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Research paper

Artificial intelligence of blockchain in agriculture products quality and safety customers leadership

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Abstract

Because digital technology enhances the effectiveness and transparency of supply chain operations while assisting in the exploration of the value of data in the chain. Digital technology can significantly increase the supply chain's efficiency for agricultural products. Beginning with a study of the road for digital technology to enable the supply chain for agricultural products, the paper then explores the internal mechanisms of digital technology that promote the development of the efficiency of the operation of the supply chain for agricultural products. Several issues in the supply chain for conventional agricultural products, including information asymmetry, uncomfortable communication, and disruptions in production and sales, can be resolved with the help of the research findings. A vital process that involves farmers, purchasers, suppliers, and several other parties is the supply chain. It is the foundation of the entire farming and agricultural system. The supply chain is time-consuming and faces multiple challenges. These days, the two most popular technologies are blockchain and artificial intelligence. The suggestion a blockchain ecosystem with AI capabilities for the agricultural supply chain. To illustrate the potential of the suggested model, a case study is provided. Artificial intelligence has completely changed the supply chain management process. AI is essential to the warehousing process because it helps with information collection, analysis, and inventory management, which helps businesses become more efficient and make more money. AI accurately forecasts demand, changes orders, and reroutes goods while they are in route. Big businesses like Google and Amazon have made significant investments in artificial intelligence. Industries like finance and agriculture have adopted blockchain for traceability, including insurance, natural state, and protecting private data. One such industry where blockchain is being widely used to improve and transform its many facets is agriculture.

Keywords: *Agricultural Products; Artificial Intelligence; Blockchain Technology; Supply Chain.*

1. Introduction

The supply chain for agricultural products still has several issues that limit its ability to operate sustainably, such as lengthy transaction times, unclear information, and a lack of trust between upstream and downstream corporate organizations the use of industry 4.0 technology to optimize the operations of agricultural producers' supply chains, the application of big data analysis to manage supply chain uncertainty, and the potential of blockchain technology to act as a bridge between IoT and big data analysis to guarantee that actual data is shared with supply chain participants are the reasons behind the development of agricultural supply chains that prioritize digital technology. Continuous communication across the supply chain can be ensured using big data analysis and the Internet of Things. Future research should examine how big data technology may be integrated with other digital technologies to increase the supply chain's efficiency. [1]. Domestic research on agricultural product supply chain management began later than studies conducted elsewhere.

2. Literature review

2.1. IoT and machine learning

The study thoroughly examines how blockchain improves supply networks' sustainability. It assesses their social effects and offers insights into practical applications. It also looks at IoT applications that use sensor technology to track assets, monitor conditions, and cut down on waste in supply chains.It gives researchers, legislators, and supply chain professionals useful advice that will help them maximize technology use to create sustainable supply networks. To sum up, this study forecasts the developments in supply chain sustainability through technological integration.The chain management: integration problems, difficulties, opportunities, and uses of blockchain have increased the global supply chain ecosystem's transparency, effectiveness, and trust. The crucial role that blockchain plays in supply chain operations is examined in this chapter, which starts with a review of its fundamental ideas: decentralization, immutability, and cryptographic security. The benefits of blockchain integration are then discussed in detail, including increased traceability, easier transactions, increased transparency, and enhanced cooperation between supply chain participants.

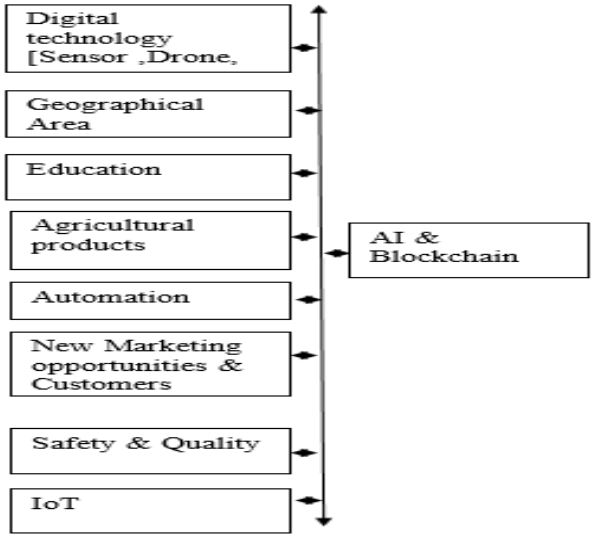

Fig. 1: Block Diagram.

2.2. Blockchain

The broad range of blockchain integration subjects includes decentralized apps, smart contracts, supply chain digitalization, and data privacy. Effective blockchain use across a range of businesses is illustrated by real-world case studies. Additionally, it discusses integration-related topics like pricing, governance, legislation, and technological complexity, offering helpful insights and best practices.The exam examines upcoming topics such as scalability, legal issues, and the integration of artificial intelligence (AI) and the Internet of Things (IoT). It highlights how businesses must adopt blockchain to gain a competitive edge and foster supply chain innovation. For professionals, scholars, and students who want to learn more about and apply blockchain integration in supply chain management, this chapter provides an extensive resource. It approaches the topic holistically, offering real-world examples, case studies, and outlooks on the future to encourage and facilitate businesses' adoption of blockchain technology for supply chain transformation and optimization.

2.3. Farmer adoption

The farmer adoption of IoT in agriculture 4.0: the road to sustainable farming, obstacles, and farmer adoption with a history reaching back to ancient civilizations, Indian agriculture has evolved through ages of varied cultural practices, colonialism, technical development, and modernization. The Internet of Things' integration with contemporary agricultural methods and practices is known as "IoT in agriculture 4.0." This entails transforming conventional farming and agriculture into a more technologically sophisticated, sustainable, and profitable industry. This study examines two crucial facets of IoT in agriculture 4.0: the overall effects of IoT on the agricultural ecosystem and farmer adoption and barriers.

But in recent years, the public's attention has progressively been drawn to it because food safety incidents in India are so common. India's agricultural product supply chain now has a lot of links. The fig1 supply chain's numerous corporate organizations cannot instantly exchange information with one another since it is opaque. The bullwhip effect will result from this. The "bullwhip effect" is primarily caused by asymmetric information between supply chain nodes; demand information is progressively increased upstream along the supply chain [2]. The supply chain's needless inventory rises as a result of upstream nodes' order quantities deviating from real market demand. Batch ordering, price swings, demand prediction adjustment, and inventory management models are some of the causes of the bullwhip effect. Every supply chain node needs to communicate demand data with the others to mitigate the bullwhip effect. One efficient method for achieving information sharing in the supply chain is the use of cutting-edge information technology [3].

3. Agricultural quality and safety

Agricultural products' safety and quality can be successfully ensured by digital technology. Because blockchain technology is permanent and unchangeable, it may significantly enhance the supply chain by delivering goods more quickly and cheaply, encouraging traceability, and guaranteeing the safety and quality of agricultural products across the supply chain. Permanent refers to the fact that every transaction, once confirmed, can always be traced back and that the blockchain always keeps track of the complete transaction history [4]. Users can swap these digital representations or token ownership in the blockchain through a process known as tagging, which creates tangible digital appendages.Blockchain technology is becoming more and more popular as it develops. One interesting use of blockchain technology is the tracking of commodities during manufacturing and delivery. In the food industry, for instance, quality and authenticity may be guaranteed, and shipping and trade requirements can be automatically complied with. Using Walmart as an example, Walmart has more commodities on its blockchain, primarily food, and tracks the movement of goods from producer to retailer to guarantee food safety and quality [5]. The

quality and safety of supply chains for agricultural products can be significantly enhanced with the help of big data and cloud computing technologies. For instance, it can more rapidly locate the source and deliver precise information. Big data technologies can capture every facet of data, from production and processing to distribution along the supply chain for agricultural products. Responsibility can be allocated more clearly and objectively in the event of a safety mishap

4. Agricultural supply chain's efficiency

The efficiency of the supply chain can be greatly increased by digital technologies. Widespread use of digital technology can enhance partner coordination, expand funding sources, encourage precise supply and demand matching, and make it easier for upstream and downstream businesses in the supply chain to engage with one another. At a more fundamental level, digital technology can be damaging, which encourages the restructuring of the political system [6]. The fig 2 foundation of any supply chain relationship is the governance structure, which can foster communication between suppliers and buyers and support their value-creation process in a highly complex and dynamic supply network. Businesses face significant challenges when it comes to changing the governance structure. The two main ways that digital technology increases the supply chain's efficiency for agricultural products are as follows: On the one hand, digital technology can guarantee the legitimacy of information by preventing tampering with the transmission process. For example, the blockchain uses a consensus process based on encryption and verification protocols to ensure the integrity of records stored and shared in decentralized, distributed databases. A centralized system is not the same as a blockchain system. Every node in the blockchain can fully witness every behavior displayed by the other nodes in the system and log these behaviors at its node. The issue of information asymmetry in the supply chain is more effectively resolved because the entire system is transparent for every node. A sophisticated distributed ledger, blockchain offers the following benefits. First, keep track of all legitimate transactions at each node, avoiding the ownership of ledgers by competing entities. Second, proof of work, also known as proof of interest, is the most widely used consensus mechanism based on decentralized voting. It uses the network to self-verify incoming transactions without the need for a reliable middleman. Additionally, this procedure may handle the synchronization process across various supply chain nodes and guarantee the security and integrity of records. Since the supply chain is already being impacted by the digital trend, both academia and industry must comprehend the effects of digital technology. As a crucial component of digital transformation, blockchain improves understanding of supply chain relationships in the context of the digital paradigm. The supply chain's operational guidelines are changing because of digital technologies. However, digital technology can help ensure that supply and demand are precisely aligned. Big data technologies can help with strategic planning for product development, supply chain network architecture, and procurement [7]. Digital technology has the potential to improve demand forecasts, procurement, manufacturing, inventory, and logistics in operational planning [8]. Cloud computing can lessen the "bullwhip effect" and encourage real-time information sharing in the supply chain by storing vast amounts of quickly changing terminal data and performing analysis and calculations at any time. As a result, it can successfully lower the costs of external transactions and raise supply chain effectiveness.

5. Supply chain

Global transactions are currently opaque, and human error, inefficiency, and delays are common during the transaction process. The risk of the supply chain will rise as a result. The supply chain for agricultural products is particularly vulnerable to issues related to quality and safety, including Risks of agricultural product loss and supply and demand mismatches. Supply chain risk can be successfully decreased using digital technology [9]. Digital technology can successfully handle uncertainty and produce accurate predictions, on the one hand [10]. due to the extensive use of big data. Leveraging cloud computing reduces risks and uncertainties by enhancing supply chain planning, demand forecasting, and identifying consumption trends and supply chain bottlenecks. As a result, decisions must be made in a market that is extremely competitive and unstable, which offers a chance to create sustainable supply chains. more resilient to shocks from the outside. On the other hand, digital technology makes it possible to see transactions and inventory, get real-time intelligence, and guarantee that the necessary amount of time is allowed for interruptions. Days of recovery are shortened to hours.

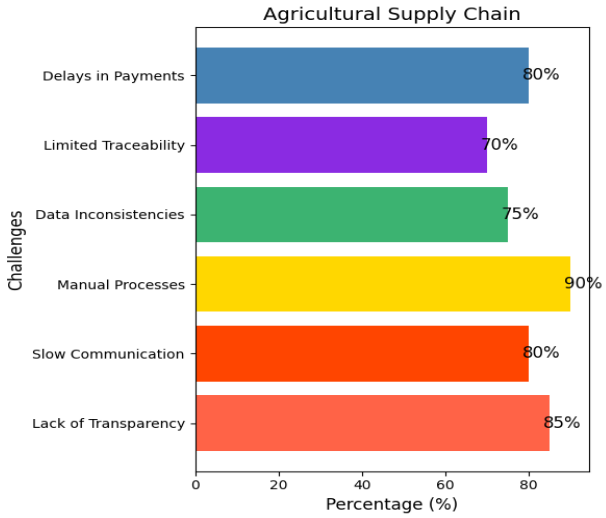

Fig. 2: Agricultural Supply Chain.

Simultaneously, digital technology aids in the ongoing promotion and optimization of supply chain planning and procedures, the reduction of operational silos, the handling of market disruptions, risk mitigation, and company continuity. Digital technology can also be very helpful in locating reliable suppliers and promptly addressing supplier problems. As a result, digital technology efficiently facilitates global supply chain optimization and offers clients services that beyond their expectations. Encouraging the agriculture supply chain to be sustainable Every aspect of the supply chain's triple large bottom line the economics, environment, and society benefits from big data [11]. Big data may help track and monitor businesses' sustainable practices in global multi-layered supply chains, which improves the supply

chain's economy and environment in a win-win scenario [12]. Digital technologies like big data, blockchain, and industry 4.0 often offer chances for a sustainable supply chain's growth, which in turn opens new avenues for supply chain management innovation. Businesses must use big data analysis-driven (information management) techniques to forecast a range of social issues [13]. Big data and industry 4.0-related technologies, for instance, can expedite the food supply chain and offer social welfare to underprivileged populations. Sustainable practices are now essential considering the world's pressing issues, which include inequality, resource depletion, and climate change [14]. An essential instrument for attaining sustainable development is blockchain technology [15]. Blockchain's special capabilities hold great promise for improving and streamlining the sustainability of various sectors and applications. Blockchain features include decentralized networks that promote cooperation, smart contracts that automate traceability, and distributed ledgers that increase transparency [16]. Blockchain can help create a supply chain that is more resilient, efficient, and transparent, which will help us reach sustainable development objectives. Applications of blockchain in sustainable development include supply chain management for agricultural products and food traceability

6. Agricultural product supply chain

For agricultural products, the extensive use of digital technology in the supply chain can have numerous benefits. chain of supply. Achieving information sharing, improving supply chain trust, adding value for customers, and cutting transaction costs are the keyways that digital technology empowers the supply chain. Sharing of information is made possible because transparency is an advantage of digital technology, which makes it possible to share multi-party data information freely. Hash operations, digital signatures, consensus algorithms, smart operations, contracts, and P2P networks are among the fundamental technologies of blockchain that enable the following features of blockchain systems: high reliability, tamper resistance and traceability, transparency and trustworthiness, and privacy and security protection. It can successfully raise the degree of trust between supply chain participants and encourage cooperative efforts in the supply chain for agricultural products, which would lower transaction costs. In the case of timely sales forecasting, it also aids in minimizing inventory waste and saving energy and resources.

7. Exchange of information

Each link in the supply chain, which includes marketing, product development, production, distribution, and up to the customer, is mostly isolated, and there is little information sharing in traditional supply chain management. The separation between supply chain links will be broken by digital technology, which will also establish a fully transparent environment for all parties. Big data analytics, robots, 3D printing, and logistics platforms are some of the critical digital technologies that this ecosystem will depend on. Businesses will be very effective at creating new revenue streams and business models to gain a competitive edge if they digitize their supply chains quickly.On the one hand, the blockchain's transparency feature allows for the open sharing of multi-party data and the collaborative participation of various nodes in the decision-making process. The consensus established by these nodes can guarantee trustworthiness. Transparency and data sharing are encouraged by blockchain, which is permanently preserved and guards against record manipulation. This allows transactions to be carried out in a setting where stakeholders lack personal trust. Hash algorithms, which may achieve information exchange and prevent data tampering, are used to build the blockchain's structure. Many businesses might be extremely inclined to keep this information private, even though doing so will reduce efficiency advantages. However, supply chain operations can benefit greatly from big data predictive analysis (BDPA). Big data may help supply chain participants share information and make decisions together, as well as make more accurate predictions. Supply chain participants can work together to establish sustainable practices with the aid of big data technologies. It promotes the supply chain's ethical behavior. chain nodes through increased openness, which could raise accountability for the industry's longevity and legitimacy. Increase trust in the supply chain cooperation in the supply chain for agricultural products is based on trust. By facilitating appropriate information sharing, digital technology can raise the level of trust among supply chain participants. Mutual supervision and cooperation are both facilitated by a transparent supply chain. Blockchain technology has the potential to significantly increase trust. It can guarantee that actual data is exchanged with supply chain participants by acting as a link between IoT technology and big data analysis. Every trading object in the network is transparent and visible to numerous nodes in the blockchain system, which is a common example of a decentralized system. Consensus techniques determine the ultimate confirmation of transactions and guarantee consistency across all nodes. Blockchain can reduce people's trust distance. Everyone is treated equally in a blockchain network, and all data is tamper-proof, open, transparent, and traceable. Value exchange can be accomplished by anyone, even in the absence of a central organization. With smart contracts, blockchain can accomplish automatic fraud screening and compliance checks. Computerized trading protocols known as "smart contracts" are used to implement the different parts of the contract.In theory, a trusted institution is not needed to carry out the contract because of the entities on the distributed blockchain network of smart contracts. For blockchain networks, smart contracts create a very trustworthy and equitable environment that allows for cooperation between several parties without the need for middlemen. Continuous communication across the supply chain can be ensured using big data analysis and the Internet of Things. Through exact prediction and remote real-time monitoring, such digital technologies can improve mutual trust and information exchange in the supply chain.

8. Customers

Now, supply chains for fig 3 agricultural products are less operationally efficient due to knowledge asymmetry.

Fig. 3: Output of Agriculture Products Quality and Safety for Customers.

On the one hand, the "bullwhip effect" has led to needless inventory and impacted businesses' liquidity; on the other hand, information asymmetry makes the supply chain as a whole less sensitive to changes in the market. By Fig. 4, increasing information transparency between upstream and downstream, digital technology can alter this pattern and add value for customers. For instance, businesses that have a lot of data, but little information, are rich in data. Not much has changed in this circumstance up to this point. Even though managers have put in place several programs targeted at creating data, companies still lack knowledge despite having a lot of data to handle.Since company operations are already complicated, many firms have not yet elevated the data to a strategic level. Businesses must consider customer wants, competitor responses, policy uncertainty, and technological advancements while developing their plans. Numerous innovative concepts, such as carbon neutrality, diversification, social responsibility, new technology, and, of course, data, are vying for resources and attention within the company. Data can be very valuable, as demonstrated by numerous situations, but it can be challenging to determine when it is appropriate. Even though many businesses gather a lot of data for various company operations, it can be challenging to evaluate this data and determine its actual value.

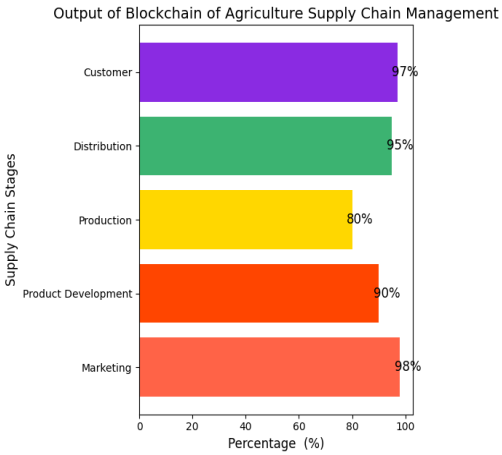

Fig. 4: Output of Blockchain of Agriculture Supply Chain Management.

9. Result and discussion

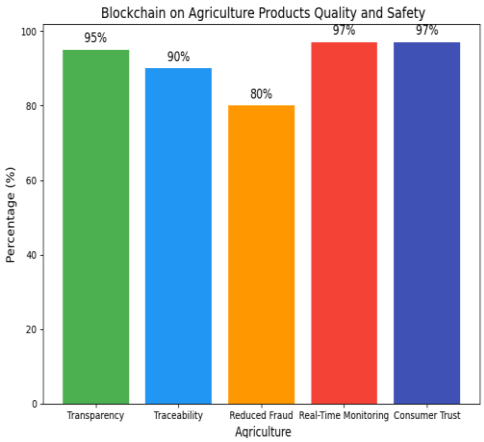

Fig. 5: Blockchain on Agriculture Products Quality and Safety.

Data is still not widely used in company strategy. For businesses to derive value from data, there are six primary value models.Optimization of the process. Strengthening the position of competition.New product development based on improved consumer demand data.Integrating data into goods and services, or informationization.Enhance human potential. Make risk management better. Lower the cost of the transaction. The figure 5 cost of searching for information before signing the contract and the cost of carrying out the contract after signing it

are the two main components of the transaction cost. Transaction costs can be successfully decreased with digital technologies. Businesses can raise their operating revenue by developing and increasing productivity by using big data analysis for cost analysis and raw material procurement. This can raise revenue, lower expenses, and provide new competitive advantages. Big data analysis can increase supply chain decision-making accuracy, reducing risk and increasing yield. Fig 6 and 7,8big data, for instance, saves energy and resources by reducing inventory waste through timely sales forecasting. Big data also aids in achieving the best possible inventory control. Increased cooperation and coordination among supply chain tiers, quicker market reaction, and quicker decision-making. Through distributed accounting and smart contracts, blockchain can efficiently identify trading partners and restrict opportunistic behavior, improving mutual trust and lowering transaction costs.

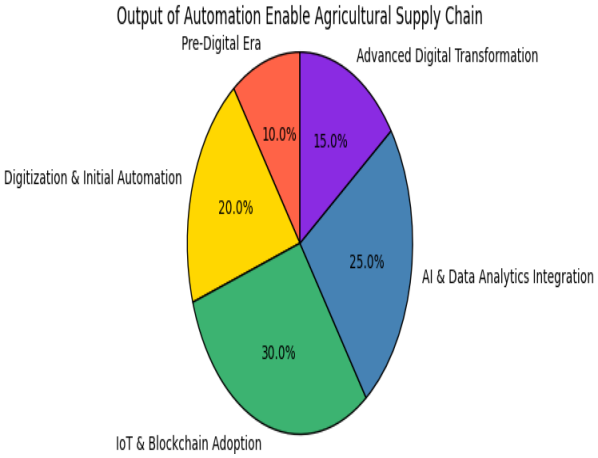

Fig. 6: Output of Automation Enable Agricultural Supply Chain.

Fig. 6 Automation enable agricultural supply chain shows how different technological equipment is used to improve and automate agricultural businesses, which aims to reduce the labor-intensive and time-consuming agricultural operations that farmers worldwide face.AI Overview The agricultural supply chain is an interconnected network of businesses that work together to deliver farm commodities to consumers, to efficiently meet consumer needs in terms of quantity, quality, and price. A smooth transition from fields to customers is guaranteed by the agricultural supply chain, which upholds efficiency and quality at every stage. Every step is essential to turning raw produce into goods that are ready for the market. It all starts with production (farmers and primary producers).

Fig. 7: Cultivation of Agriculture Yield to product.

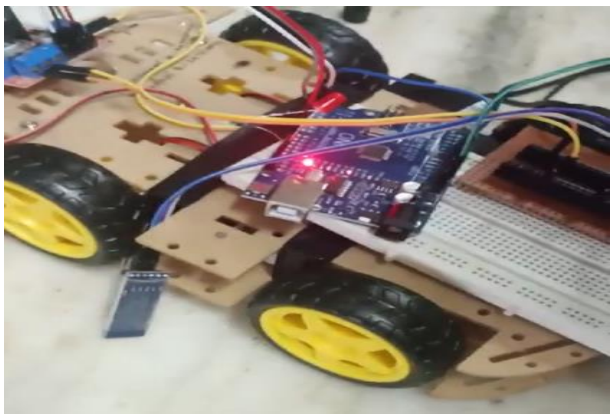

Fig. 8: Automation Kit of Agriculture Quality and Safety.

10. Future directions

AI's role in climate-resilient agriculture. The AI is revolutionizing agriculture through work automation and data-driven insights, it is more likely to supplement rather than completely replace farmers' employment. AI has the potential to increase production, efficiency, and decision-making, but it is unlikely to completely replace human judgment and experience in farming. AI's contribution to climate-resilient farming, precision agriculture driven by AI, provides a viable solution to the dual problems of food security and climate change. AI enables farmers to embrace eco-friendly methods while maintaining livelihoods by optimizing resources, increasing productivity, and fostering resilience

11. Conclusion

Information sharing, lower transaction costs, increased supply chain trust, and customer value creation are just a few of the many benefits of digital technology. The operational effectiveness and transparency of the delivery of agricultural products can be significantly increased by digital technology. chains. First, precise forecasting using digital technology may successfully satisfy customer demand for agricultural goods. Second, digital technology-based supply chain management can successfully lower agricultural product loss during the shipping process. Lastly, digital technology can increase supply chain transparency, which in turn can boost consumer trust in agricultural products' safety and quality. This article goes into detail about supply chain artificial intelligence (AI), supply chain blockchain, and blockchain in agriculture. The agriculture sector, where buyers, sellers, and other stakeholders interact, is the subject of the case study. It has been explained how AI and blockchain work together to manage a safe and reliable environment for a range of application cases. Additionally, we will create a mobile application for this system and make it available to the public

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