International Journal of Engineering Research and Science & Technology

A BLOCKCHAIN SURVEY FOR ELECTRONIC SUPPLY CHAIN MANAGEMENT

Ch. Satyanarayana Reddy[1], K. Pavani[2], Sk. Nehirinbi[3]

#1 Assistant Professor in the Department of MCA, SRK Institute of Technology, Vijayawada.

#2 Assistant Professor & Head of Department of MCA, SRK Institute of Technology, Vijayawada.

#3 Student in the Department of MCA, SRK Institute of Technology, Vijayawada.

Abstract: Over the past century, the supply chain environment has changed significantly, moving from simple manual procedures (Supply Chain 1.0) to fully digitalized and networked systems (Supply Chain 4.0). Despite these developments, problems including traceability, lack of transparency, and susceptibility to cyberattacks still exist, especially in the electronics sector where supply networks are intricate and include several players. The purpose of this survey is to investigate how blockchain technology, which offers a decentralized and impenetrable architecture, may be included into the electronics supply chain. The research investigates several blockchain frameworks based on network type, deployment platform, security methods, identity verification, cost-efficiency, and implementation feasibility through a thorough comparative analysis of current literature. Additionally, it assesses security models and privacy-preserving strategies while outlining their benefits and drawbacks. The study concludes with a discussion of open research issues and possible future paths for creating blockchain-based supply chain ecosystems that are safe, effective, and transparent.

Index terms *- Blockchain, Supply Chain 4.0, Electronics Industry, Decentralized Ledger, Smart Contracts, Product Traceability, Data Integrity, Ethereum, Stakeholder Management, Real-Time Tracking, Secure Data Sharing, Supply Chain Transparency*

1. INTRODUCTION

In order to ensure the smooth movement of raw materials, components, and completed items from suppliers to manufacturers and, eventually, to customers, supply chain management is an essential part of the worldwide electronics industry. From the simple transactional structure of Supply Chain 1.0 to the fully digitalized and linked Supply Chain 4.0, the supply chain has undergone significant change over the years. The most recent version offers worldwide multi-party integration, digital recordkeeping, and real-time data transmission. But complexity also makes a system more vulnerable; centralized systems frequently have issues with data fragmentation, low transparency, limited traceability, and vulnerability to fraud and cyberattacks.

Because of its complex and widely dispersed supply networks, the electronics sector is particularly affected. Before reaching end users, products frequently go through several hands and locations, resulting in several data silos and raising the possibility of manipulation and misunderstandings. As a result, there is an increasing need for a decentralized, transparent, and safe substitute for conventional centralized systems.

Blockchain technology shows promise as a potent remedy for these issues. Blockchain provides transparency, traceability, and tamper-proof data management for all supply chain participants by upholding a distributed, unchangeable ledger. This study presents a thorough survey to investigate the use of blockchain in supply chain management in the electronics sector. Important elements are examined, including deployment platforms, security frameworks, identity authentication methods, blockchain network kinds, and financial ramifications. In order to improve blockchain-based supply chain systems, the study also explores privacy issues, existing constraints, and potential future research avenues.

This study intends to demonstrate how decentralization may improve product traceability, expedite operations, and create a more secure and robust supply chain infrastructure by concentrating on blockchain integration in electronics supply chains.

2. LITERATURE SURVEY

2.1 I'll trade you diamonds for toilet paper: Consumer reacting, coping and adapting behaviors in the COVID-19 pandemic:

ABSTRACT: In this study, we document some of the many odd consumer behavior patterns that predominated in the early phases of the COVID-19 pandemic. In order to guide future research and marketing strategy, we provide theoretical insights to assist understand and forecast these actions and related effects. We examine three stages of behavior from the standpoint of environmental constraints: reacting (e.g., hoarding and rejecting), coping (e.g., maintaining social connections, do-it-yourself behaviors, and altering brand perceptions), and longer-term adapting (e.g., potentially revolutionary changes in consumption and individual and social identity). We discuss the implications for marketing practice and researchers.

2.2 Traceable, trustworthy and privacy preserving agri-food supply chains

ABSTRACT: The supply chain for tracking agricultural output and storing data has been digitized as a result of complex global trade patterns. However, many traceability systems have issues including data being spread over multiple silos and being susceptible to erroneous or manipulated data, which might jeopardize food safety through fraud or counterfeiting. Making ensuring that information about a product is reliable is another challenge because the data that is now available may not adequately reflect the actual physical events that take place across a product's existence. Business-sensitive data must be provided in order to provide transparency and traceability. When product-related data is made public, it is difficult to ensure provenance and traceability to consumers while protecting trade secrets including shipments, pricing, and transaction frequency. This paper highlights the need for agri-food supply chain traceability and provides a broad framework for the traceability model that incorporates blockchain as a key component. The framework includes building blocks from the data, storage, application, and blockchain layers. Lastly, we demonstrate our work on supply chain management using blockchain technology utilizing fresh fruit as an example use-case. We also highlight the challenges and possible benefits of using blockchain technology for supply chain resilience.

2.3 Supply chain disruptions and resilience: a major review and future research agenda:

ABSTRACT: Our study examines the literature on supply chain disruptions, a topic that has arisen over the past 20 years and has been published in reputable publications, with an emphasis on current developments in the field. Using a review method, we have found and examined significant research. Content analysis was used to synthesize studies on various types of disruptions and how they impact supply networks, as well as resilience strategies for creating resilient supply chains and recovery plans supported by cost-benefit assessments. The most widely used modeling techniques on the subject are also examined in our review, along with illustrative examples and IT technologies that improve resilience and lower disruption risks. Finally, a thorough roadmap for future study is established and the research needs pertaining to SC disruptions are highlighted. The goal of this project is to compile information on supply chain interruptions, which is crucial given the increasing frequency and impact of disruptions. The results of earlier surveys and reviews that have been widely cited in this topic are supplemented and synthesized in this work.

2.4 Supply chain management during and post-COVID-19 pandemic: Mitigation strategies and practical lessons learned

ABSTRACT: Global supply systems have been severely affected by the COVID-19 epidemic, creating several problems at a rate and scale never seen before. This study looks at the crucial supply chain problems that industrial companies, especially those in developing nations, are facing as a result of the epidemic. To evaluate these issues and related mitigation techniques, a conceptual framework based on Dynamic Capability Theory is put forward. A thorough assessment of the literature, analysis of several news stories, and expert interviews were used to identify ten major difficulties. The Grey Decision-Making Trial and Evaluation Laboratory (Grey-DEMATEL) approach is used to investigate the connections between these difficulties. According to the study, the biggest issue is Labor Shortage (PSL), which is closely followed by Material Shortage (SSM). Furthermore, it is discovered that Supply Inconsistency (PIS) has the greatest degree of correlation with other problem variables. In order to help practitioners and scholars better handle supply chain disruptions in the post-COVID-19 environment, this study ends with strategic recommendations.

2.5 Blockchain technology in the supply chain: An integrated theoretical perspective of organizational adoption

ABSTRACT: Although blockchain technology has received a lot of attention and acceptance lately, there is still a dearth of empirical study on the organizational and technological aspects that have a major impact on supply chain adoption. By identifying important facilitators and conducting an empirical analysis of their interdependencies and impact on implementation, this study seeks to develop a thorough framework for blockchain adoption. Twenty enablers are found by a thorough analysis of the literature and the application of theoretical viewpoints from the Diffusion of Innovation (DOI) theory and the business technology adoption model put out by Iacovou, Benbasat, and Dexter (1995). To determine the linkages and effects of these enablers, data gathered from 37 French experts is subjected to the Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach in the confirmatory phase. By categorizing the enablers across organizational, supply chain, technical, and external environment dimensions, the study adds to multi-theoretic empirical research on blockchain. The results show that the most important factors encouraging blockchain adoption in supply chains are technology relative advantage and outside pressure. Furthermore, the growth of legal frameworks, the rising customer need for traceability, and blockchain's potential to reduce transaction costs are all seen as crucial adoption process drivers.

3. METHODOLOGY

i) Proposed Work:

In order to improve supply chain operations' security, traceability, and transparency in the electronics sector, the suggested solution presents a blockchain-based architecture. A decentralized ledger, which replaces conventional centralized databases, ensures data integrity along the supply chain by cryptographically storing each transaction in immutable, traceable blocks. By automating essential procedures like order verification and shipment updates, smart contracts minimize human participation and lower the possibility of mistakes. To guarantee that only authorized parties—such as suppliers, manufacturers, distributors, and retailers—can interact with sensitive data, all transaction data is encrypted and access is rigorously restricted. Role management and governance are managed by a "Super Admin" module, which guarantees efficient operations and restricted user access.

Additionally, the system uses GPS or RFID technology for real-time product tracking, updating blockchain records with each movement across the supply chain. A user-friendly web-based dashboard that provides visual insights into the product journey, smart contract status, and transaction logs allows stakeholders to keep an eye on these improvements. Decision-making and teamwork are improved by this configuration. Each stakeholder, including suppliers of raw materials, manufacturers, distributors, retailers, and customers, has its own login module in the system. Customers can enter a product ID to track the product's whole route and verify its legitimacy. Ethereum is used to create the backend blockchain, which offers a safe and verifiable foundation for supply chain operations. Solidity-based smart contracts are used to govern all operations.

ii) System Architecture:

The decentralized Ethereum blockchain that underpins the suggested system architecture guarantees traceability, security, and transparency across the electronics supply chain. Through a secure, role-based online interface, each stakeholder—admin, manufacturer, distributor, retailer, raw material supplier, and customer—interacts with the system. Solidity smart contracts, which automate procedures like order formation, shipment tracking, and verification, record all supply chain interactions as unchangeable blocks. GPS or RFID sensors provide real-time location tracking, and the data is immediately connected to the blockchain for real-time monitoring. Additionally, the design includes a public tracing module that allows customers to confirm the product path using its ID, an encrypted data sharing module for security, and a Super Admin module for controlling user roles and permissions. Throughout the supply chain, this layered architecture improves operational efficiency, lowers fraud, and guarantees data integrity.

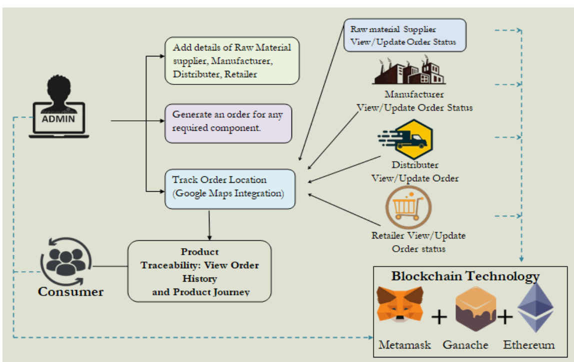


Fig 1Proposed Architecture

iii) Modules:

a. Admin Login

The admin logs into the system using default credentials and manages the onboarding of all stakeholders including raw material suppliers, manufacturers, distributors, and retailers. Admin can generate new orders, monitor supply chain flow, and track each product's movement on Google Maps.

b. Raw Material Supplier

This user receives order requests from the admin and updates the system once the raw materials are shipped to the manufacturer. The supplier can track and manage order status.

c. Manufacturer

The manufacturer receives materials from the supplier and updates the system after production. Once manufacturing is complete, the product details and movement are forwarded to the distributor.

d. Distributor

The distributor receives the manufactured goods and is responsible for delivering them to retailers. The system allows real-time tracking and updates on product handover.

e. Retailer

Retailers receive the products from distributors and make them available for consumers. They update the system regarding product sales and availability.

f. Consumer Tracing Module

Consumers can enter the unique Product ID through this module to view the complete journey of the product from origin to purchase, ensuring authenticity and transparency.

g. Smart Contract Module

Smart contracts automate tasks like order validation, shipping status updates, and access control. These contracts are created using Solidity and ensure error-free execution.

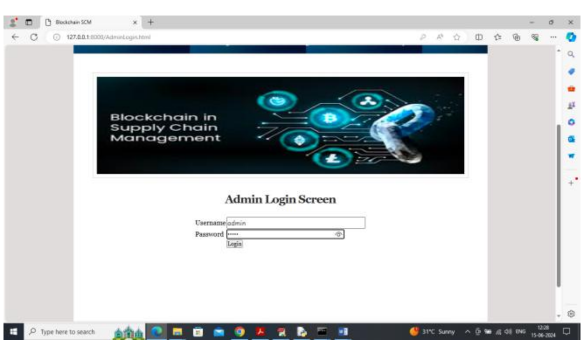
h. Web-Based Dashboard

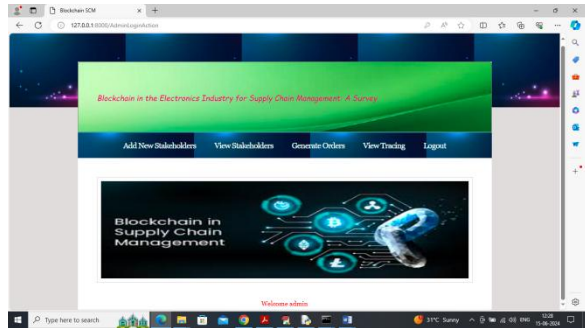
All stakeholders access a responsive interface to monitor product movements, transaction history, contract execution, and role-specific analytics for better coordination and decision-making.

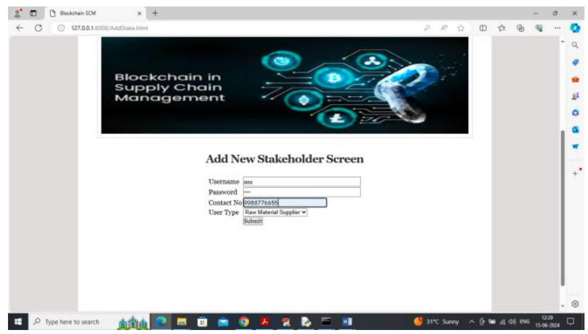
4. EXPERIMENTAL RESULTS

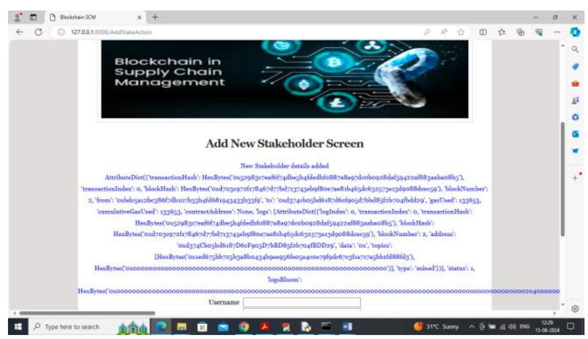
The Ethereum blockchain and Solidity-developed smart contracts were used to create the suggested blockchain-based supply chain management system. The major players in the electronics sector, such as suppliers of raw materials, manufacturers, distributors, retailers, and consumers, were represented by a simulated environment. Web-based dashboards for role-based access were used to verify each module, and smart contract automation for transaction processing and status updates was verified.

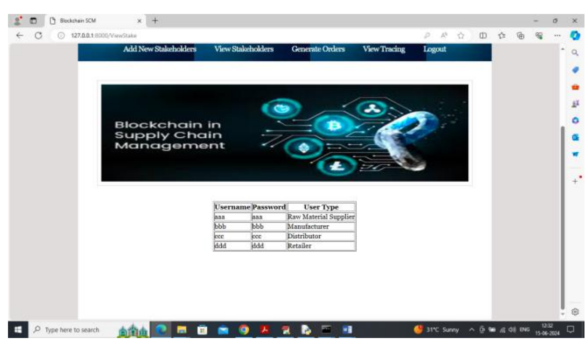
The technology successfully showed real-time product traceability across the supply chain during testing, with each transaction being permanently logged on the blockchain. Without human interaction, smart contracts automatically validated and carried out crucial tasks including order creation, shipping confirmation, and delivery tracking. All nodes maintained data integrity and consistency, and the role-based access control system made sure that sensitive data could only be accessed by authorized users. Customers may also use a product's unique ID to see its whole history, demonstrating the system's dependability and openness. The trial findings confirm that the suggested method uses blockchain technology to increase product traceability, reduce fraud, and improve supply chain efficiency.

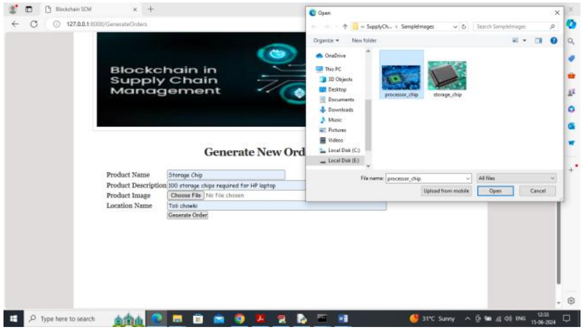


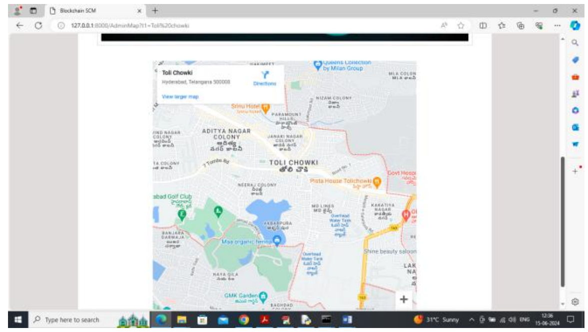


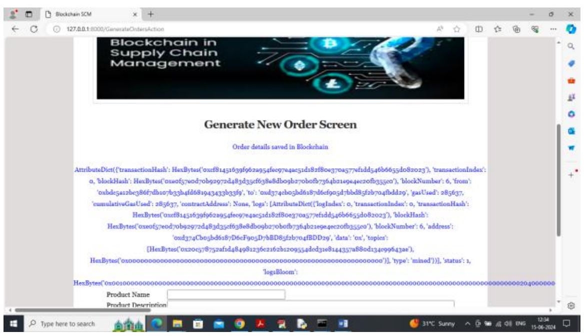


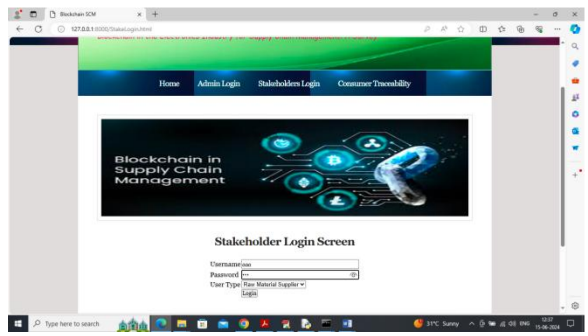


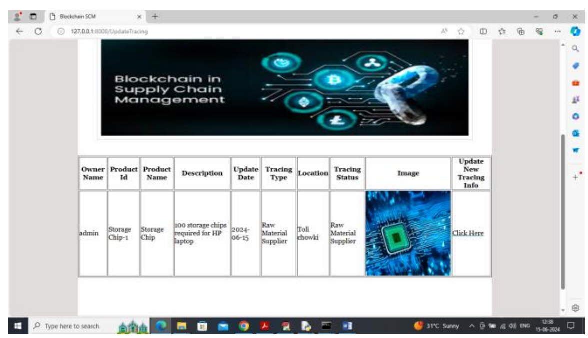


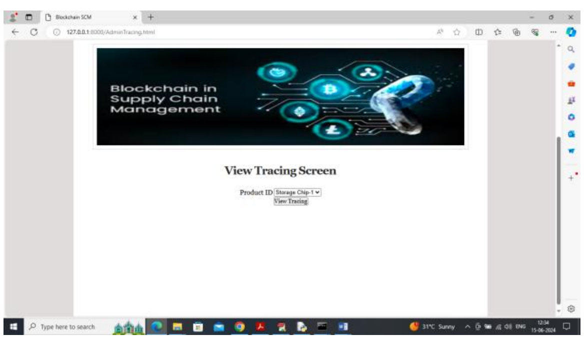

Blockchain in Supply Chain Management
Product Name
Product Description
Product Image
Location Name

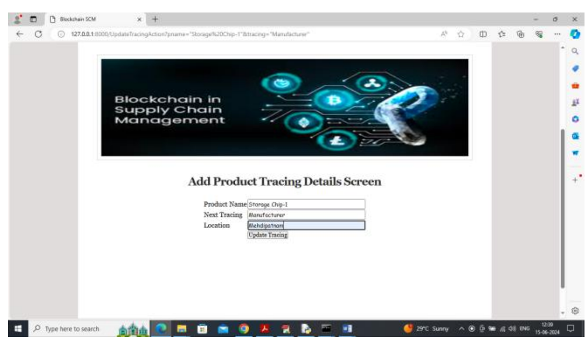


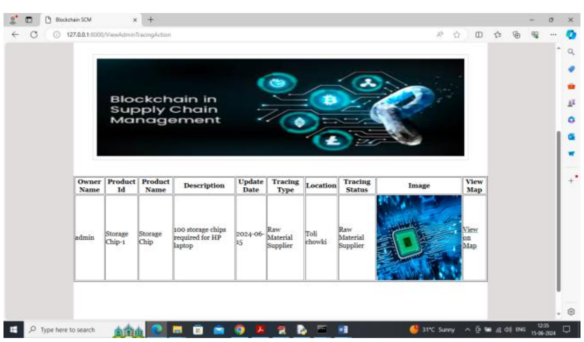

Blockchain in Supply Chain Management
Generate New Order Screen
Order details saved in Blockchain


Home
Admin Login
Stakeholders Login
Consumer Traceability
Blockchain in Supply Chain Management
Stakeholder Login Screen


Blockchain in Supply Chain Management


Blockchain in Supply Chain Management
View Tracing Screen


Blockchain in Supply Chain Management
Add Product Tracing Details Screen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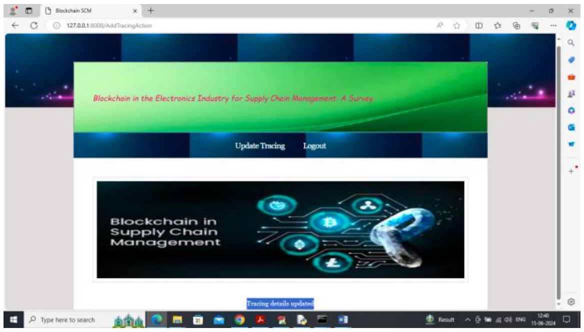

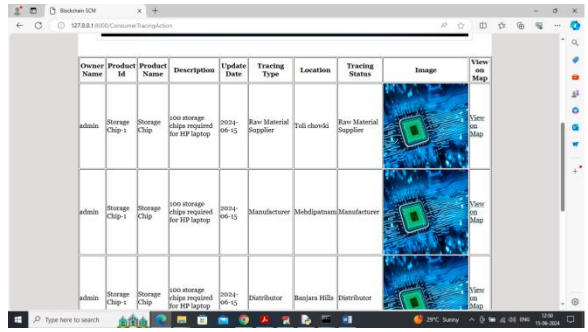

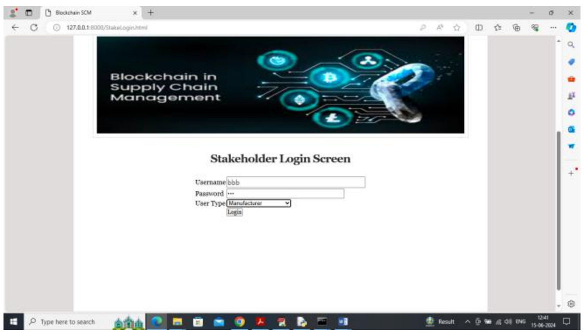

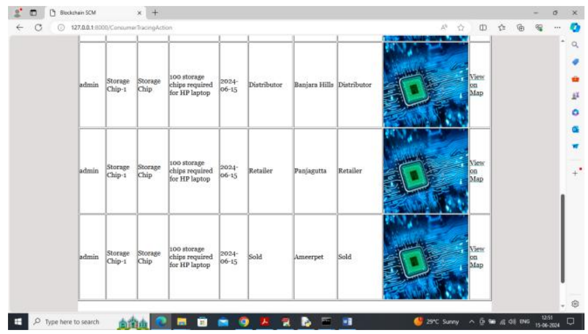

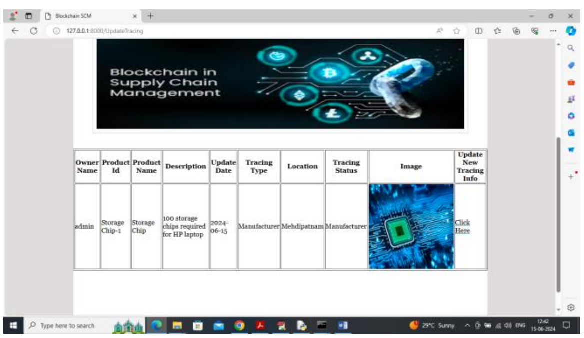

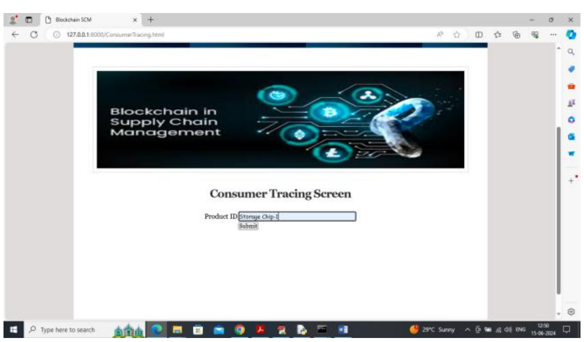

5. CONCLUSION

The suggested solution effectively illustrates how blockchain technology might revolutionize supply chain management in the electronics sector. Throughout the product lifetime, the system improves transparency, accountability, and data integrity by switching from a centralized model to a decentralized, tamper-proof ledger. Smart contracts automate important processes, while role-based access control and protected storage provide safe and reliable data sharing between stakeholders. Real-time tracking and a Super Admin module are examples of features that enhance visibility and governance, leading to improved operational efficiency and quicker decision-making. All things considered, the system provides a safe and scalable basis for contemporary supply chains, resolving persistent problems like data manipulation, traceability, and centralized vulnerabilities.

6. FUTURE SCOPE

By using Artificial Intelligence (AI) for predictive analytics, the suggested system may be improved even further, allowing for precise demand forecasting, anomaly detection, and inventory optimization. While Layer 2 and sharding solutions can increase scalability and transaction speed, multi-blockchain interoperability will enable smooth global supply chain collaboration. By automating increasingly complicated processes like payments and quality checks, smart contracts may be expanded to minimize fraud and human interference. Data privacy and stakeholder authentication will be improved via decentralized identity management. Blockchain integration with IoT sensors may provide real-time product condition tracking, guaranteeing responsiveness and transparency. Blockchain may also be used to confirm ethical sourcing and eco-friendly methods, assisting businesses in establishing credibility and achieving sustainability objectives.

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Author Profiles

Mr. Ch. Satyanarayana Reddy Completed his MCA, He also a web developer and python developer, currently working has an Assistant Professor in the department of MCA at SRK Institute of Technology, Enikepadu, NTR District. His area of interest includes Artificial Intelligence and Machine Learning.

Ms. K. Pavani Working as Assistant & Head of Department of MCA, in SRK Institute of technology in Vijayawada. She done with MCA, M. Tech in Computer Science. Her area of interest includes Machine Learning with Python, AI and DBMS.

Ms. Sk. Nehirinbi is MCA Student in the Department of Computer Applications at SRK Institute of Technology, Enikepadu, Vijayawada, NTR District. She has Completed Degree in B.Sc. (Computers) from V.K.R College Kesarapalli. Her area of interest are DBMS and Machine Learning with Python.