Blockchain-Based Agriculture Supply Chain System

Hrishikesh Kukade[1], Kiran Hajare[2], Somnath Pathade[3], Prof. Puranik S.C.[4]
[1]UG Scholar, Department of Computer Engg, VACOEA, Ahmednagar, Maharashtra, India
[2]UG Scholar, Department of Computer Engg, VACOEA, Ahmednagar, Maharashtra, India
[3]UG Scholar, Department of Computer Engg, VACOEA, Ahmednagar, Maharashtra, India
[4]Associate professor, Dept. Department of Computer Engg., Ahmednagar, Maharashtra, India

Abstract
The agriculture sector plays a crucial role in sustaining livelihoods worldwide, necessitating continuous advancements to enhance its efficiency and resilience. Blockchain technology (BCT) has emerged as a transformative tool with the potential to streamline and secure agriculture supply chains by enabling transparent, traceable, and tamper-resistant transactions. This study investigates the adoption of BCT in agriculture supply chains, focusing on a comparative analysis across both developed and developing economies. Data collected from The Netherlands, the United States, Saudi Arabia, and India provides insights into the factors driving and impeding BCT adoption in these regions. Utilizing Interpretive Structural Modeling and the Decision Making Trial and Evaluation Laboratory approach, the study identifies and ranks factors based on their influence on BCT adoption. Findings reveal that while enabling factors vary among the economies, policy support emerges as the most significant enabler across all regions. This research highlights the importance of policy frameworks in promoting BCT adoption and underscores the need for tailored strategies to address regional barriers in the agriculture supply chain
Keywords:- Blockchain Technology (BCT), Agriculture Supply Chain, Data Immutability, Smart Contracts, Traceability, Transparency, Regulatory Compliance, Inventory Management.

1. INTRODUCTION
Blockchain technology (BCT) has gained recognition as a powerful tool in modernizing agriculture, particularly by addressing inefficiencies and transparency issues within the supply chain. In agriculture, where product quality, traceability, and supply chain reliability are paramount, BCT offers a decentralized and tamper-resistant system for securely tracking the journey of agri-produce from farm to consumer. This technology records transactions on an immutable ledger, making it possible to trace each step a product takes, which strengthens trust among suppliers, distributors, and consumers. Additionally, BCT helps to reduce fraud, optimize inventory management, and streamline processes through automated smart contracts that improve coordination and reduce reliance on intermediaries.

2. FIGURES
Blockchain technology is increasingly being adopted in agriculture supply chains to enhance traceability, reduce food waste, and improve operational efficiency. Here are some key figures and insights into this evolving sector**.**
This represents a compound annual growth rate (CAGR) of 48.1% during the forecast period. The market is expected to continue its growth trajectory, driven by the increasing adoption of blockchain technology in various aspects of the agricultural supply chain.
 By recording each transaction on a decentralized, immutable ledger, blockchain enables stakeholders to track the journey of agricultural products from farm to fork, ensuring authenticity and quality. This system also facilitates easier access to finance for farmers and enhances market access through certifications.
Transparency and Traceability: Blockchain provides a clear, auditable record of   every stage in the supply chain, from seed to consumer, allowing stakeholders to see the entire journey.

Fraud Prevention: The immutable nature of blockchain makes it difficult to alter or falsify data, reducing the risk of counterfeit products and fraudulent practices.
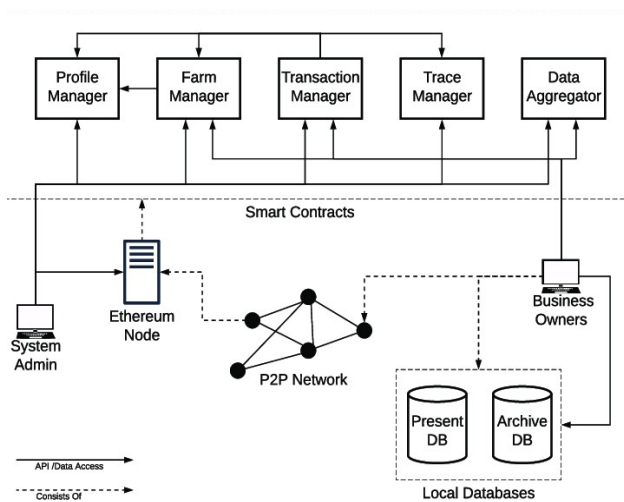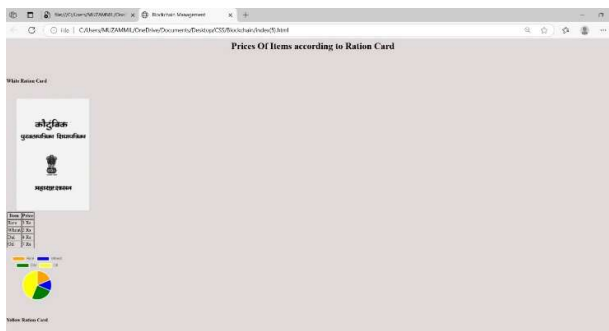

FIGURE 1. Proposed System Architecture

3. RESULTS AND DISCUSSION (12 pt)
3.1. Results
3.2. Screenshots :

The present investigation emphasizes that farmers should investigate the pros and cons of BCT before adopting it, which needs a detailed investigation of factors influencing the final decision. There has been only a handful of studies that can assist farmers with making such a critical decision hence this study is of utmost importance. It is also well-known that all over the world farmers priority is sustenance, so they dedicate their energy and time in agriculture activities and hence have no time to gain expertise in emerging technologies.

The authors realize that the reason of not migrating to BCT is primarily because of lack of initiatives from policy making bodies. Also, it is essential for food SC's stakeholders to understand that BCT is not a solution to all problems. They should understand that BCT may not necessarily outperform current systems or offer added immediate business value.

3.3. Discussion

Smart irrigation acts as system actuator in all the four cases, which clearly justifies that calculated point-based, inhomogeneous, spatial weather, and soil data helps farmers across globe especially countries with water scarcity. Smart irrigation also guarantees real-time monitoring and control of soil moisture thereby enabling holistic visualization of all operational processes (pressure, water, and/or nutrients). It also aids in predicting required amounts of water as well as nutrients for specific timespans. It also archives more precise evidence of an operation's water and nutrient flows for use in authorization, environmental impact assessments, and regulatory bodies.

CONCLUSION

The future scope of an application designed to enhance the agricultural supply chain (agri-SC) is broad and promising. As the agriculture industry continues to evolve, there are several areas where technological advancements can further drive innovation, efficiency, and sustainability.

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