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Understanding the supply chain efficiency in e-commerce using the blockchain technology

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Abstract

E-commerce has been revolutionary in it significantly improved customer experiences; however, the integration of Blockchain technologies are transformative in the sense that they are revealing critical weaknesses in global supply chains, in the areas of transparency, traceability, inventory management and fraud prevention. Fragmented data and operational inefficiencies are commonplace in traditional systems. This course is a promising solution for the need to procure an independent, unchangeable ledger through which not only will be increasingly visible, but also more secure, and important - more efficient. This tech is a more secure way to digitize the transport of goods, reducing complexity, speeding up processes with self-executing contracts and improving transparency. Thanks to Blockchain, data integrity is preserved, fraud risk is significantly reduced and demand forecasting is supported, this results in no overstocking, as well as no stockouts. This paper examines how blockchain can be integrated in e-commerce supply chain industry, and how it can contribute to operational efficiency, costing and compliance to transparency and sustainability requirements. In the future, using blockchain with IoT (Internet of Things) and AI (artificial intelligence) will narrow down the time for data collection and predictive analysis and will definitely lead to increased efficiency in every step of supply chain processing. Realizing the full potential to replace existing e-commerce supply chain with more scalable, interoperable, and regulatory-compliant alternatives, thus, solving all problems for this new digital age.

Keywords: Blockchain Technology, Internet of things (IOT), Supply Chain Systems, Data Collection, Data Security, Energy Efficiency, E-commerce, Sustainability.

Introduction

As e-commerce has exploded across the globe, it has also pushed businesses to transform nearly all aspects of their operations, driving customer experiences to an all-time high, but it has also uncovered the many cracks in supply chains around the world, leading to inefficiencies in delivering goods to clients in a timely manner. One is transparency, and overall traceability through the supply chain. Traditional systems make it one of the most challenging tasks to track the nature of goods from source to end consumer, as data is highly fragmented and usually kept inside silos [1]. This lack of visibility can make it hard to verify the authenticity of products and to guarantee that products will perform to pre-set quality standards, which in turn can generate suspicion among consumers of the products, and even stealth and safety problems. E-commerce supply chains also have an inventory management problem, as well. Demand forecasting is often the root cause of overstocking and stockouts, which in turn leads to higher storage fees and sales lost due to stockouts, and countless retailers have faced this issue [2]. These issues are only magnified by the intricacies of logistics and distribution. There are some strong reasons for the problems which include, coordination of multiple carriers and logistics providers, especially for cross border shipping comes with the hassle of managing customs regulations and ensuring timely delivery. These complications can also cause delays and higher costs of operations leading to poor performance on the supply chain efficiency landscape [3].

E-commerce supply chains are confronted by the third challenge of fraud and counterfeiting. E-commerce has many instances of small dollar automated transactions driven by its digital nature making the risk of scams and counterfeit goods easier to carry out than actual brick in addition to mortar businesses. With counterfeiting on the rise, products are

increasingly difficult to ensure quality and safety. This is both detrimental to the brand and also very dangerous for the consumer. Moreover, problems such as data silos and miscommunication between partners in the supply chain only make things worse [4]. Data siloes are present making the attainment of a single source of truth possible, but challenging Poor communication can result in errors, delays, and mismanagement which in turn hampers the operational efficiency of the supply-chain . The other main problem is the significant cost issue related to the operational costs of an e-commerce supply chain. Delivering to the final consumer is perhaps the most costly and complex part of the logistics process, especially in the case of last-mile delivery [5]. This effort is resource-intensive and comes with many inefficiencies that contribute to increasing operating costs. Moreover to this, the operability of the system is exacerbated by the fact that it must continually respond to the dynamics of consumer preferences and market demand. Because current and traditional supply chain systems often aren't flexible or responsive enough to adapt effectively to dynamic factors, it generates additional inefficiencies that can ultimately cost money [6].

E-commerce is significantly bottlenecked when it comes to the challenges and constraints of a logistic and operational nature, not to mention the tensions put on it about being a more sustainable and fairer supply chain in the context of our current social circumstances. As stated by Boston Consulting Group, consumers are asking for transparency about the societal and environmental effect of their purchases. These expectations led to supply chains becoming more than just efficient, meaning supply chain management is more complex due to the added ethics and sustainability dimensions [7]. The complexity of these challenges calls for innovative solutions that unlock accountability, visibility, and efficiency. Blockchain is one of those promising solutions. Whilst blockchain can revolutionize supply chains with a decentralized and immutable ledger that adds far greater transparency and traceability. The technology enables all parties to access the same tamper-proof version of the truth making it easier to keep track of goods and verify their authenticity [8]. For one, blockchain contracts or smart contracts are self-executing contracts in which the terms of the agreement directly written in code, using automation it could replaced much of the need for third-parties, thus reducing the risk of error and fraud while also saving time and cost by automating the supply chain process. Blockchain allows for better data sharing and collaboration among supply chain stakeholders, thus eliminating silos and improving communication. In short, blockchain has the ability to solve these core issues can transform the e-commerce supply chain to make it more efficient, reliable and sustainable, basically establishing a fair-trade world [9].

Table 1: Sector wise Impact of Block Chain Technology [24]

Sector	Autonomous Procedures	Dispersal of Business Models	Asset Traceability	Ability to trace processes	Openness of Procedures	Asset Sharing	Integrity and Trust	Process Automation
Government	9.74	-	-	23.88	5.35	24.17	14.05	1.54
Power & Energy	3.69	4.10	15.54	15.54	1.90	14.05	16.03	11.07
Accounting	0.71	1.41	0.75	21.98	7.95	23.04	10.69	21.84
Industry 4.0	4.12	0.87	4.25	4.86	0.95	11.03	21.12	11.02
Medical	13.47	5.92	6.05	12.46	-	18.11	18.18	4.95
Transportation	10.98	6.78	8.11	8.15	4.03	15.06	15.20	15.06
IT Industry	8.95	1.89	2.18	6.98	0.53	3.99	17.83	9.98

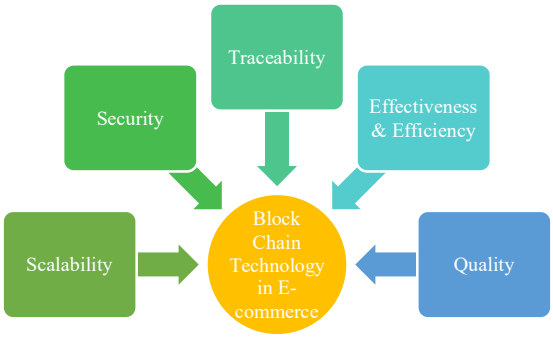

Fig 1:Impact of Blockchain Technology on E-Commerce Supply Chain

1. Features and Fundamentals: Leveraging Blockchain Technologies for Supply Chain Management and Financial Risk Mitigation

With blockchain technology, e-commerce supply chains are evolving to higher levels of transparency, security, and efficiency. Blockchain is at its core a distributed ledger system wherein everyone on a supply chain has access to a synchronised and updated copy of the ledger. This is decentralization in action again, one point of failure is mitigated and control is distributed to all parties, no overseeing authority is required; this ensures data integrity. This transparency brings up the second most important aspect of this system as every transaction is in the open for everyone to see, this gives rise to an immutable, verifiable audit trail [10]. This is especially important in e-commerce since consumers increasingly want to know where and how products come from. Blockchain with its, end-to-end supply chain traceability can be implemented and the authenticity of goods can be determined, which makes it easy to find any bottlenecks or inefficiencies in the supply chain, thus improving the overall reliability and trust. Because the blockchain records are immutable, with the cryptographic hash that is ensuring that once added to the blockchain, the transaction can never be changed or deleted [11].

This makes the data secure, since modifying the data would mean having to proceed with altering all the following blocks, and this is pretty much impossible. This security is essential for e-commerce supply chains where the data is sensitive, and integrity with the information very important. Further, the smart contracts of blockchain (which are computer programs that automatically execute specific contracts term directly written into code), allow various processes such as payment release, order confirmation and proof of compliance automated without the use of intermediaries [12]. This keeps the administration time low, reduces chance of human errors and most importantly speeding up the transactions. Example use-case: A smart contract may be used for automatically releasing payment after delivery and verification of goods, facilitating the financial transaction and avoiding delays in payments. Blockchain even enables better collaboration and data sharing based on its single, shared source of truth, thereby removing data silos and giving all parties a shared view of the truth [13]. Boosted data sharing helps organisations to co-ordinate and make decisions better, enabling them to more accurately control inventory, predict demand and react to market trends. Visibility of inventory data in real time throughout the supply chain can help avoid both overstocking and stockouts, operationalizing inventory management and saving the company some dollars [14].

Blockchain prevents middlemen while it also reduces the amount of paperwork and automation of procedures can help in cutting a lot of costs and improving efficiency in the supply chains. The improved transparency and streamlined procedures would lead to lesser manual reconciliations and audits and thus fewer time and money costs. Blockchain, also assists the transfer in real-time extremely accurate data that do not only reduce latency but also the entire chain speed [15]. Blockchain technology is also a potential solution for sustainability and ethical sourcing, both of which are increasingly important to the world and what they purchase. Verifiable origin and manufacturing are among the other benefits that blockchain has to offer to supply chains in offering proof to the sustainability and ethical chain of practices. Blockchains can track and record the origin and journey of sustainably sourced materials, verifying they meet environmental standards and providing consumers with the knowledge that their goods are not only vegan but also ethically produced [16].

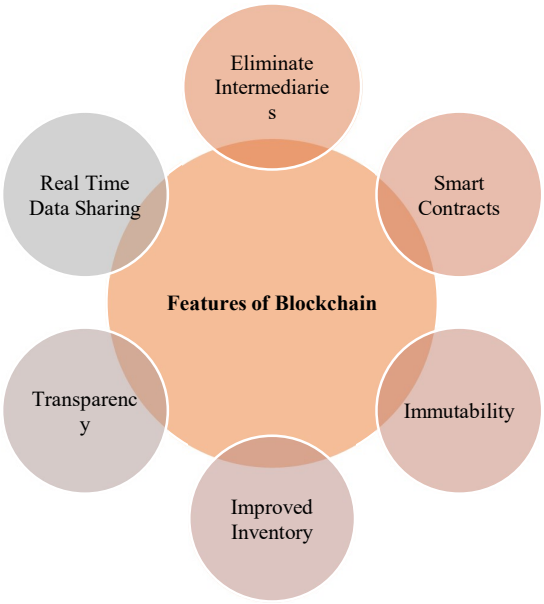

Fig 2:Features of Blockchain Technology in E-Commerce Supply Chain

3. The Future Prospects and Implementation of Blockchain Technology in Supply Chain of E-Commerce and Beyond

In the future blockchain technology is also considered to be revolutionary in the scale of importance for efficiency in e-commerce, thus affecting a diverse selection of industries. Blockchain is an area where supply chains are perhaps most likely to experience the effects of technology as long as adoption remains high. A main focus for the future is a higher grade of transparency and traceability in the supply chain. As a decentralized and immutable ledger, blockchain technology allows goods and services to be tracked in real time from the producer to the end consumer, ensuring transparency and visibility throughout the entire supply chain ecosystem [17]. Such transparency aids in not only confirming that what is being offered is genuine, but also in discovering and eliminating waste, cutting delays, and ensuring compliance with regulation. In addition to the growing demand for these products among consumers, there is growing need within the business sector for reliable, tangible proof of the sustainability of products; this is something blockchain technology can readily provide by recording everything from the origin of the product to the way it was produced [18].

Another feature to look out for is the automation of numerous supply chain processes through smart contracts, thereby cutting the intermediaries from the network. Smart contracts remove the need for intermediary payment processors, compliance checks, and any other costs associated with the formalisation of agreements between parties, thus significantly reducing administrative overhead. The more smart contract technology gets better the more it can anticipate the efficiency in running supply chains automatically which will result in displaying faster transactions, and better collaborations between parties involved [19]. Beyond- that, the use of blockchain technology could essentially redefine the way in which imports and exports are conducted across borders by uncomplicating the customs process and reducing paperwork. Due to the unchangeable, transparent nature of blockchain records, documentation processes are streamlined, mistakes are reduced, and regulatory compliance is guaranteed, which speeds up the movement of goods between regions. As a result,

businesses could save a lot of money on transportation and delivery times for consumers would be much faster than it is today, thus improving the effectiveness of global supply chains [20].

Beyond the operational, blockchain technology also has risk management and broader supply chain resilience applications. Blockchain's decentralized data storage prevents a single point of failure, making your supply chain resistant to many forms of disruption such as natural disasters, political uncertainty, or cyber attacks. With its control decentralization and data integrity, there are risks that blockchain could help alleviate as well as business continuity in the face of the unanticipated [21]. Aside from the foreseeable future, the conjunction of blockchain technology and new technologies from the Internet of Things (IoT), Artificial Intelligence (AI) is a different horizon of promises for the fine-tuning of the Supply Chain in e-commerce. Real-time data of product location, temperature and other parameters will be obtained using IoT sensors, and the data will be written into the blockchain to create a full record of product history, which will be secured and cannot be altered. The data generated can be analyzed by AI algorithms to recognize patterns, forecast demand and improve supply chain practices, resulting in greater efficiency and lower costs [22].

Table 2: The emergence of blockchain in the future. [23]

Blockchain Features	Reactions (in percentage %)
Accountability and Insights	20 (84.60%)
Decentralization and Reliability	18 (73.79%)
Safety and Confirmation	14 (63.70%)
Worldwide Network	16 (64.75%)
Permanent Records	11 (48.65%)
Additional Benefits	6 (26.68%)

4. Conclusion

Blockchain stands to streamline the supply chain, though its speed bump issues include: scalability issues, interoperability issues, and regulatory concerns. But with enough blockchain maturity, it could even see supply chain efficiency improve drastically once IoT and AI come into play. Better demand forecasting, improved utilization and efficiency, cost savings etc., can be embraced with blockchain by making real-time data capturing and predictive analytics more efficient. As companies and consumers value transparency and sustainability, blockchain is poised to disrupt e-commerce supply chains making them more sustainable and performing in this new economy. Blockchain technology offers a great means to combat some of the most pressing inefficiencies provided by e-commerce supply chains, such as minimal transparency, the inefficiencies relating to inventory management, and the presence of fraud. A proven, decentralized, immutable record preserves the integrity of data and creates trust among interested parties thanks to a demonstrable audit trail. They serve to automate processes without intermediaries and basically help to cut costs on bureaucratic expenses. The versatile uses of the technology with metrics associated such as providing a means for proving that are ethically sourced and eco-friendly. So, this paper affirms that blockchain technology can improve the e-commerce supply chain and do it better than talking about it. Blockchain is prepared and able to answer the call for transparency and sustainability from businesses and consumers alike, meaning the transformation of supply chains to match the tech-driven requirements of this era.

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