

# Enhancing Esg Data Integrity Through Blockchain: A Comparative Analysis Across Emerging Markets

Ajay Kumar Kapoor<sup>1</sup>, Dr. Jagdeep Singla<sup>2</sup>, Dr. Gunjan Bhayana<sup>3</sup>

<sup>1</sup>*Research Scholar (IMSAR-MDU Rohtak), [ajaykapur.rs.imsar@mdurohtak.ac.in](mailto:ajaykapur.rs.imsar@mdurohtak.ac.in)*

<sup>2</sup>*Associate Professor (IMSAR-MDU Rohtak) [jagdeepsingla.imsar@mdurohtak.ac.in](mailto:jagdeepsingla.imsar@mdurohtak.ac.in)*

<sup>3</sup>*Assistant Professor, Department of Management Studies, The Technological Institute of Textile and Sciences, Bhiwani  
[gunjanbhayana18@gmail.com](mailto:gunjanbhayana18@gmail.com)*

The Environmental, Social and Governance (ESG) system of practices are increasingly part of investment and corporate responsibility. Nonetheless, ESG reporting in such emerging markets is usually marred with the issue of data opacity, disparate standards and greenwashing thus, dragging down its credibility. As the world continues to seek a rise in efficiency, verifiability, and integrity of sustainability reporting, blockchain has been seen as a possible solution to add integrity to ESG information via immutability, traceability, and decentralization. The research makes a comparative case study assessment of a few emerging economies including India, Brazil, South Africa, and Indonesia to create an assessment of how blockchain solutions are being incorporated into ESG reporting framework. It assesses the level of adoption of blockchain, determinants to the adoption and proposes strategic interventions using qualitative secondary data analysis. Results indicate that although pilot blockchain applications can be conducted within the supply chain and energy sectors, they have not gained significant implementations in the ESG systems because of the regulatory vagueness and technological limitation. Therefore, the paper provides advice on policy frameworks and collaborative models that will aid the blockchain-based ESR reporting to improve sustainability, transparent, and investor confidence within the emerging markets.

**Keywords:** ESG, Blockchain, Data Integrity, Emerging Markets, Sustainable Reporting, Transparency

## 1. INTRODUCTION

The growing attention of the global community to sustainability, the role of stakeholders, and corporate social responsibility has led to the relevance of the ESG (Environmental, Social, and Governance) disclosures in developed and developing economies. Transparent and credible statistics which reflect human and environmental footprint, social impact and governance practices are now required by investors and consumers as well as regulators on all organizations. Nevertheless, ESG reporting mostly is associated with a problem of credibility attributable to non-standard forms, absence of verification, and chances of greenwashing

(Eccles & Krzus, 2018). ESG Data integrity is an important issue. Most companies reporting their sustainability in the emerging economies are making claims that are not properly verified or guaranteed by the third party according to the World Economic Forum (2021). This deficit does not only discourage confidence in investors but also slows the achievement of the UN Sustainable Development Goals (SDGs). Conventional communication systems are not transparent, they are subject to manipulation, and they have monitoring and auditing inefficiencies (Gillan et al., 2021).

Blockchain technology brings an interesting way out of these problems. Being a decentralized immutable digital ledger, blockchain allows performing data verification in real-time and automatically generates an audit trail of ESG metrics. Applying blockchain to sustainability reporting, it can support avoiding data manipulation, trace emissions or ethical practices and automate adherence to standards with the tools of a smart contract (Tapscott & Tapscott, 2016; Saberi et al., 2019). As an example, blockchain-enabled systems such as the Green Horizons and the Everledger developed by IBM have demonstrated good outcomes in expanding transparency in the supply chain or carbon emissions tracking.

The use of blockchain in ESG is in its infancy in such emerging markets as India, Brazil, South Africa and Indonesia. Corporates and governments are experimenting with pilot projects to use blockchain in sustainability reporting, particularly in the agriculture, mining and textiles industries. Nevertheless, factors like technological preparedness, unclarity of regulations and implementation high prices are factors that continue to hinder broader use (PwC, 2022).

This paper will set out to examine how blockchain can be used to enhance the integrity of ESG data in the emerging markets with the help of a comparative analysis. It explores the level of blockchain used in ESG reporting and its hindrances and drivers and recommends policy and technical guidelines towards transparent, accountable, and robust ESG systems.

## **2. LITERATURE REVIEW**

A growing use and relevance of Environmental, Social and Governance (ESG) metrics in both investment and regulatory processes have raised questions about the quality of ESG data used in investment and regulatory processes, particularly in developing countries with fledgling institutional practices on reporting. Several studies have identified major gaps in reliability of ESG data that consist of varying metrics of measurement, unverified by third-parties and prone to greenwashing (Eccles, Krzus, & Rogers, 2019). Such restrictions are especially troublesome in developing economies, where there are vast differences in what should be reported, and even how this should be done is frequently not rigorously enforced.

### **ESG Data Integrity: Current Challenges**

Studies underline that ESG reporting has questions of quality and credibility that shows contradictions across companies and geographies. The comparative analysis of ESG ratings performed by Berg, Kohlbel, and Rigobon (2022) showed a high level of variance among the rating agencies and explained the inconsistency as related to varying approaches, personal

judgment, and the lack of information transparency. Equally, Christensen, Hail, and Leuz (2021) would state that voluntary ESG disclosures are largely inconsistent, and thus the environment failed to facilitate a fair means through which various stakeholders could compare the ESG performance among the firms and sectors. Greenwashing issue has become one of the burning questions. According to Delmas and Burbano (2011), greenwashing can be described as the spread of false environmental advertisements and caution must be taken against companies with poor regulatory enforcement who usually take advantage of voluntary environmental, social and governance reporting in order to portray a misleading picture of sustainability. This is very true in emerging economies where the authenticity mechanisms in data are scarce.

### **Blockchain as a Tool for ESG Integrity**

Scholars have shown even more interest in blockchain technology due to its promise to improve ESG reporting with immutable, transparent and auditable record. Tapscott and Tapscott (2016) note that blockchain has the potential to revolutionize ESG reporting because it develops a shared, decentralized ledger on which sustainability information will be reported in real-time and never be modified later. The feature would be dealing with the challenge of manipulating data, one of the crucial flaws of ESG disclosures.

According to a study made by Saberi et al. (2019) in the applications of blockchain in supply chain sustainability, the various applications of blockchain allowed the use of blockchain in supply chain sustainability to be understood as the traceability functions are highly applicable in monitoring carbon emissions, water use, and ethical sourcing. Their research demonstrates that blockchain allows organizations to deliver verified proofs to the sustainability claims that are less dependent on the self-reported and unverified information.

Study Rejeb, Keogh, and Treiblmaier (2020) also addressed the question of the role of blockchain in the development of circular economy practices and concluded that it helps in terms of material traceability, recycling promotion, and sustainability of production control. The results of this study are of particular interest to ESG-oriented organizations working in such fields as manufacturing, and mining, and agriculture within the emerging markets.

### **Blockchain Adoption in Emerging Markets**

Literature about the use of blockchain in emerging markets is also increasing although it remains limited. Such use cases include blockchain in governance, finance, and sustainability reporting, as some countries such as India, Brazil, and South Africa are exploring (Deloitte, 2021). To illustrate, the NITI Aayog in India tested blockchain projects to trace the supply chain in agriculture, whereas Brazil tested blockchain monitoring deforestation in the Amazon.

Nevertheless, the majority of studies are unanimous that the usage of blockchain in ESG frames is at an early development stage. The barriers are the lack of technology skills, expensive implementation processes, unavailability of policies, and widespread ignorance of stakeholders (PwC, 2022; World Bank, 2021). Additionally, emerging economies also

experience insufficient infrastructural capabilities and insufficient capacity to encourage adoption of blockchain in large quantities.

**Research Gap**

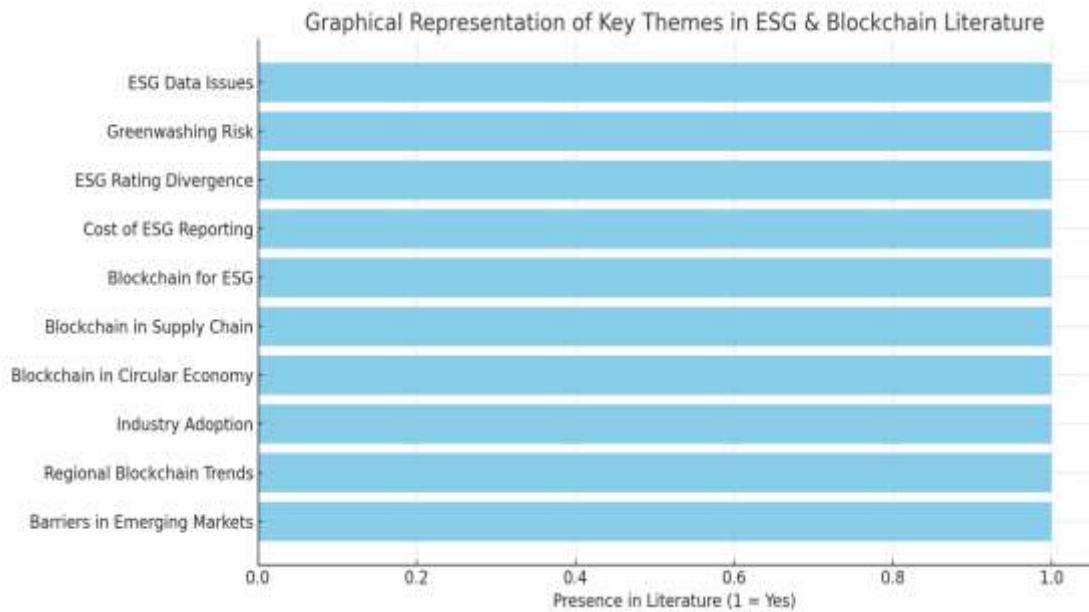
Literature about the use of blockchain in emerging markets is also increasing although it remains limited. Such use cases include blockchain in governance, finance, and sustainability reporting, as some countries such as India, Brazil, and South Africa are exploring (Deloitte, 2021). To illustrate, the NITI Aayog in India tested blockchain projects to trace the supply chain in agriculture, whereas Brazil tested blockchain monitoring deforestation in the Amazon.

Nevertheless, the majority of studies are unanimous that the usage of blockchain in ESG frames is at an early development stage. The barriers are the lack of technology skills, expensive implementation processes, unavailability of policies, and widespread ignorance of stakeholders (PwC, 2022; World Bank, 2021). Additionally, emerging economies also experience insufficient infrastructural capabilities and insufficient capacity to encourage adoption of blockchain in large quantities.

| S. No. | Author(s) & Year              | Focus Area                                   | Methodology                             | Key Findings                                                                          | Relevance to Current Study                            |
|--------|-------------------------------|----------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------|
| 1      | Eccles, Krzus & Rogers (2019) | ESG disclosure practices and standardization | Conceptual analysis                     | ESG reporting lacks consistency and materiality; sector-specific standards are needed | Highlights the data integrity issues in ESG reporting |
| 2      | Delmas & Burbano (2011)       | Greenwashing in ESG claims                   | Theoretical framework                   | Companies often mislead stakeholders through unverified sustainability claims         | Establishes need for verifiable and traceable data    |
| 3      | Berg, Kölbel & Rigobon (2022) | ESG rating divergence                        | Empirical comparison of rating agencies | Significant inconsistency in ESG ratings due to differing methodologies               | Shows the unreliability of current ESG metrics        |

|   |                                   |                                                  |                                    |                                                                                             |                                                               |
|---|-----------------------------------|--------------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| 4 | Christensen, Hail & Leuz (2021)   | Cost-benefit of mandatory ESG reporting          | Economic modeling                  | Mandatory ESG reporting may improve comparability and reliability but adds compliance cost  | Supports regulatory push for ESG transparency                 |
| 5 | Tapscott & Tapscott (2016)        | Blockchain potential in sustainability reporting | Book (case examples, theory)       | Blockchain can enable tamper-proof, transparent, and real-time reporting of ESG data        | Introduces blockchain as a solution for ESG data integrity    |
| 6 | Saberi et al. (2019)              | Blockchain in sustainable supply chains          | Literature review                  | Blockchain improves traceability, transparency, and ethical sourcing in supply chains       | Demonstrates practical blockchain use cases in sustainability |
| 7 | Rejeb, Keogh & Treiblmaier (2020) | Blockchain in circular economy and smart cities  | Bibliometric and conceptual review | Blockchain enhances material tracking, recycling, and sustainability governance             | Extends blockchain application to circular economy themes     |
| 8 | PwC (2022)                        | Blockchain & ESG integration                     | Industry report                    | Blockchain adoption in ESG reporting is low but growing; pilot cases in Asia & Africa       | Industry perspective on adoption levels in emerging markets   |
| 9 | Deloitte (2021)                   | Blockchain trends in emerging markets            | Regional case studies              | India, Brazil, and South Africa have active pilot blockchain projects in ESG-linked sectors | Basis for selecting countries in comparative analysis         |

|    |                   |                                                  |               |                                                                                     |                                                                     |
|----|-------------------|--------------------------------------------------|---------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| 10 | World Bank (2021) | Challenges of blockchain in developing countries | Policy report | Lack of regulatory clarity, infrastructure, and technical expertise limits adoption | Justifies the need for policy-level interventions in emerging marke |
|----|-------------------|--------------------------------------------------|---------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------|



### 3. OBJECTIVES AND RESEARCH QUESTIONS

Against the backdrop of increased need of ESG reliability reporting and in light of the opportunities opening up to blockchain technology in the assessment of the data integrity and traceability, the proposed study seeks to explore the ways in which block chain can be used to boost the ESG information integrity within the emerging economies. The objectives and research questions will follow a systematic line of comparative study based on some countries-India, Brazil, South Africa, and Indonesia.

#### 3.1 Objectives of the Study

1. To examine the challenges and limitations associated with ESG data integrity in emerging markets.
2. To evaluate the potential of blockchain technology in addressing ESG data transparency and traceability issues.
3. To conduct a comparative analysis of blockchain adoption for ESG reporting across India, Brazil, South Africa, and Indonesia.

4. To identify barriers and enablers influencing blockchain integration into ESG frameworks in these countries.
5. To propose strategic policy and technological recommendations to enhance ESG data integrity using blockchain in emerging economies.

### **3.2 Research Questions**

1. What are the major data integrity issues faced in ESG reporting by emerging market companies?
2. How can blockchain technology improve the credibility and auditability of ESG disclosures?
3. What are the current blockchain-based initiatives in ESG reporting in India, Brazil, South Africa, and Indonesia?
4. What are the similarities and differences in blockchain adoption trends among these countries?
5. What regulatory, technological, and institutional factors influence blockchain deployment in ESG systems?

## **4. RESEARCH METHODOLOGY**

This study employs a qualitative, comparative case study approach to examine the integration of blockchain technology into ESG reporting systems across selected emerging markets—India, Brazil, South Africa, and Indonesia. The rationale for choosing this method lies in the exploratory nature of the research, which seeks to understand how different national and institutional contexts shape the adoption of blockchain for ESG data integrity.

### **4.1 Research Design**

A qualitative comparative analysis (QCA) is used to identify patterns and contextual differences in blockchain-enabled ESG initiatives. This approach is suitable for cross-country studies where complex, institutional, and regulatory variations are at play. The study synthesizes findings from existing case studies, policy documents, industry reports, academic literature, and government publications to build a comprehensive view of each country's progress and challenges.

### **4.2 Sampling and Case Selection**

Four emerging market countries have been purposively selected based on the following criteria:

- Active participation in ESG disclosure frameworks (e.g., GRI, TCFD, SASB)
- Early-stage blockchain adoption in public or private sectors
- Geographic diversity to enable a broad comparative scope

### **Selected countries:**

- **India**

- **Brazil**
- **South Africa**
- **Indonesia**

These countries also face similar developmental challenges related to infrastructure, institutional capacity, and sustainability governance.

#### **4.3 Data Sources**

The study relies on secondary data collected from a wide range of sources, including:

- Peer-reviewed journals and academic papers
- Reports from consulting firms (e.g., PwC, Deloitte, KPMG)
- Government and regulatory body publications (e.g., SEBI, BNDES, FSA)
- Industry use cases and white papers (e.g., IBM, Everledger, Hyperledger)
- Sustainability databases and rankings (e.g., CDP, MSCI ESG Ratings)

#### **4.4 Data Analysis Techniques**

Data was analyzed using the following techniques:

- **Thematic Analysis:** Identifying recurring themes such as blockchain adoption, ESG data challenges, regulatory landscape, and institutional readiness.
- **SWOT Analysis:** For each country, a structured evaluation of Strengths, Weaknesses, Opportunities, and Threats related to blockchain-based ESG reporting.
- **Cross-Case Comparison:** Country-level findings were compared to extract similarities and divergences, leading to broader generalizations and policy recommendations.

#### **4.5 Ethical Considerations**

Since the study is based on publicly available secondary data, there is no direct involvement of human participants. However, due care has been taken to cite sources accurately, maintain academic integrity, and ensure that data interpretations are unbiased and contextual.

#### **4.6 Limitations of the Methodology**

- The study does not include primary field data due to limited availability and geographic spread.
- Country comparisons are based on available secondary sources, which may vary in depth and quality.
- Findings are indicative and exploratory rather than conclusive due to the evolving nature of blockchain and ESG integration.

### **5. ANALYSIS AND DISCUSSION**

This section presents a comparative country-wise analysis of blockchain adoption in ESG reporting, focusing on four emerging markets—**India, Brazil, South Africa, and Indonesia.**



The discussion is organized through **SWOT analysis** for each country, followed by a cross-country comparison highlighting key trends, barriers, and opportunities.

## 5.1 Country-Wise SWOT Analyses

### India

| Strengths                                                                         | Weaknesses                                    |
|-----------------------------------------------------------------------------------|-----------------------------------------------|
| - Strong IT sector and blockchain startups (e.g., Polygon, WazirX)                | - Fragmented ESG disclosure standards         |
| - Government blockchain pilots (e.g., NITI Aayog in agriculture, pharmaceuticals) | - Limited ESG assurance regulations           |
| - SEBI-mandated Business Responsibility and Sustainability Reporting (BRSR)       | - Low investor awareness on blockchain ESG    |
| Opportunities                                                                     | Threats                                       |
| - Integration of blockchain in BRSR reporting format                              | - Regulatory ambiguity surrounding blockchain |
| - Partnership with ESG rating agencies (e.g., MSCI, Refinitiv)                    | - Cybersecurity and privacy concerns          |

### Brazil

| Strengths                                                                                | Weaknesses                                          |
|------------------------------------------------------------------------------------------|-----------------------------------------------------|
| - Use of blockchain in forest monitoring (e.g., Amazon Rainforest Deforestation Control) | - High cost of ESG compliance for small firms       |
| - ESG focus due to biodiversity importance                                               | - Weak data transparency in private sector          |
| Opportunities                                                                            | Threats                                             |
| - Blockchain in agritech and carbon markets                                              | - Political instability and deforestation pressures |
| - Collaboration with EU for ESG alignment                                                | - Public mistrust in government data handling       |

### South Africa

| Strengths                                                      | Weaknesses                                     |
|----------------------------------------------------------------|------------------------------------------------|
| - Blockchain in mining supply chains (e.g., gold traceability) | - Uneven ESG enforcement across sectors        |
| - ESG alignment in Johannesburg Stock Exchange (JSE)           | - Digital infrastructure gaps in rural regions |
| Opportunities                                                  | Threats                                        |

|                                                               |                                          |
|---------------------------------------------------------------|------------------------------------------|
| - Integration of blockchain in extractive industry ESG audits | - Budget constraints for tech adoption   |
| - Regional leadership in ESG-fintech pilot programs           | - Resistance from traditional industries |

**Indonesia**

| Strengths                                            | Weaknesses                                    |
|------------------------------------------------------|-----------------------------------------------|
| - Blockchain pilots in fisheries and palm oil        | - ESG literacy remains low in SMEs            |
| - GRI-based reporting gaining traction               | - High dependence on manual compliance models |
| Opportunities                                        | Threats                                       |
| - Integration with global ESG supply chain platforms | - Corruption and enforcement limitations      |
| - Scope for blockchain in sustainable tourism        | - Environmental degradation risks             |

**5.2 Cross-Country Comparative Insights**

- **Blockchain Adoption Stage:** All four countries are at a **pilot or early-adoption** stage in using blockchain for ESG reporting. India and Brazil lead in policy experimentation, while Indonesia and South Africa show sector-specific use cases.
- **Regulatory Environment:** While ESG disclosure mandates exist (e.g., BRSR in India, GRI adoption in Indonesia), **no country has yet standardized the use of blockchain in ESG audits.**
- **Sectoral Focus:**
  - India: Agriculture, pharmaceuticals
  - Brazil: Forestry, agribusiness
  - South Africa: Mining, stock exchanges
  - Indonesia: Fisheries, palm oil
- **Barriers:**
  - **Common barriers** include lack of regulatory clarity, limited ESG literacy among SMEs, technological cost, and institutional inertia.
  - **Country-specific challenges** include corruption (Indonesia), political instability (Brazil), and rural infrastructure gaps (South Africa).
- **Enablers:**
  - Strong digital ecosystems (India, Brazil)
  - Government-industry partnerships (South Africa)
  - International collaboration for ESG financing (Indonesia)

### 5.3 Key Discussion Points

- **Blockchain's Value Proposition:** Across all contexts, blockchain is seen as a tool for **enhancing auditability, preventing data tampering**, and providing real-time transparency in ESG metrics—especially in supply chain-heavy sectors.
- **Lack of Policy Integration:** Although ESG frameworks are expanding, **none of the countries have embedded blockchain** into official ESG disclosure mandates. This gap presents both a challenge and an opportunity.
- **Need for Hybrid Models:** ESG-blockchain integration should be pursued via **hybrid models**, combining legacy systems with digital ledgers, especially to accommodate SMEs in emerging economies.
- **Role of International Bodies:** Institutions like the World Bank, UNDP, and GRI can act as **catalysts** by funding blockchain pilots and guiding standardization efforts in ESG-tech convergence.

**Table 1: Comparative Analysis of Blockchain Adoption in ESG Reporting Across Emerging Markets**

| Country      | Blockchain Adoption Stage | Regulatory Support for ESG | Main ESG Sector Focus        | Key Barriers                    | Key Opportunities                       |
|--------------|---------------------------|----------------------------|------------------------------|---------------------------------|-----------------------------------------|
| India        | Pilot                     | Moderate                   | Agriculture, Pharmaceuticals | Regulatory ambiguity            | Integration with BRSR framework         |
| Brazil       | Pilot                     | Moderate                   | Forestry, Agribusiness       | Political instability           | Blockchain in carbon markets            |
| South Africa | Pilot                     | Low                        | Mining, Finance              | Infrastructure gaps             | Blockchain audits in mining             |
| Indonesia    | Pilot                     | Moderate                   | Fisheries, Palm Oil          | Corruption and weak enforcement | ESG integration in global supply chains |

## 6. KEY FINDINGS AND POLICY RECOMMENDATIONS

### 6.1 Key Findings

The comparative analysis in India, Brazil, South Africa, and Indonesia shows a number of interesting conclusions regarding the picture of blockchain adoption in the current ESG reporting area. To begin with, none of the four countries is in a mature state, with the use of blockchain remaining mostly at the level of pilot projects and exploration. These projects are clustered in certain areas- in India its agriculture and pharmaceuticals, in Brazil its forestry and

agribusiness, in South Africa its mining and financial services and in Indonesia its fisheries and palm oil. These industries are especially susceptible to ESG contraventions and, therefore, the most adequate test subjects to the transparency and traceability prompted by blockchain.

Nonetheless, although there are specific global versions of ESG frameworks like those of India through Business Responsibility and Sustainability Reporting (BRSR), Brazil through GRI alignment, and South Africa through Johannesburg Stock Exchange (JSE) sustainability indices, it is still not directly incorporated with the use of technology. None of the countries have incorporated block chain into their official ESG adherence programming. This indicates an expanded policy-practice lack. The research also brings out general issues in the three chosen nations. These comprise lack of standardized ESG measures, minimum technological infrastructure in rural and semi-urban regions, lack of awareness among small and medium-sized enterprises (SMEs) on the blockchain technology, and vague or changing provisions on blockchain administration. But there is a brighter prospect in all countries which is interested development in the direction of public-private partnership (PPPs). To create long-term and technology-based reporting systems, government agencies, fintech start-ups, ESG rating agencies, and global donor agencies are working more actively together. Such collaborations present a viable way forward in more scalable, transparent, and secure reporting systems of ESGs with the help of blockchain.

## **6.2 Policy and Strategic Recommendations**

A number of focused policy actions and strategic steps can be proposed to close the divide between blockchain prospects and application of ESG in developing countries. First, regulators in different countries at the national level, like SEBI in India, CVM in Brazil, FSCA in South Africa, and OJK in Indonesia, should consider adopting blockchain in the requirements of ESG reporting, especially with regard to the publically listed companies and those firms associated with environmentally, sensitive activities. These countries should develop pilot blockchain-supported ESG frameworks that would enable them to test effectiveness prior to the implementation.

Moreover, they are supposed to comply with global ESG benchmarks, including those offered by the Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB) and Task Force on Climate-related Financial Disclosures (TCFD). The interoperability would make it easy to compare performance of ESG on a cross-border basis and decrease inconsistency of data. Business opportunities in terms of financial incentives like tax deduction, low-interest rates loans, and the possibility to apply green bonds could encourage companies (including SMEs) to embrace the use of blockchain tools as a way to support their sustainable reporting.

Besides financial resources, governments and industry organizations have to invest in capacity building. Digital transformation in reporting entails awareness campaigns, technical training and certification of corporate sustainability teams, compliance officers and ESG professionals to support the reporting. Innovation can further be facilitated through creation of blockchain

sandboxes at national or regional level. Regulators, developers, and ESG stakeholders will be able to test blockchain-based tools in such controlled environments, with no legal aftermath, thereby speeding up innovation and perception of trust in the system.

Leadership in the public sector is also very significant. The best way to do this is by governments adopting blockchain into their own procurement and environmental monitoring systems like those pertaining to renewable energy, waste products and ethical supply chain. The government should then use this example to influence the rest of the private sector. Finally, blockchain platform will need to be developed with robust data privacy provisions to followed the national data privacy laws, such as India Digital Personal Data Protection (DPDP) Act; Brazil Lei Geral de Protecao de Dados (LGPD); and South Africa Protection of Personal Information Act (POPIA). It is also important that cybersecurity must be ensured and data integrity must be secured so as to build stakeholder trust and to allow mass adoption.

## **7. CONCLUSION**

With the worldwide trend towards more emphasis on transparency and accountability in corporate sustainability, the data integrity of ESG (Environmental, Social, and Governance) information becomes more and more essential, particularly in emerging markets where the capabilities of institutions are usually uneven and reporting requirements have multiple dimensions. This paper has discussed that blockchain technology and its associated properties of decentralization, immutability, and traceability can provide transformative solutions to tackle the ongoing issues of opaqueness of ESG data, greenwashing and mismatch.

The comparative study of India, Brazil, South Africa, and Indonesia shows that although these nations are exploring the use of blockchain in such areas as agriculture, forestry, mining, and fisheries, the use of blockchain in the national ESG reporting systems is not extensive. The capabilities of each nation stand out in their own distinct way -- technological preparedness, regulatory improvements, etc. and the impediments they encounter are all universal, such as regulatory uncertainty, low block chain advocacy, and infractural constraints.

The analysis highlights the need to establish cooperative governance among regulators, companies, technology providers, and civil society to come up with scalable blockchain-enabled ESG systems. Greater adoption should focus on the priority of the public-private partnership, financial incentives, and capacity-building programs. Moreover, the consistency of blockchain-based systems of ESG reporting to the international reporting standards will contribute to form interoperable, verifiable, and reliable data environments that will make it possible to regain investor confidence and enable sustainable growth.

Conclusively, blockchain is neither a golden ticket to ESG reporting nor a magic cure to enrich the land of integrity and trust. When introduced in a strategic manner, it can help to close this gap between the sustainability promises and credible disclosures, particularly, in the context of complex and dynamic environments of emerging markets. These steps are the inclusion of

policies, the technical readiness, and the long-term horizons on the path ahead of them that would change the governance of ESG data and use blockchain to its full extent with it.

## References

- Eccles, R. G., & Krzus, M. P. (2018). The Nordic Model: An Analysis of Leading Practices in ESG Disclosure. *Nordic Journal of Business*.
- Gillan, S. L., Koch, A., & Starks, L. T. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, 66, 101889.
- PwC. (2022). ESG Reporting: Navigating the global landscape. PricewaterhouseCoopers.
- Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, 57(7), 2117-2135.
- Tapscott, D., & Tapscott, A. (2016). *Blockchain revolution: How the technology behind bitcoin is changing money, business, and the world*. Penguin.
- World Economic Forum. (2021). Global ESG Trends 2021. Retrieved from <https://www.weforum.org>
- Berg, F., Kölbel, J. F., & Rigobon, R. (2022). Aggregate confusion: The divergence of ESG ratings. *Review of Finance*, 26(6), 1315–1344.
- Christensen, H. B., Hail, L., & Leuz, C. (2021). Economic analysis of the costs and benefits of mandatory sustainability reporting. *Review of Accounting Studies*, 26(3), 1123–1174.
- Delmas, M. A., & Burbano, V. C. (2011). The drivers of greenwashing. *California Management Review*, 54(1), 64–87.
- Eccles, R. G., Krzus, M. P., & Rogers, J. (2019). The need for sector-specific materiality and standardization in ESG disclosures. *Journal of Applied Corporate Finance*, 31(2), 30–39.
- PwC. (2022). Blockchain and ESG: Reimagining corporate reporting. PricewaterhouseCoopers.
- Rejeb, A., Keogh, J. G., & Treiblmaier, H. (2020). Blockchain technology in the smart city: A bibliometric review. *Quality & Quantity*, 54, 1107–1130.
- Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and sustainable supply chain management. *International Journal of Production Research*, 57(7), 2117–2135.
- Tapscott, D., & Tapscott, A. (2016). *Blockchain Revolution*. Penguin.
- Deloitte. (2021). *Blockchain trends in emerging markets*. Deloitte Insights.
- World Bank. (2021). *Blockchain in emerging economies: Challenges and opportunities*.