A Hybrid Model for Agri-Food Supply Chain Model Using Block Chain and IoT

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Abstract: *Consumers buy products from farmers through the Agri-food supply chain (ASC). Buyers are stressing theimportance of product safety in this process, and manufacturers are looking to increase their profits. India's CSA is dynamic and complex, which creates significant challenges in tracking and managing agricultural and food commodities. However, due to reliance on intermediaries, financial and legal restrictions, Ethereum-based financial solutions, etc., most of the current solutions do not meet ASC's monitoring and control standards in India. To address these issues, the authors advised using the Hybrid Model of Agricultural Supply Chain (HASC) model. I' Thematic analysis was applied in this work to perform a systematic literature review. The authors have used a linear physical block diagram to highlight ASC India's reliance on intermediaries and to illustrate intermediaries' linksand objectives.The strategy uses IOT and blocks chain to track the whereabouts of goods, improve supply chain (SC) management, increase transparency, reduce errors,preventproductdelays, and eliminatecontrarianactivities. Ethical and illegal, and ultimately increase customer and supplier confidence. The report also notes that financial exchanges using crypto currencies by blockchain playersare currently prohibited in India. Solutions based on mobile banking and electronic payments have been proposed for block chain APIs.*

Keywords: *Internet of things, block chain, Hybrid model of agriculturalsupply chainmodel,food safety,sustainability, transparency, real-timed at a exchange, communication, collaboration, sensors, environmental monitoring, immutability, security, dairy, efficiency, trust, trust consumers.*

Introduction

Agriculture began thousands of years ago in Neolithic times when the great agricultural revolution tookplace. Fromthe 1950s until the end of the 1960s, there was a movement known as the Agricultural Movement, which began in the late 1960s and was characterized by much research and technological development aimed at increasing agricultural production worldwide. Today, farmers in developing countries regularly use the concept ofvalue chains, also known as agricultural supply chains. There is no single explanation for this term, but it refers to the various goods and services needed to get produce from the farm to the

consumer.Agriculture is one of India's main economic forces. The contribution of agriculture to the country's GDP in 2021-2022 was around 11.50%. In rural areas, where the majority of the population lives, 84% of people are employed in agriculture, manufacturing and commerce. Agriculture accounts for about 40.6% of total employment in India. Agriculture not only provides rawmaterials and exports for thecountry'sindustry,butso essential to employment, livelihoods and access to foodfor many rural populations. Agriculture is the backbone of many agricultural economies, including India, although the modern economy relies heavily on technology and industry.The Agrifood supply chain (ASC) faces a number of challenges, including a large workforce, skills shortages, environmental dependence and rural supply bases. Information and communication technologies (ICT) are used to solve these problems. Internet of Things (IOT), which has recently been adopted for information processing, is one of the key technologies used in CSA. The IOT operates through network connections, sensors, and actuators embedded in hardware. To facilitate information sharing, these devices enable real-time communication and data exchange between various smartdevices in the supply chain.Cryptography is a new technology used in blockchain. Create a decentralized and secure commercial registry system. This ensuresthat neither transactions nor thepersonaldataofusershare compromised. Decentralized mining methods prevent fraudulent transactions from being added to the crypto chain. Supply chain logistics can benefit from blockchain. This allows you to keep track of goods and things and helps you plan ahead for expected delays. AccordingtoKumar, R, Kim, M. & Hwang, J. (2019),the most obvious application of blockchain technology is logistics. Blockchain technology and the Internet of Things (IOT) can be used together to track the supply of fresh products in India.

The ASC process is highly dependent on the flowof funds. Most block chain and IOT-based CSAs recommend using Ethereum or another blockchain-based currency to speed up the process. However, India has banned the use of blockchain-based Crypto currencies. Therefore, a different method of cash flow control is needed to maintain a reliable and reliable record of financial transactions between ASC parties.

Several supply chains for agricultural and food products arebeing built and researched around the world using blockchainand the Internet of Things. However, India has yet to see the development of such a model. The development of Hybrid Model of Agricultural Supply Chain (HASC) model is important for India, as Indian supply chains rely heavily on complex intermediaries and it is illegal to transact using crypto currencies. The study proposes an HASC model for India that uses IOT, blockchain databases, and digital financial solutions to improve supply chain transparency.

Literature Review

ICT stands for information and communication technology. These technologies include computers, sensors, communication technologies, and the networks that connect them. The availability of large amounts of data and information will facilitate the use of ICTs in agriculture and the food industry. However, there are gaps in the integration of ICT and supply chains in the agri-food sector. Moreover, there is little to help make effective use of the data and information already available. These results were reported by Chen S., Lin Y. (2018), Goyal,S.Singh,S.Soni,SK(2019)and Lee L, Fan L, Ren S (2019).[2]

Through the use of technologies such as computers and telephones, the waypeople produce and distribute food to people has improved over the past three decades (Butt, P. Singh, J. (2020)).However,therearestill issues that make it difficult to develop better technologies. Whether it is information management in companies or in the supply chain, it is one of the biggest challenges for the agricultural sector (Butt et al., 2020). There are manydifferent people with different interests involved in the supply chain.

This can make it difficult to share information with everyone who needs it.[5]

Middlemen play an important role in the agricultural supplychain (ASC) in India. They act as a link between farmers and consumers. Previous research shows that intermediaries make significant profits by capturing a large share of the consumer price. There arefive intermediaries in the main distribution chain of ASC in India. The Faria are small traders who sell their wares in small quantities in three or four local markets. The farmers supply them with goods which they resell in Bepari. The Bepari are skilled traders who buy food from farmers and farmers in the local market. Aratdar buys goods from Bepari and acts as an intermediary between Bepari and the merchants for a fee. Retailers who buy Beparis products through Aratdar and resell them to their customers[6]

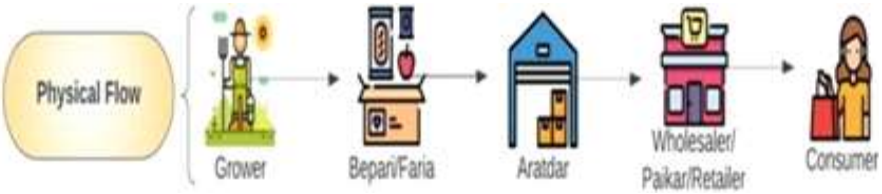

Figure 1: CSAAgriculture and Food Supply Chain Physical Linear Flow

Source: economic times.indiatimes.com

Middlemen play an important role in the food supply chain in India. The seintermediary'shelp farmers get their products to Market and share the profits with producers. Unfortunately, small-scale farming is the most common farming method in India and on average farmers only own 0.6 hectares of land. This means producing products in small batches and using certain modes of transport to transport these small batches is not always economically viable. Indian farmers also face challenges such as low levels of education and limited access to market knowledge. Asaresult,they relyon intermediariesto promotetheirproducts. However, it is important to educate farmers on how to increase their income. Marketing data helps manufacturers make better decisions. Thus, you need up-to-date knowledge of the market to have a good marketing strategy in India.[7]

According to Xue, L., Shen, X., Sun, Y., Dai, J. (2019) farmers are concerned about marketing risks, which makes them more dependent on intermediaries [3]. Xue, L., Shen, X., Sun, Y., Dai, J. (2019) also suggest that marketing data is essential for making smart product sales decisions. Farmers are concerned about marketing risks, which makes them more dependent on intermediaries. Butt, P., Singh, J. (2020) also suggest that marketing data is essential for making smart product sales decisions. Farmers are concerned about marketing risks, which makes them more dependent on intermediaries. Butt, P., Singh, J. (2020) also suggest that marketing data is essential for making smart product sales decisions.When farmers decide when to harvest, they need information about market demand, when to sell and price forecasts. This avoids situations where there is too much harvest and prices are too low. But in India, most farmers don't know how to readprices in newspapers. Instead, they rely on traders and truckers coming to buy their produce, and these intermediaries often put their own interests ahead of farmers'needs.ThegovernmentDisseminates price information, but farmers do not have free access to it. Most vegetables are sold in local markets or wholesalers, and onlya small percentage issold in supermarkets. The vegetable trade in India is dominated by wholesalers and small traders. This means that vegetable production is poorly organized, and few farmers are engaged in contract farming According to Xue, L., Shen, X., Sun, Y., Dai, J. (2019). [8]

Research Method

The authors of this study began by reviewing the relevant academic literature on the subject. They did this using some methods described by Al-Turjman,F., Shahrestani,S.(2019). Planning, executing the plan, and analyzing the results are processes. First, the authors developed a strategy that included the proposed research topic, information-gathering methods, and information sources used. They then implemented this strategy and obtained the key data they found. Finally, they used this data to make decisions about the model studied. To carryoutthe research, the authorsused web toolssuchas Google Scholar and Web of Science.

To find relevant research papers, authors search for various research papers such as agriculture, agriculture supply chain transparency, agriculture supply chain in India, IOT, and agriculture supply chain based on block chain, cryptocurrency, etc. We used a search query consisting of alternative agricultural supply chains. " and " Mobile Banking in India ". I created a search string by connecting these words with "AND" and "OR". Masters' theses, doctoral theses and publications written in languages other than the English are not included.In addition, we have removed duplicate papers collected from Web of Science and Google Scholar.

The authors used the lucid chart program to display theproposed model. This web-based tool allows users to collaboratively create, edit, and share charts and diagrams to improve a wide variety of systems, processes, and organizations. Ayaryu, M., Rausch, L. (2018) explains that Lucid Program Inc. is the company that published the program.

Development of a Conceptual Model

Internet of Things, blockchain and digital financial solutions are proposed by the authors as new ideas to strengthen India's agrifood supply chain. The authors' research led them to develop a theoretical model of how different technologies can be combined to improve supply chains.

Generating the Hybrid Modelof IOT into the agricultural and food supply chain

The network of devices, databases, objects, and sensors constitute the Internet of Things (IOT).To respond to community demands, the network works together (Ahmad R, Zhang J & Fu L (2020)) [12]. According to Chen S., Lin Y. (2018) and Feng, X., He, X. (2021)IOT is a computing and communication innovation that allows people to interact anytime, anywhere, and through any AVERAGE. High-quality food and food products are produced using various modern technologies (Efstatiou 2019). Some of these technologies, such as irradiation, ICT, and genetic engineering, can help solve problems anticipated in the food industry, such as products with short shelf lives. Data based on radio frequency identification (RFID), one of the cornerstones of IOT applications, are very important in solving this problem (Feng, X., He, X. (2021) [16]. Recently, RFID has become the subject of considerableresearchintheliterature(BanerjeeS, Chakraborty S& DayS (2019)[19]. The Internet of Things will connect digital and physical elements, enabling ASC to deliver new classes of applications and services. According to Chen S., Lin Y. (2018) and Goyal,S.Singh,S.Soni,SK(2019) networks automatically recognize food, track its location, control it and generate events. RFID has become the subject of considerable research in the literature Tao, F., Yang, Y., Zuo, Y., Xu, LD (2019). The Internet of Things will connect digital and physicalelements, enabling ASC to deliver new classes of applications and services. According to Feng, X., He, X. (2021) and Ayaryu, M., Rausch, L. (2018), networks automatically recognize food, track its location, control it and generate events. RFID has become the subject of considerable research in the literature (Tao, F., Yang, Y., Zuo, Y., Xu, LD (2019)). The Internet of Things will connect digital and physicalelements, enabling ASC to deliver new classes of applications and services. According to Feng, X., He, X. (2021) and Ayaryu, M., Rausch, L. (2018), networks automatically recognize food, track its location, control it and generate events[22].

There are several technologies on the Internet that can help improve processes. Examples include artificial intelligence, cloud computing, 3D printing,

and biosensors. Reducing food waste is another goal of the Internet of Things (IOT). However, some South Asian countries are not using these powerful IOT solutions to manage their agricultural and food supply chains. It was discovered by Efstatiou, J., Mikhailidis, A., Gkiulos, V., Katsikas, S., Bursianis, A. (2019)[9].

According to Gupta, A., Sharma, A., Singh, S. (2020), IOT technologies are important for advanced supply chain management in developing countries. Internet of Things technologies such as RFID and wireless sensors are used in advanced supply chains (ASCs) to manage the production, distribution, storage and retail of products while meeting customer demand for genuine highqualityproducts. Using RFID and wireless sensors, managers can track accurate product information and ensure product quality. This reduces food waste and improves food quality.

Theuseof IOTtechnologymakesthe work of farmerseasier. The entire agricultural supply chain is automatically tracked using RFID tags, increasing transparency and reducing labor and inventory costs. Farmers can benefit if it results in increased productivity and lower costs. IoT technology can make everystep of the agricultural supply chain efficient. Technologies such as vibration spectroscopy, artificial intelligence, high-pressure processing, and trace-based distribution tactics can increase the abilityofsupplychainsto meetdemand for Agricultural products. Al-Turjman, F, Shahrestani,S.(2019) say this could help rural Indian farmers where the majority of the population has limited access to modern conveniences. health problems.

Butt, P., Singh, J. (2020) explain that traditional supply chain traceability depends on centralized systems using the Internet of Things such as cloud databases. However, these systems have security risks, data loss and are easy to use, which affects transparency. Al-Turjman, F., Shahrestani,S.(2019 (2019) also found the limitations of traditional supply chains. These include a failure to ensure food safety, an inability to trace the source of a product, and a lack of oversight and transparency throughout a product's lifecycle.

Generating the Hybrid model of Block chain technology into agricultural and food supply chains

Blockchain is a technology that can be used for secure and tamper-proof record keeping without the need for third-party intermediaries. It is a secure system that uses cryptography to verify users and transactions, increasing trust. This technology reduces transaction costs and improves product quality. In a blockchain, each block contains data and a link to the previous block. User IDs and new transactions are verified on a peer-to- peer basis. The Proof of Stake (POS) approach requires the user to perform an action which, if successful, is added to the block. This information is displayed in the chain of ledgers as a history of all transactions ever made.

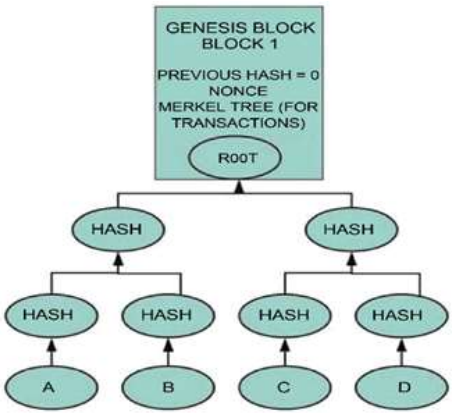

Figure 2: Block1-Genesisblock

Source: economic times. coindesk.com

Blockchain technology is more efficient than traditionalcontracts. Traditional supply chains use a lot of paper documents that can be lost or stolen, making them difficult to trace. Smart contractscansolvetheproblemsby automatically executingwhen certain conditions are met. Smart contracts eliminate intermediaries and allow pre-determined actions such as payments to be performed automatically. This reduces the risk of fraud and saves time and money. Smart contracts ensure that participants in transactions are held accountable and that the contract is fulfilled. This improves the visibility, traceability and transparency of the supply chain.

Solutions for Cash and Information Flows in Indian Agribusiness Supply Chain

Cash flow management in the agriculture and food supply chain is extremely important. Most block chain and IOT-based agriculturalsupplychain modelsrecommend usingablockchain- based currency such as Ethereum to simplify the process. However, the use of blockchain-based cryptocurrencies in India's illegal. Therefore, there is a need for an alternative secure and tamper-proof method for controlling the movement of cash between ASC parties.

AccordingtoRangarajan (2008), financial inclusion means providing financial services and credit at reasonable rates to vulnerable and low-income groups on demand. According to the World Bank, 62% of India'spopulation will live in rural areas in 2020 most of them unbanked. The commercial banking sector can take advantage of this opportunity. However, due to prohibitive costs and restrictions, construction of bank branches in rural India is not feasible. According to Kabir, Islam and Inam (2013), the central bank allows up to 15 new branches to open per year. Somecommercial bankshave recentlytriedto helpthose who do not have access to conventional banking services by using Mobile Financial Services (MFS).Remote banking is an excellent solution to this problem. This will allow banks to provide financial services to disadvantaged people that are not availableat traditional bank branches. It also reduces costs for banks and their customers because they don't have to build and operate bank branches and customers don't have totravelorqueue. Users can use MFS on their mobile devices to send, receive, depositand withdrawmoneyfromtheir accounts. The serviceis relies on bankers to help customers with mobile accounts transact outside of the bank. Millions of people now have easier access to the established financial system. An Indian bank wants to create a safe and prosperous MFS market. S.Singh,S.Soni,SK(2019) and Lee L, Fan L, Ren S (2019) develop this theme in more detail.

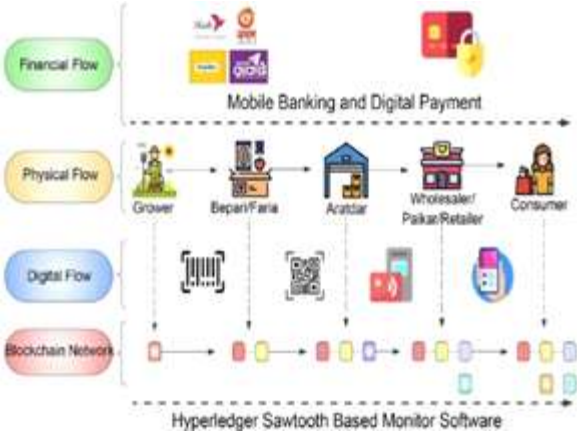

Figure 3: A Hybrid Model for Agri-Food Supply Chain Model Using Block Chain and IOT

S.Singh,S.Soni,SK(2019) claim that almost all Indians now have mobile banking apps installed on their smartphones such as Bkash, Nagad and Rocket. Without having to handle cash, mobile banking digital payroll solutionssuchas BKashhavegreatly simplified payroll procedures in the Indian textile industry. Similar to the blockchain's tamper-proof hashing process, each transaction made through mobile banking creates a transaction ID containing all the necessary information. Therefore, we recommend combining mobile banking transaction identification systems with smart contracts on the blockchain as an alternative to crypto currency solutions.

Blockchain-based tools like hyper ledger Sawtooth can be usedto track data from manufacturers to customers. The Linux Foundation started the hyper ledger project in 2016, which led to the development of the Hyperledger open source collaboration. The initiative offers a set of free frameworks and tools for businesses to build their own blockchain solutions based on their specific needs. Saw toothletsyoubuild, run, and distribute public and private enterprise applications and DLT solutions. We attach great importance to the disclosure of sensitive information in open access. Using a modular consensus schema that can be modified even after system deployment, provides a flexible framework for making transaction-based changes in shared state between participants who don't trust each other. Baralla, Pinna and Corrias explained it in 2019.

In fig. Figure3 shows the proposed hybrid model of agriculture and food supply chain for India. Hyperledger sawtooth integration, blockchain network, physical flow, digital flow and financialflow are shown in the diagram. This concept improves the efficiency of the entire supply chain and ensures a smooth flowof goods fromfarmto customer. The author of this statement has not been identified.

Discussion

When Bepari purchases products from growers, it uploads product data such as harvest time and price. Then an RFID tag is attached to the product, resembling a small computer and containing a unique code. This machine-readable code can be used to track goods through the supply chain. RFID tags help ensure the correct product is delivered and minimize errors. For greater accuracy and efficiency, products can be tracked via the Internet of Things (IOT) during storage and transportation. The IOT helps locate products so that theft and other illegal activities can be quickly detected and eliminated. There is a QR code on the packaging of Aratdar which leads to additional product information. This approach ensures the safety of the products we purchase. Excellent quality and from a reliable source. Thesedata come from a study published in 2019 by BanerjeeS et al.

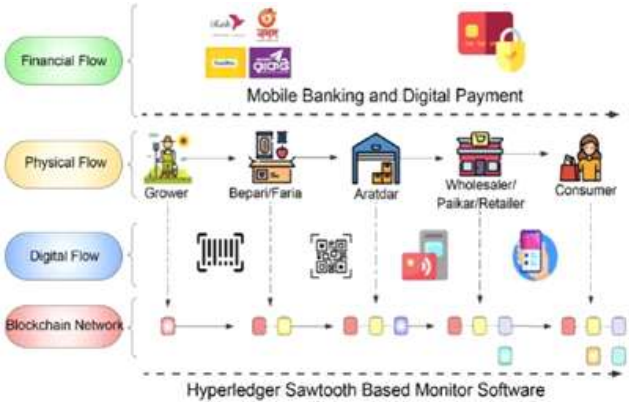

Figure 4 :Hybrid Model ofAgricultural Supply Chain (HASC)Model

The author discusses the role of the company "Aratdar" as a distributor of food products. Once the goods are received by Aratdar, Theyaredeliveredtothe wholesaler retailer,whonotifies the retailer that the food has arrived. The goods are then sold from the store to the customer. The product shipping schedule is clear and orders and promotions are subject tochange. All transactions use digital payments or mobile banking apps such as Bkash, Nagad, Rocket. At each stage of the manufacturing process, each party scans RFIDand updatesblock data stored in the cloud via a mobile app. Block storage is an important cloud feature.

The authors argue that blockchain technology starts working when a genesis block is formed containing the first transaction between producers and Bepari. This step is performed when the genesisblock isinstalled. Customerscan use the smartphone app to scan the product's QR code and get detailed information about the product's age, production location, expiration dates andexpiry dates.

Mobile client, web client, offline repository and application subsystem with REST API are described by Butt,et al. (2020). This subsystem is responsible for creating transactions and batches and sending them to nodes in the Sawtooth networkusing the REST API. You can use the Sawtooth JavaScript SDK to create separate clients for mobile and online platform users. The web client controls client application logic and performs system actions through its interface. Batch and transactional user IDs are verified using the client signature method. User data is stored in offline repositories and can also be used for key management. QR code showing IOT generated data and product related events such as temperature, location, company, certification, raw materials, etc. It can be scanned by a non- member to view product history. The distributed data management platform is provided by the Sawtooth Network.

According to the conceptual paradigm proposed, IOT devices can be used to track production in real time from farm to fork. As a result, supply chain transparency is increased, since all parties always know where the product is at any given time. This data is secured and verified using blockchain technology, ensuring that everyone hasaccesstothesameinformationandthatit cannot be manipulated or tampered with. Digital financial solutions canalso be used to increase accountability and efficiency in payments. This idea was put forward by an anonymous author.

Conclusion

India's economy is heavily dependent on agriculture, but the complexity of supply chains and the frequent involvement of middlemen mean that mistakes are made and consumers and producers suffer. As a solution to this problem, the Hybrid Model of Agricultural Supply Chain (HASC) model is introduced, which uses block chain technology and IOT deployment to improve supply chain security and traceability. . The proposed digitalflow improves productivity, accuracy and accountability by tracking product information in storage and in transit. It is also recommended to use mobile banking and digital payments to streamline financial transactions between supply chain actors. Customers can scan the QR code of the offered system to view the complete product history.

The authors of the study believe it has the potential to grow India's economy by reducing corruption and improving the welfare of consumers, producers and farmers. Farmers and customers experiencing financial difficulties may find this concept very useful. This concept can be used by large Indian agricultural distributors such as Future Retail, D-Mart and Big Bazaartomaketheirsupplychainsmoreu nderstandableand Manageable. This concept has yet to be tested in the real world. For now, it's just a table concept. This research limitation may pose new research questions for other scientists.

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