line with the Sustainable Development Goals (SDGs), especially SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), and SDG 12 (Responsible Consumption and Production), by implementing the five economic perspectives of productivity, resilience, innovation, efficiency, and most importantly, diversification.

Both state-owned and private mining companies can increase operational output while reducing ecological damage by implementing clean technology and performance monitoring systems. Stronger social safety nets and inclusive development strategies can help Indonesian mining communities become more resilient, as they are susceptible to changes in regulations and price volatility.

Indonesia underutilizes innovation, including waste valorization, digital mining, and the integration of renewable energy. Adoption of green innovations could be accelerated by bolstering R&D and collaborations with academic institutions. Energy transition projects in mining operations should be the main focus of efficiency efforts, especially in areas that produce coal.

Most importantly, economic diversification can lessen an excessive dependence on exports of raw minerals, both geographically and sectorally.

It is crucial to implement policy incentives for downstream processing and regional industry diversification. By deliberately putting these five viewpoints into practice, Indonesia's mining industry may be positioned as a major contributor to its long-term sustainable development goal.

*3.5. Future Research*

Future research is suggested to deepen the integration of economic diversification perspectives in the context of the sustainability of the mining industry. Focus can be directed to practical strategies that combine product diversification, green technology, and waste management into commodities of economic value to support the achievement of the SDGs.

In addition, further research needs to explore synergies between technological innovation, social resilience, and market diversification as an adaptive response to global policy dynamics and climate change. A collaborative approach between stakeholders is key so that the diversification strategy implemented can be more effective and sustainable.

Quantifying the effects of diversification strategies on sustainability metrics and operationalizing them should be the main goals of future study. Deeper understanding of best practices and implementation obstacles can be obtained through case-based comparison analysis and longitudinal investigations.

## 4. Conclusion

This study concludes that the economic perspective plays an important role in environmental sustainability efforts of the mining industry. Through a systematic review, it was found that resilience, innovation, efficiency, and productivity have been widely studied, but the diversification aspect is still not paid attention. In fact, diversification is a key element in reducing economic risks and supporting the adaptability of the industry to global changes.

Therefore, further research is needed that explores comprehensive diversification strategies to address sustainability challenges and strengthen the mining industry's contribution to sustainable development goals.

In addition, it is important for stakeholders—whether government, industry, or academia—to adopt a collaborative approach in designing and implementing policies that promote sustainability in the mining sector. The integration of technological innovation, efficient resource management, and product and market diversification should be seen as the main strategy in strengthening the economic resilience of this industry. Education efforts and capacity building of human resources also need to be improved so that the transformation towards sustainable mining can be achieved comprehensively and sustainably in the long term.

This comprehensive research demonstrates that economic strategies have a major impact on the mining industry's environmental sustainability. The sector's capacity to adapt and change is aided by the integration of productivity, efficiency, innovation, and resilience.

However, the industry's potential for long-term sustainability is limited by the ongoing disregard for diversification initiatives. Diversification should be given top priority by policymakers as a foundational element of sustainable mining.

This entails developing intersectoral relationships, encouraging the growth of renewable mining applications, and boosting secondary resource markets. Furthermore, in order to balance economic objectives with environmental demands, cooperative frameworks comprising the government, business, and academic institutions are crucial.

## Open Data:

This data can be accessed on https://data.mendeley.com/datasets/s2k7hbb8jc/1.

## Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

## Copyright:

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