

Original Article

Blockchain: Transforming Supply Chain Management Amidst Covid-19

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Abstract - The COVID-19 outbreak has affected many supply chain segments and highlighted the importance of building a single-source Blockchain-based pandemic patient records management system to solve several current and future difficulties. Blockchains, crucially, provide a plug-and-play form of interconnectivity that may act as a foundation for many other enabling technologies facilitating the implementation of artificial intelligence for demanding healthcare services. The formation of this literature allows us to discover various new research concerns and conceptual frameworks. Blockchain-based technologies are being developed to combat this COVID-19 outbreak by using authentication techniques and methods for contact tracing and a system for sharing data, transferring information, and application interface for research purposes. Supply chain management, including an important concept of Logistics for smooth supply of medications, emergency aid, and a potential vaccine, can be effectively planned using blockchain technology. In this paper, several studies have been undertaken on the mentioned topic because the need for a comprehensive review study that identifies the gaps and limitations of existing research and possibilities and objectives for future research is significant in this new normal.

Keywords - Blockchain, COVID-19, Healthcare applications, Logistics, Supply chain management.

1. Introduction

A supply chain is a whole system of creating and distributing a product or service, starting from acquiring raw materials through the ultimate delivery of goods or services to the end-users. The supply chain monitors all parts of the manufacturing process, including the actions that take place at each level, information that is transferred between, natural wealth that is converted into usable commodities, human capital, as well as other elements that go into the making of the final product or service. One of the most important aspects of Supply Chain Management is its traceability, or the capacity to make prompt and fast judgments as firms require precise and on-time/real-time information regarding stocks, in-transit flows of physical goods, and many other things to support the proper decisions and smooth flow of supply chain operations. Information and communications technology (ICTs) has advanced quickly in recent years, allowing businesses to access, receive, and analyze data more quickly and easily, allowing them to make more prompt choices and forecast customer requests, behavior, and subsequent operations, enhancing the overall business operation [1]. Whereas, Logistics management can be termed as the process of efficiently managing the procurement, movement, and storage of materials, parts, and finished inventory through an organization's marketing channels to improve immediate and long-term profits by being efficient

in budget handling and inventory management. The Logistics Management Council has given a much more accurate definition as Logistics is a part of the supply chain management framework that intends, administers, and also safeguards the overall flow of material and transportation to be effective and efficient in assistance and related information from the point of procurement to the point of consumption to meet the needs of consumers. Conceptually, supply chain and logistics management are different and are meant to perform different functions. The supply chain is a much wider concept, including logistics management, Customer Relationship Management, Product Development, and Commercialization [2]. Logistics management aids the supply chain for a smooth run. It manages all the logistics activity in a supply chain. But at the same time, it is important to note that all logistical actions in Logistics management must be planned, coordinated, and controlled while considering the remaining supply chain aspects.

During this time of turbulence and advancement, supply chain management is not quite efficient in maintaining and running the business world. A large inventory scale can lead to delays and defaults in goods delivery, among other things. Furthermore, to satisfy all of the demands of retailers, major distributors require a significant number of workers. It might cause significant interruptions in processing orders and



increase the risk of delayed orders and lost data. Companies have digitized all of their operations to overcome this challenge, resulting in a huge surge in firms and intermediaries in the logistics system. However, as the volume of digital data grows and Internet firms expand, the risk of cyber-attacks on their databases also grows. Hackers may want to change, steal, or remove information. Hence, some newer and advanced technology is needed that will not only help to strengthen the supply chain but also increase its efficiency [3]. The answer to the above question is blockchain technology. Blockchain technology has made its way into the realm of the supply chain to allow for more efficient and secure transactions. It can change how the product is made, sold, brought, and consumed. Faster purchase order execution can be achieved, simpler invoice processing can be executed, less time is needed for payment reconciliation, and eliminating counterfeit or lost items are only a fraction of Blockchain's countless advantages for managing the supply chain. Contracts between parties may be created digitally and automatically, removing the need for enormous documentation, inaccuracies, delays, and fraud concerns [4]. Using the Blockchain, the significant economic value may be achieved by boosting transparency, decreasing risks, and improving overall supply chain management. It helps build trust and a sense of loyalty seeded in the end-users for the brand and business moguls. But in the last two years, the scenario of Blockchain and its implementation in supply chain management has significantly changed due to the global pandemic caused by coronaviruses which are RNA viruses that trigger sickness in the cardiovascular system and are members of the Coronaviridae family's Nidovirales order. Due to the fast transmission of the deadly virus and no known treatment to cure patients, governments worldwide were forced to shut down its border and any activities that could further transmit the virus. Hence the supply chain was disrupted, causing a massive loss in inventory or a huge hike in the general price level of the normal goods affecting millions and millions of lives dwelling on earth. This paper discusses the COVID-19 outbreak, how it has affected the supply chain and logistics management system, and how blockchain technology can eradicate the problem.

2. Covid-19 Outbreak and Its Effect on Supply Chain and Logistics

COVID-19 was officially classed as the very first coronavirus pandemic by the World Health Organization on March 11, 2020. Coronaviruses are RNA viruses that trigger sickness in the cardiovascular system and are members of the Coronaviridae family's Nidovirales order. Camels, bats, and other animals are regularly infected with this virus. Occasionally, a phenomenon known as "species jump" or "cross-species transmission" happens, in which animal viruses evolve the ability to infect humans as a result of their development. COVID 19 is a one-of-a-kind pandemic. It has had significantly more severe, diverse, and dynamic effects

than earlier pandemic outbreaks like the SARS epidemic in 2003 or the H1N1 epidemic in 2009. Overcrowding health facilities is inevitably a big issue produced by such an accelerating contagion: bed accessibility (or lack thereof) is a key necessity not only for ongoing and prospective COVID-19 patients but also for the rest of the people affected by unrelated illnesses [5]. It has not only impacted the lives of humans in one way but uncountable ways; one such way is disruptions of the supply chain on a global basis which have inflicted inflation in many countries and more in the future. Thousands of lives are surrounded by this sector, and the lockdown has only weakened their financial status making it difficult to survive in such a turbulent nature. Covid-19 has had a major influence on society, not just in terms of social issues but also in terms of economic and political ramifications in many nations throughout the world. Many communities adopted social separation as the norm, while many governments imposed 14-day quarantine periods on visitors from other countries. In addition, many enterprises have closed or filed for bankruptcy due to regulated curfews, quarantines, and social alienation. As a result of these safeguards, several sectors have seen significant disruptions in their day-to-day operations due to the reduced intake of consumers that would ordinarily support their enterprises [6]. Fortune had released an article stating that "COVID-19 has caused supply chain disruptions in 94 percent of Fortune 1000 organizations," as well as "75 percent of enterprises have had severe or highly unfavorable impacts on their operations," and "55 percent of corporations forecasted a reduce in their growth outlooks." COVID-19 has had a tremendous influence on the aviation industry's functionality across the world. It has deteriorated the aviation industry's supply chain and the sectors that surround and rely on it. When discussing the airline business, people primarily refer to the transportation of passengers from one location to another. On the other hand, the cargo sector is a substantial section of the airline business that is often neglected. The majority of commodities are delivered by air in today's economy, which the worldwide pandemic has significantly influenced. Hampering other nodes of the supply chain.

In the pharmaceutical industry, supply chains are tough to come by because a result of the pandemic, which is affecting all nodes (supply chain members) and edges (ties) in a supply chain [7]. The supply chain (SC) has had major problems dealing with unanticipated demand for certain products as the simultaneous travel ban, production restrictions and acquiring of raw materials, and human resource restrictions were imposed on it [8], which further delayed the supply of pharmaceutical components that created a shortage of products in many countries which stimulated the creation of black market and distress outcry among the common person until the government was forced to bring some policy which helped the common person and also the supply chain management system. Due to subsequent lockdowns, travels ban, and restrictions, the

supply chain's flow has been significantly disturbed. The demand for essential commodities like personal protective equipment kits (PPE), ventilators, and dry and tinned meals, among others, has risen over time. Meanwhile, sourcing, transit, and production confront a series of issues limiting their capabilities. Border closures, supply market lockdowns, automobile and international commerce disruptions, labor shortages, and preserving physical distance in industrial facilities slow down the supply chain [9]. In the meantime, the closure of national borders has triggered a cascade of events that significantly influenced the logistics industry. Means of transportation and courier services, for example, have grown less bound by traditional conventions and are more open to alternative business models and methods. Businesses are adjusting to the new circumstances, and there will likely be alterations that will affect the rest even after the pandemic has settled.

The entire supply chain profitability is maximized when lead times are reduced at any stage of the supply chain. The time is taken from the point a sales order is placed for a supplier until the items are transported from that seller to the buyer is referred to as a lead time. Lead time is a pivotal component of logistics management and the supply chain [10]. As a result, reducing lead times may be considered a long-term investment for any company or supply chain. But during the pandemic, the uncertainty of the lead time and lower demand for certain goods have adversely affected the supply chain.

Employees must be fully engaged in the activities of an organization for it to perform at its full potential. It is particularly challenging during the present epidemic since new legislation, and health and safety restrictions limit the ability to undertake any meaningful labor. Staff either are cut off or given fewer hours to perform the same type of job that they would be expected to complete under normal conditions. With a smaller staff, continuous work might lengthen the time it takes to complete tasks, increasing the chances of unexpected outcomes. In a logistics firm, where there is a lot of reliance on social interaction to ensure sustainability and clarity across the supply chain, a decline in the workforce and the unpredictability is a perpetual storm over today's organizations in this fragile industry atmosphere might be exacerbated by delayed job management leading to a lack of said human resources. Even small chores that need only a short amount of time might take significantly longer to do in some circumstances due to social distance and health and safety concerns [6].

3. Problem Statement

COVID-19 has demonstrated that typical supply chains are still not necessarily resilient or adaptive enough to withstand a pandemic or other large-scale catastrophe. Many organizations had severe supply chain disruptions during the

pandemic, probably most notably in the healthcare industry, which was impacted by shortages of critical healthcare resources. In COVID-19 pandemic management, data verification and validity are critical for public conclusions and recommendations based on recorded or published data statistics. Supply chain operations in logistic management are disrupted across different businesses. Moreover, online buying behaviors in countries like India, China, and Vietnam, have expanded by more than 50% over the COVID-19 period, making supply chain processes vulnerable to manipulation, cyberattacks, and theft. Consequently, corporations failed to resolve provenance concerns or do thorough research on new suppliers to manage ongoing supply chain-related problems. Thus, transparency and data security are crucial for the widespread adoption of technology [11].

4. How Blockchain can be used to Support the Emergence

Technological advancement is one of the most important considerations in overcoming the obstacles provided by the COVID-19 pandemic. The Internet of Things (IoT), machine learning (ML), artificial intelligence (AI), Blockchain, robotics, 3D printing, nanotechnology, synthetic biology, crewless aerial vehicles (UAVs), 5G communications, cloud and edge computing, and big data can all be used to develop effective COVID-19 pandemic response strategies. Furthermore, the European Parliamentary Research Service has named blockchain technology one of the top ten critical technologies to combat COVID-19 [5]. The application of blockchain technology in several industries, such as financial, banking, insurance, commercial, and agri-food, for the reorganization of certain processes is highlighted in this literature [12-14].

Blockchain is a decentralized system with unique characteristics such as built-in impermeable data architecture, secrecy, and crypto-security software [15]. The cryptographic framework is utilized to authenticate and validate users from the available database of members, which makes the overall decentralized blockchain infrastructure protected and secure. This system comprises a peer-to-peer (P2P) computing network that collectively analyses the transactions inside this distributed network [16]. Blockchain is a novel system that involves digital information and can increase transparency, immutability, anonymity, and decentralized management [17]. A blockchain is a transaction ledger in which all participants of a computer system may see an exact copy. In the health sector, transactions, including purchasing and transporting operations in supply chains for medical instruments and pharmaceuticals and tracking access permissions of personnel to infrastructures, medical history, and other health data, may require transparent and irreversible record keeping.

Data like a sales record of transactions or a health record is maintained in blocks on a blockchain.

During a pandemic like the present one, Blockchain implemented in the health sector might provide new and effective options to enhance numerous activities linked with the prevention and management of diseases and, as a result, improve clinical risk management. When all of the data for a block is input, it is added to the chain from the previous layer, and a new block is produced for the next data entry. Blockchains are decentralized networks with infinite members, such as a global network of medical equipment providers and buyers. Every blockchain member has a complete copy of the ledger, which is updated and synchronized when new blocks are added. The COVID 19 outbreak has prompted large-scale data collaboration and administration. These data are frequently sensitive, yet they must be easily verified and openly handled [18, 19]. Unfortunately, if these data processing platforms provide central authorities complete access to the data, serious privacy problems may arise, which might be counterproductive [20, 21]. Second, the establishment of health and vaccination certificates may be required to undertake quick, broad testing and vaccination programs. For cross-verification confirmation of COVID-negative or immunity systems status, the blockchain framework system would provide a safe and decentralized environment [22-24]. As explained, Blockchain is a mechanism for exchanging value without using an intermediary via the internet. By default, of its architecture and design, Blockchain provides several intrinsic benefits that the market has been yearning for a long time. Because of its distributed nature, Blockchain provides a high level of processing transparency, reducing the necessity of manual verification and authorization.

People, systems, knowledge, and procedures are part of the supply chain management equation. It's tough to view all interactions within a broad supply chain comprehensively. This information is often maintained in several systems only available to select supply chain participants. Integration of the supply chain is becoming more dynamic. Blockchain technology supports supply chains in the delivery of source, process, and goods, a significant advancement. The introduction of Blockchain should speed up the process while also improving the robustness and reliability of transactional data. Rather than confining a supply network to a single place, using several Blockchains will enable global manufacturing chains to be visible from afar. The previously hidden dimensions from the elaborate system of merchants, dealers, shippers, warehouses, and suppliers involved in design, manufacture, delivery, and sales will become visible [25]. Blockchain technology aids in the selection of a better delivery route for a product. So that a company's freight costs can be reduced. In addition to the services mentioned earlier, Blockchain also provides a consumer brokerage service. Consumer authorization, logistics, export operation, export

licensing aid, timely shipping, warehouse management, electronic data interchange potential, preferred production, consignments preparation, traffic control, merchandise restoration, improvement of products, merchandise labeling, item arrangement, delivery service as well as distribution, abroad procurement, abroad allocation, order tracking, online booking as well as handling, stock control and return of goods [26]. The continuing pandemic is wreaking havoc on the global supply chain, with manufacturers unable to cope with the closure due to additional measures like physical interaction and social distance. As a result, the worldwide supply chain has been banned from importing and exporting. Because of the increasing demand, pharmaceutical industry supply chains are tough to obtain.

Furthermore, domestic supply chains have seen a significant increase in demand. Blockchain is one of the greatest solutions for controlling the supply chain. First, it can link all stakeholders through a decentralized universal network, and it can safely reveal the data of the silos due to its property transparency. Numerous blockchain systems in the supply chain management industries are undergoing adaptation. In any sector or application, blockchain technology enables rapid data handling, decreases processing time, and lowers risk in operations [15].

The capacity to quickly locate persons who have already been connected to an infected individual is a powerful public health approach for a highly contagious illness like COVID-19 since it can limit the infection's transmission. Even as the number of COVID-19 case scenarios keeps rising and outbreaks occur worldwide, it is becoming clear that social isolation and lockdown restrictions cannot be continued forever. Lockdown compliance has also proven difficult to implement in many circumstances, involving intimidation and major resource investment [27]. To restore some sense of normalcy, managing diseases individually and taking measures in confined areas at risk of transmission will be necessary. In this case, contact tracing using Blockchain is a useful technique [18, 28]. Ever since the beginning of this pandemic, numerous states belonging to the United States and nations worldwide have quickly developed and deployed contact-based tracking applications with inconsistent outcomes. Symptom-tracking applications were developed to help and guide patients in estimating their liability of getting infected by COVID-19 and their probable need for diagnosis, even though public healthcare delivery approaches were heavily burdened with screening and treatment commitments. To organize those treatment procedures, almost all these applications require updates or data exchange over several public health services and other health care authorities. Due to inadequate testing facilities, only those having symptoms were instructed to get examined. But unfortunately, there can be concerns relating to security and privacy, which may restrict such techniques from being applied in different regions worldwide [29-31]. Public health

authorities have traditionally utilized contact tracers, who offer this information to possible contacts via mail or phone and ask them to get tested. This strategy can work when such numbers are not as massive as in the COVID-19 pandemic. Because of the relative ease of android app development and widespread availability of mobile phones, contact tracking for COVID-19 was just an obvious public health choice. As an approach to healthcare, countries including Norway, South Korea, China, Singapore, Germany, and Qatar have also created, promoted, or mandated the use of contact tracking applications. Contact tracking has been accomplished using various technologies, including a Global positioning system, Bluetooth, Wi-Fi, and quick response (QR) codes, all of which are incorporated into mobile phone platforms. Citizens and advocacy groups soon worried about data protection, confidentiality, and security [32]. However, the necessity of contact tracing and infection control through identifying those at risk has not diminished. This circumstance is where blockchain technology's trustless system might give viable solutions for balancing public health demands with privacy concerns [33]. Utilizing the technological framework of both public and private keys, Blockchain allows data to be obtained from individuals without identifying them [34]. Because of privacy protection and data security, a blockchain-integrated contact monitoring application maintains confidentiality while permitting health care organizations to approach anyone who may be exposed to SARS-CoV-2. This virus can end up causing COVID-19 [30].

5. Conclusion

Blockchain undeniably is one of the emerging technologies with vast potential. At the time of its emergence, the potential of Blockchain has been understood and used to maximum capacity. Covid-19 caused havoc in every livelihood sector, but with the use of Blockchain, the adverse effect was reduced to a limited level. Blockchain applications might be used to reduce network latency by providing a secure framework for collecting, storing, and transmitting sensitive data. The current integration of Blockchain with other emerging technologies like Big Data, AI, and Cloud computing might effectively control deadly illnesses and supply chain management. Blockchain plays an important role in sustaining the supply chain. All supply chain components could be connected through Blockchain, making data more secure, traceable, and organized. Blockchain technology best suits transactions with a small digital footprint and benefits from transparency and immutability. It can become particularly beneficial in the health industry for identity verification, managing pharmaceutical industry supply chains, and maintaining dynamic patient consent, data sharing, and access permissions. All parties, including customers, manufacturers, and delivery providers, mostly benefitted from this during the pandemic, mainly in supply chain and logistics management.

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