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Blockchain for Transparent Supply Chains: Enhancing Accountability in SDG-Aligned Trade

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Abstract: The research aims to determine how blockchain technology has the capability to improve transparency and accountability in global supply chains with regard to the Sustainable Development Goals (SDGs). The study examines blockchain's impact on traceability, trust, and ethical sourcing using multi-sectoral case study and performance evaluation analyses. Findings suggest that blockchain-enabled supply chains are more compliant with the SDG principles, have lower fraud rates, and higher consumer trust compared to non-integrated ones. The study calls for the adoption of blockchain technologies and policies to facilitate universal coverage and collective compliance to guarantee responsible trading systems.

Keywords: Blockchain; Supply Chain Transparency; Responsible Commerce; SDG Compliance; Ethical Sourcing; DLT; Traceability; Smart Contracts.

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I. Introduction

As a core element of trade and economic activity, global supply chains encompass substantial sections of commerce and economic development. However, they are usually associated with non-transparent practices relating to the provenance and movement of goods, which are false trading practices. This lack of transparency further compounds various unethical trade issues such as exploitation of labor, environmental damage, and trading fraud which violates the Sustainable Development Goals (SDGs) 8: Decent Work and Economic Growth, 12: Responsible Consumption and Production, and 16: Peace, Justice and Strong Institutions. Recently blockchain technology has been introduced as a possible solution to these difficulties. As a kind of distributive ledger technology (DLT), blockchain allows for the safe and permanent recording of transactions. In the context of supply chains, it enables tracking of products from their place of origin to their point of consumption which improves responsibility, decreases fraud, and enhances sustainability. The implementation of blockchain technology can transform supply chains by enabling complete traceability. Smart contracts, which are computer protocols intended to facilitate, verify, or negotiate contracts, can ensure compliance and decrease reliance on other parties. This change dovetails with the movement toward the adoption of digital government and responsible commerce. There are technical, organizational, and legal issues that need to be resolved before incorporating blockchain into supply chains. Between the developed and developing parts of the world, interoperability, expandability, and the digital divide are enormous obstacles. Additionally, the absence of uniform guidelines coupled with high implementation costs prevents adoption. The purpose of this paper is to analyze the effect of blockchain technology on the transparency and accountability of the supply chain in agriculture, apparel, electronics and other sectors. Using the case study approach, this research analyzes the potential of blockchain technology to support commercial activities that are in line with the sustainable development goals (SDG). This research draws attention to these policies and the need for stakeholder cooperation in fostering responsive and clear supply systems.

II. Literature Survey

The role of blockchain technology in supply chain management has been widely discussed in the literature. Mumany Pesarrodona (2021), for instance, demonstrated through case studies that blockchain significantly enhances traceability and reduces unethical practices, particularly in the delivery of financial

development aid. Their findings highlight how supplier accountability improves due to the transparency provided by blockchain systems.

Similarly, Walker et al. (2019) explored post-pandemic supply chain transformations and emphasized that blockchain-enabled smart contracts improve trust among stakeholders. Certifications and compliance frameworks can be verified in real time, thereby increasing product value and consumer confidence.

The World Economic Forum case studies, summarized by Mumany Pesarrodona (2021), also showcased blockchain's role in conflict minerals traceability within electronics. Companies tracking cobalt and tungsten through blockchain gained investor trust and avoided strict EU and US due diligence enforcement.

From a regulatory standpoint, Singh (2022) investigated legal frameworks that support green digital finance, underscoring how blockchain-based standards for auditing and verification can enhance both inclusivity and cost reduction in emerging economies. Likewise, Michael (2021) critically examined how FinTech policies, including blockchain, can promote the Sustainable Development Goals (SDGs), highlighting the importance of coherent governance mechanisms.

In addition, Walker et al. (2019) highlighted blockchain's role in sustainability reporting and carbon footprint tracking. Initiatives such as the Global Reporting Initiative (GRI) and the Task Force on Climate-related Financial Disclosures (TCFD) benefit from immutable blockchain records, which make emissions monitoring more accurate and transparent.

Although blockchain offers clear benefits for supply chain transparency and sustainability, challenges remain in scaling adoption—particularly among small and medium enterprises (SMEs). The literature indicates a need for subsidized infrastructure, training programs, and harmonized guidelines to close the technological gap and ensure uniform implementation.

III. Methodology

The study uses a mixed methods design, which combines case study, qualitative interviews, and quantitative assessment of performance. The agriculture, apparel, and electronics sectors were chosen for the study because they are highly exposed to trade related to the SDGs and have low levels of transparency. The study aimed to gather data from 10 firms of each sector in 5 regions: North America, Europe, South Asia, Latin America and Africa.

To evaluate the motivations, implementation frameworks, and benefits associated with blockchain, semi-structured interviews were done with supply chain managers, IT experts, and sustainability executives. Primary data was collected from blockchain, third party audit's documentation, and sustainability reports.

Three phases were determined regarding the integration of blockchain: initiation, expansion, and full-scale deployment. Performance evaluation was conducted on parameters like accuracy of traceability, stakeholder satisfaction, compliance with legal requirements, audit interval, and transaction verification timing. In order to measure the impact of block chain systems on supply chain accountability, a Block Transparency Index (BTI) was introduced.

Furthermore, a comparison was done in supply chains that utilized blockchain technology and the conventional systems. The variables included data accuracy, delays in processing, human participation, and the results of the audit. Qualitative interview data was coded and analyzed thematically to highlight the main motivating factors, barriers, and enablers based on features.

Achieving the goal towards the monitoring and evaluation of blockchains reliance towards strong monitoring and evaluation and improvement of supply chains transparency was achieved via this approach. This methodology allows analysis of cohesive participation in trade aligned with SDGs while maintaining sustainability principles.

IV. Results and Discussion

With the apparel and electronics sectors achieving the most maturity on blockchains use, the BTI results showed the most variance across regions and sectors. Because of the full scale implementation of blockchain solutions, many firms increased their compliance rate, stakeholder trust towards them, and traceability.

Table 1: Blockchain Transparency Index and Supply Chain Performance

Sector	Avg. BTI Score (0-10)	Traceability Accuracy (%)	Compliance Improvement (%)	Stakeholder Trust Index
Agriculture	7.1	82	28	7.5
Apparel	8.4	91	36	8.9
Electronics	8.1	88	34	8.6

Table 2: Comparison of Blockchain vs Traditional Supply Chains

Performance Metric	Blockchain System	Traditional System
Audit Cost Reduction (%)	30	10
Error Rate (%)	4.5	12.3
Verification Time (hours)	1.2	5.4
Regulatory Breach Incidence	Low	Moderate

The blockchain enabled supply chains comparatively are more efficient with audit cost and error cost when compared to traditional supply chains. Companies using smart contracts claimed that their administrative costs have lessened and disputes are resolved at a faster rate. All these outcome support the assumption that blockchain uses greatly improve supply chains transparency and accountability more so when used with other governances and technologies capablities.

V. Conclusion

The outcome of this research has identified that untapped potential blockchain technology has. As real time tracking accurately aligned with the sustainable development goals indicates remarkable transparency, zero tolerance fraud, and enhanced stakeholder trust which makes way for ethical trade. Future obstructions that hinders optimal outcome of SMART chains involve standard unification, and fostering a partnership model to attract more funding to encourage public utilization.

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