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ENHANCING THE FLOW OF SUPPLY CHAIN IN INDIA USING BLOCKCHAIN TECHNOLOGY

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ABSTRACT Often in modern times, people encounter the issue of not being able to find the products they need in nearby stores. This problem not only affects customers but also local retailers, as they lose their regular customers/Our project aims to implement an effective supply chain management system that utilizes blockchain technology to provide a transparent view of how products are first acquired from farmers shipped to the manufacturer and distributed to the end customer. This involves the manufacturer acquiring new items from the farmers, the wholesaler purchasing the items in bulk from the manufacturer, and the retailers buying goods from the wholesalers.With this system, local shopkeepers will be able to anticipate when they will receive their products in the desired quantities from the manufacturer, enabling better tracking of inventory,minimizing delays in orders,etc.With a blockchain-based system, every transaction in the supply chain can be recorded as a block in the chain, creating a secure and tamper-proof record of every movement of goods and services. This can help to eliminate the need for intermediaries and reduce costs associated with supply chain management.Blockchain technology has emerged as a promising solution to address some of the challenges in supply chain management. With its decentralized,

transparent, and tamper-proof ledger, blockchain technology has the potential to improve transparency, traceability, security, and efficiency in the supply chain. This paper provides an overview of how blockchain technology can be applied to supply chain management, including its benefits and challenges. The paper also discusses some of the current use cases of blockchain in the supply chain, such as tracking product provenance, reducing fraud and counterfeiting, and improving logistics and inventory management. Overall, the paper highlights the potential of blockchain technology to transform supply chain management and enhance collaboration among stakeholders in the supply chain.

INDEX TERMS Blockchain, industrial applications, smart contracts, secure transactional ledgers, smart systems, technological impact.

I. INTRODUCTION

Blockchain technology has become increasingly popular in recent years due to its ability to provide secure, transparent and decentralized record-keeping capabilities. This technology has many potential applications in various industries, including supply chain management.A supply chain is a complex network of interconnected parties, including manufacturers, suppliers, distributors, retailers, and customers. The process involves the exchange of goods, services, and information between these parties. The traditional supply chain system is often plagued by inefficiencies, including lack of transparency, fraud, and errors.Blockchain technology can potentially address these inefficiencies by creating a secure and transparent platform for supply chain management. The distributed ledger technology allows all parties in the supply chain to have access to the same data in real-time, thereby reducing the risk of fraud and errors. Additionally, the immutability of blockchain records makes it possible to trace the movement of goods and services from their origin to their final destination.Incorporating blockchain technology in supply chain management can also help with inventory management, order tracking, and payment processing, among other benefits. With the potential to improve supply chain efficiency, reduce costs, and increase transparency, it is no wonder that more and more companies are exploring the use of blockchain technology in their supply chain management systems.

II .LITERATURE REVIEW

[1]This research paper reviews different industrial application domains where blockchain can be applied and examines the opportunities, benefits, and challenges of incorporating blockchain in various industries. The paper also identifies the requirements needed to implement blockchain for different industrial applications. While several opportunities are available for utilizing blockchain in different sectors, there are still challenges that need to be addressed to achieve optimal use of this technology. [2]This research paper provides a review of literature on the use of blockchain-based systems in transportation. The main objective was to identify current research trends, gaps in the literature, and future challenges using a multi-step methodology. The study began with a bibliometric analysis to obtain a broad overview of the topic, followed by an in-depth analysis of the most influential contributions in two areas: supply chain and logistics, and road traffic management and smart cities. The results showed that while blockchain technology is still in its early stages, it has promising applications in various fields, including food tracking, regulatory compliance, smart vehicle security, and supply-demand matching. However, much effort is still needed to reach maturity as many models have been theorized but few have been implemented in real contexts. The paper also explores the relationship between blockchain and sustainability, highlighting the potential for the technology to limit food waste, reduce exhaust gas emissions, support proper urban development, and improve overall quality of life. A supply chain involves a network of individuals, organizations, and resources responsible for moving goods or services from the supplier to the customer, while maintaining quality throughout the process. However, centralized supply chain management systems can pose risks such as corruption, fraud, and tampering. The emergence of blockchain technology offers a new approach to address the challenges of visibility and transparency in supply chain management. [3]This paper examines how

blockchain can be integrated into supply chain architecture to create a reliable, transparent, authentic, and secure system. The study explores the benefits of blockchain in supply chain management and the challenges of implementing it. Both theoretical and real-world applications are examined to develop a comprehensive theory of the requirements for an efficient blockchain-based supply chain.The manufacturing of goods has become increasingly complex due to the involvement of more intermediaries between producers and consumers. With globalization and market expansion, companies have had to expand their product portfolios and life cycles to meet the demands of new markets. As a result, there is limited knowledge about the origins, processing, and shipping journeys of products. The supply chain faces challenges in both quantity and quality, with traceability and data management being the primary concerns. In most sectors, including healthcare, finance, food, and education, information systems are managed centrally. However, centralized management systems can pose a threat to data integrity, availability, and resiliency, and the system may be vulnerable to corruption, fraud, and tampering. A trustworthy ecosystem between suppliers and customers can be created by implementing policies that focus on supply chain transparency, requiring accurate data collection and secure data storage to ensure product traceability

III. PROJECT OBJECTIVE

Our project aims to solve the problem by decentralizing the entire supply chain network using blockchain technology. This will provide the following benefits:Transparency: All stakeholders will be able to track the product at every stage, promoting transparency.Increased security: The system will be tamper-proof, providing increased security.Risk management: The blockchain will enable us to monitor and manage risks within the supply chain.High-quality products: By implementing blockchain, we can ensure the delivery of the best quality products.Instant payment: Smart contracts will enable instant payment between stakeholders upon buying and selling.

IV. PROJECT SCOPE

The project aims to increase visibility and maintain accurate records of products using blockchain technology. By doing so, we can eliminate the inefficiencies in the current supply chain and save firms a significant amount of money. This will involve replacing traditional paper-based systems with digital document transfer at every level of the supply chain hierarchy.

V. CASE STUDY

Firsty, the study analyzed a generic supply chain management system using an appropriate dataset of a product based company.The company offered 4 modes of shipping the product namely- standard, same, first and second class. However, every mode of delivery shows some level of inefficiency. Therefore, there is a delivery data variance associated for all the modes of shipping.The study also analyzed the best model for prediction for the given dataset,the model was found out to be XGBoost with an accuracy of 99.65%. Using this model forecasting was done between predicted and actual sales.To analyze the supply chain performance by different shipping modes,we have plotted a barchart.

Fig 1: Barchart for Percentage delay in delivery modes.

As the stacked bar chart in which x axis is taken as different modes of shipping and y axis percentage of deliveries it shows that the performance of all shipping modes is not so good. In general, 40% of the orders are late delivery.Almost 95% of First Class shipping mode is late delivery.As a result, First Class and Second Class shipping modes require improvements in terms of supply chain to deliver orders on time.

In order to compare the shipping days and the variance in date, a line graph has been plotted between the different shipping modes and actual days required for shipping has been plotted.

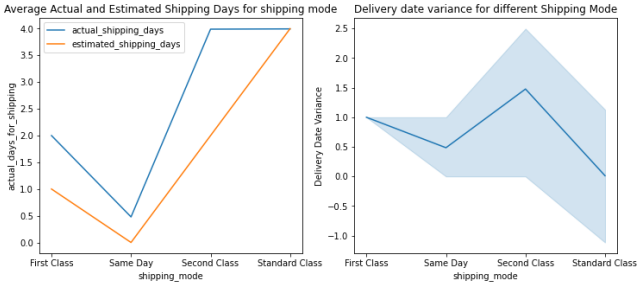

Fig 2: Graphs showing variance in actual vs estimated delivery.

From the line graph on the left-hand side, it is clear that the actual shipping days are larger than the estimated one for First Class, Same Day, and Second Class shipping modes. Only Standard Class can complete the delivery as estimated.It shows that First Class, Second Class, Same Day takes longer to be completed as expected.However, Standard Class normally deliver on time.From the line graph on the right-hand side, it is more clear about the delivery date variance.A table comparing the performance of all the modes has been chalked out.

Table 1: Analysis of various shipping modes.

MODE OF SHIPPING	ANALYSIS
FIRST CLASS	Takes longer time for shipping than estimated
SECOND CLASS	Takes longer time for shipping than estimated
SAME DAY	Takes longer time for shipping than estimated
STANDARD	Delivers on time.

In order to identify which model best fits the dataset, we analyze the accuracies of various algorithm

Table 2:Accuracy analysis of different algorithms.

ALGORITHM	ACCURACY
LINEAR REGRESSION	0.7852
RANDOM FOREST	0.9954
XG BOOST	0.9965

The above table shows that the accuracy of XG Boost is the maximum,hence this model can be used for making predictions of the actual and predicted sales.For the same analysis a line chart between actual and predicted sales has been made.

Fig 3: Line chart for actual vs predicted sales.

The above graph depicts line plots for actual and predicted sales of different products.From the graph,it can be seen that there are few discrepancies in the actual and predicted sales.

From the first barchart it is clear that all shipping days take more time for shipping than expected.From the line chart it is clear that . Only Standard Class can complete the delivery as estimated.The shadows present in the line graph indicate the Delivery date variance,. To conclude we can say that Delivery Date Variance = Actual Shipping Days - Estimated Shipping Days.It indicates that ,First Class is very stable, which is always one day behind the schedule.The performance of Same Day shipping mode is not bad as it has an average 0.5 days longer than expected.Second Class has the most poor performance as it usually takes 1.5 days longer to complete the delivery, which is the longest among others. Besides, it has the largest maximum delivery date variance, which indicates that it has the longest delay.Standard Class has the best performance as it usually delivers on time. Besides, it sometimes delivers earlier than expected. Next, in order to predict the sales of various products,we need to first find which model is best suited for the dataset.Firstly, appropriate parameters will be selected for the model based on their p and f values.After applying various ML algorithms, the study found out that XG Boost has the maximum accuracy.As the accuracy of XG boost is maximum,the work will use this model for making predictions of the actual and predicted sales. The study found out that there are discrepancies in the graph obtained for actual vs predicted sales using XG boost model.These are mainly caused by late deliveries and fraud orders of products.

.Delays on delivery of products can have adverse effects on the customers, delays in shipping can hinder the customers-seller relationship,ultimately leading to the

retailer losing their daily customers.If a business fails to deliver products or services on time, it can lead to customer dissatisfaction. Customers may become frustrated and angry if they do not receive their orders when expected, which can harm the business's reputation and lead to negative reviews.A delay in delivery can result in lost revenue, especially if customers decide to cancel their orders or take their business elsewhere. This can be particularly damaging for businesses that rely on repeat business or have a high level of competition.

VI. IMPLEMENTATION

Implementing blockchain for a given supply chain can be implemented in this way:

1. Identifying the Use Cases: The specific use cases for which blockchain technology can provide value in the supply chain management was determined. The specific pain points or inefficiencies that blockchain can address, such as improving traceability, increasing transparency, reducing fraud, or streamlining payments were considered.

2. Selecting the right Blockchain Platform: Evaluating the available blockchain platforms and choosing the one that best suits the use case. Factors such as scalability, security, interoperability, and community support were considered and finally an Ethereum based network was chosen to deploy the smart contract, although the main aim would be to deploy it into a Digital Rupee (INR) network in further research work.

3. Building the Network: A network of partners who will participate in the blockchain-based supply chain is built. The roles and responsibilities of each partner are defined to ensure everyone agrees to participate in the network.

4. Building the smart contract: Defining the smart contracts that will govern the interactions between the different parties in the supply chain is very important. Smart contracts are self-executing programs that automate business logic and enforce the terms of a contract.

5. Implementing the Solution: Developing and deploying the blockchain solution to ensure that all the necessary hardware and software components are in place, and that the system is fully integrated with the existing supply chain management systems.

6. Educating and Training the Participants: Educating and training all the participants in the blockchain-based supply chain on how to use the system is one of the most important aspects of the complete model. It needs to ensure that they understand the benefits and limitations of the system, and how to use it to improve their business processes.

VII. WORKING MODEL

The farmers produce the raw materials like rice and milk.The Manufacturer buys the raw materials from these farmers. But this process of buying happens through a smart contract where the transaction is instant and is validated and stored in a block.The manufacturer does the processing and creates a product called ‘Kheer’ from the raw materials. The manufacturer then makes the product in bulk and packages them. In between there are multiple data points which collect vital information from the manufacturing plant. These are done with the use of IOT devices and sensors which collect data from the data points. Then these products are bought in bulk by the Wholesalers/Distributors with instant payment with the help of the smart contract.The Wholesalers then ship the product to their warehouse from where the retailers order their quantity.The complete shipment process is tracked with data points and all these are stored in a private/public cloud.The retailer lists their product in the shop from where the customers buy them.So, from the starting till the end point, every movement of the product is tracked and stored in multiple blocks and the transactions are validated and converted into blocks and added to blockchain.This blockchain is a Distributed Ledger System which is available throughout all the stakeholders. Hence the complete system becomes transparent, trackable and much more secure.The diagram below shows the architecture for a supply chain model.

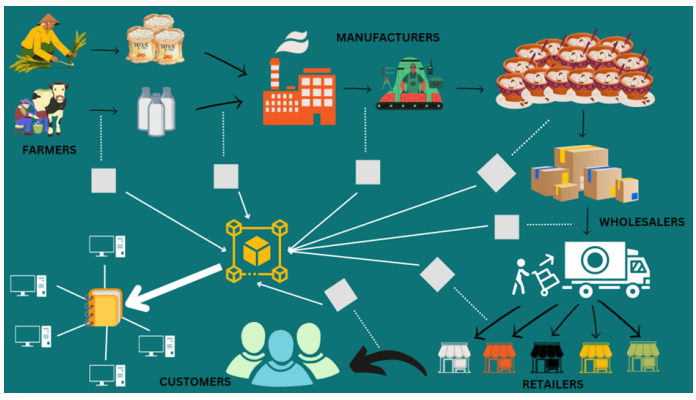

Fig 4:Architecture for the project

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A. SMART CONTRACT

This smart contract is based upon Ethereum and can be deployed into any Ethereum network for testing purposes.This smart contract can have multiple stakeholders of the supply chain including Farmer(Producer), Manufacturer, Distributor(Wholesaler), Retailer and Customer(Consumer). The stakeholders can add themselves into the network without the consent of any central authority. Also each of them are defined with a specific set of roles. The Roles of a farmer are-A farmer first produces their raw materials and lists them in the contract, A farmer can choose which items to sell and list them for selling with appropriate price. When a manufacturer buys with the proper amount, the farmer can ship the product to the manufacturer The Roles of a manufacturer are-The Manufacture can buy product from any farmer with instant payment method The Manufacturer then processes the raw materials It moves on to packaging/Finally the manufacturer list its product for sell with appropriate price.After a distributor buys with the proper amount, the manufacturer ships the product to the distributor. The Roles of a distributor are defined as-The Distributor buys the product from the Manufacturer with instant payment.The Distributor then stores them in their warehouse.Finally the distributor list its product for sell with appropriate price.After a retailer buys with the proper amount, the distributor ships the product to the retailer.The Roles of a retailer are defined as- The Retailer buys the product from the Distributor with instant payment.The Retailer then stores them in their individual shops. Finally the retailer lists its product for sale with an appropriate price. The Roles of a customer are as follows-The customer buys the product from the retailer with instant payment.

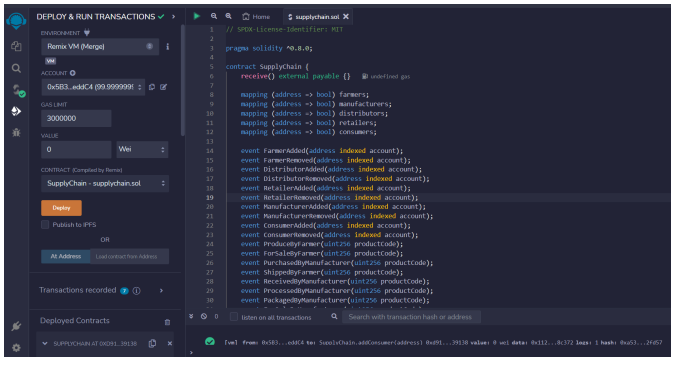

Fig 5: Working of the Smart Contract.

VIII. NOVELTY

In India, cryptocurrency is not widely used because the Reserve Bank of India has prohibited banks from dealing with cryptocurrency exchanges, and there is no specific legal framework for cryptocurrencies in the country. So, implementing a blockchain over the generic supply chain without any digital currency is next to impossible. This is where we introduce our novelty.Digital Rupee is a proposed digital currency in India that will be issued by the Reserve Bank of India. It is also called an E-rupee. This is what would replace Ethereum and our complete blockchain can be deployed in this Digital Rupee network.Digital Rupee is an innovative solution that leverages blockchain technology to provide a decentralized and secure platform for supply chain management. One of the key features of Digital Rupee is the use of smart contracts to automate and enforce contractual obligations between different stakeholders in the supply chain. These smart contracts are self-executing and programmable, allowing for real-time monitoring and tracking of products as they move through the supply chain.

The novelty of using smart contracts in Digital Rupee lies in their ability to improve supply chain efficiency and transparency. By automating the contract execution process, Digital Rupee eliminates the need for intermediaries and reduces the likelihood of disputes and errors. This leads to faster transaction times and reduced costs for all parties involved. Additionally, the use of smart contracts enables real-time tracking of products and automatic updates to the blockchain ledger, providing stakeholders with complete transparency and accountability throughout the supply chain. Overall, the use of smart contracts in Digital Rupee is a novel and innovative approach to supply chain management that has the potential to revolutionize the complete industry in Ind

IX. RESULTS AND DISCUSSION

Delays on delivery of products can have adverse effects on the customers, delays in shipping can hinder the customers-seller relationship,ultimately leading to the retailer losing their daily customers.If a business fails to deliver products or services on time, it can lead to customer dissatisfaction. Customers may become frustrated and angry if they do not receive their orders when expected, which can harm the business's reputation and lead to negative reviews.A delay in delivery can result in lost revenue, especially if customers decide to cancel their orders or take their business elsewhere. This can be particularly damaging

for businesses that rely on repeat business or have a high level of competition.Hence implementation of a distributed ledger via the use of a smart contract can make all the goods completely trackable and reduce the risks of late deliveries and fraudulent orders. The smart contract can make the complete supply chain trackable with a single source of truth. This ensures that any damage to any product can be validated under whose ownership the event happened. Moreover this smart contract issues an instant payment option which prevents the farmers from being exploited. This feature ensures that the farmers get their deserved value upon selling the raw materials. Also the customers benefit in the way that the product reaches the retailer on time and a customer does not need to wait for the product at any retail shops. Hence implementing blockchain with all its parameters, makes the supply chain much more transparent and helps to reduce the delay of delivery.

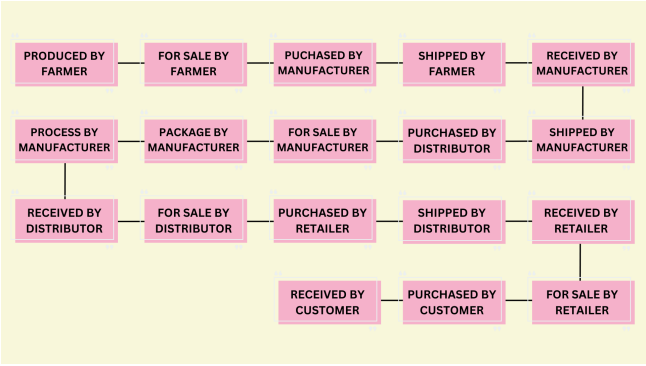

Fig 6: Process flow of Blockchain implemented supply chain.

X. CONCLUSION

It is clear that in a generic supply chain system in India, there are a lot of issues including late deliveries of orders, improper payment schemes, fraudulent orders etc. These issues create hindrance in any business in aspects of management as well as analysis. Implementation of blockchain has the potential to transform supply chain management systems by providing an immutable and decentralized ledger that allows for secure and transparent tracking of goods. Blockchain can be used to provide end-to-end visibility of the supply chain, allowing all parties involved to trace the origin of a product or service, track its movement through the supply chain, and verify its authenticity. This can help prevent fraud, counterfeiting, and other types of supply chain risks. Blockchain can be used to automate supply chain processes through the use of smart contracts, which are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. This can help to eliminate manual processes, reduce administrative costs, and improve efficiency. This smart contract can be implemented in the Digital Rupee network which would be a revolutionary game changer in terms of the supply chain. The stakeholders can work on their own and within a set of rules and guidelines. Blockchain can also be used to streamline payment processing in the supply chain by enabling secure, instant, and low-cost transactions between buyers and sellers. This can help reduce the risk of fraud, eliminate the need for intermediaries, and improve cash flow for all parties involved.Overall, the use of blockchain technology in supply chain management has the potential to improve efficiency, reduce costs and increase transparency.

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XII. PROJECT LINK

Github Link for Smart Contract
https://github.com/the-neelguy/supplychain-smartcontract.git