The Applications of Blockchain and Artificial Intelligence in Logistics

Gabriela Călinescu[1]

Abstract

There are many advantages to using the technologies of blockchain and artificial intelligence in businesses. Since computers and other machines were created, their capacity to carry out a variety of activities has increased tremendously in recent years. In several fields of employment, people have created robust computer systems that speed up processes and cut down on the amount of time needed to complete a task. The aim of this paper is to demonstrate how relying on blockchain and artificial intelligence for logistic processes can greatly improve their efficiency. In order to achieve this purpose, analyses were conducted on academic writings and research done by various authors and specialists. Moreover, the method of the case study was used. The results show that, in the logistics sector, blockchain technology and artificial intelligence have several potential advantages and uses, including traceability, transparency, smart contracts, authenticity verification, freight tracking, and cybersecurity. However, there is still confusion and skepticism regarding the use of these new technologies.

Keywords: Artificial Intellligence, Blockchain, Logistics

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1. Introduction

For conventional businesses to compete in the age of the digital economy, company activities must be digitalized. In this sense, implementing cutting-edge technologies like blockchain technology and artificial intelligence, along with the growth and maturity of pertinent digital capabilities and skills is essential for the digital transformation of companies.

By utilizing the technological capabilities of cutting-edge technology applications, digitalization is also anticipated to revolutionize whole supply chain processes. Despite the operational benefits connected to the use of digital technology, their overall impact has gone unnoticed due to a lack of empirical data.

The objective of this paper is to demonstrate how relying on blockchain and artificial intelligence for logistic processes can greatly improve their efficiency.

[1] PhD candidate, Bucharest University of Economic Studies, Bucharest, Romania; gabrielacalinescu07@gmail.com

2. Literature Review

In a broader sense, the term "logistics" refers to the act of organizing and transporting resources, such as people, goods, inventories, and equipment, from one site to storage at the intended location.

Logistics has a considerable amount of trapped value, which is mostly caused by the fragmented and competitive character of the logistics business.

Artificial intelligence is the imitation of human intelligence of computers intended to think and mimic human conduct and it usually improves every process, making it faster and more accurate.

Blockchain is a technology that allows users to access a distributed and decentralized digital ledger to store non-modifiable data. It's a fundamental technology with a wide range of applications.

With the development of bitcoin, the first recognized application of blockchain was in the financial industry. Other areas, on the other hand, stand out. Blockchain technology is already being used in logistics and the insurance industry, among other sectors (Blockchain in logistics, 2021).

The supply chain may benefit from both artificial intelligence and blockchain technology by increasing data security, doubling data efficiency, and making more informed choices (Banerjee, Lee & Choo, 2018).

Many parties are engaged in logistics when it comes to moving raw materials or finished goods to clients. To ensure transaction reliability, all logistical transactions are conducted using numerous papers. Work is done in global trade using conventional trade paperwork; however, in face-to-face exchanges, there are typically no trust difficulties because the buyer pays after seeing the goods.

Given the fact that worldwide commerce transactions are primarily based on paperwork, the risk is typically substantial because one does not know if the other party will provide the goods or if the importer will pay. Furthermore, in the event of global trade, when documentation verifying product quality is essential, there is a risk that these documents may be tampered with or fabricated (Thistlethwaite, 2018).

Unless one contacts or sends an email, one also has no means of knowing what tasks or procedures the other person is working on in real time. Blockchain technology, on the other hand, establishes a trustworthy environment by ensuring that transaction data on blocks is resistant to falsification or manipulation.

Moreover, through a public ledger system that tracks the movements of each shipping container, blockchain can help logistics businesses become more efficient.

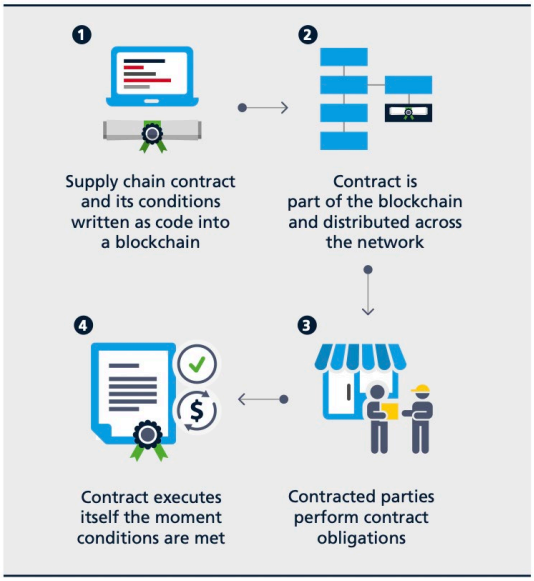
Companies may use this information to develop faster delivery routes and reduce superfluous stages in the process.

The applications of blockchain technology for supply chain operations extend beyond manufacturing firms to include the most important government sectors as well as those in the healthcare, retail, banking, media and entertainment, agriculture, law, and fintech start-ups. Inventory management, demand forecasting, asset monitoring, and intellectual property storage are some of the additional features of blockchain that are utilized to increase the agility of supply chain operations (Nawari and Ravindran, 2019).

The other area where several businesses or suppliers are involved is real estate. Construction businesses find it challenging to follow the whole process and lifetime of each supplier and distributor. The real estate sector may benefit greatly from blockchain and its integration with other technologies to create a fully decentralized system (Wang, Wu, Wang & Shou, 2017).

Bottlenecks and clerical mistakes are also reduced with distributed and decentralized ledgers. Retailers no longer require brokerages, attorneys, or other third parties to execute activities thanks to smart contracts.

Smart contracts allow merchants and logistics organizations to enter into legally enforceable agreements that will terminate promptly if all agreed-upon conditions are not satisfied. These ledger-based contracts improve transparency and revenues while shortening delivery times and reducing expensive mistakes.



Source: DHL

The logistics industry is in desperate need of a technology upgrade, and a distributed ledger is the next big thing, due to its transparent records, lower prices, and accurate route information. Blockchain, when combined with upcoming technologies such as big data and artificial intelligence, has the potential to boost global GDP by 5% (Daley, 2022).

According to a recent research (Hackett, 2021) in which IBM and Maersk conducted an experiment where they traced a flower-filled shipping container from Mombasa, Kenya, to Rotterdam, the Netherlands' largest port, it was found out that this single refrigerated cargo went through 30+ entities and required 200+ unique conversations. Any hitch in these procedures might result in the container being delayed or lost. All of these actions may be recorded safely and immutably in real time using blockchain.

One of the key challenges that logistics is presently experiencing is the widespread introduction of counterfeit items into the market without being detected. Recognizing and eliminating counterfeiting is a massive task when there are so many people involved in the logistics chain (How blockchain, smart tags are tackling counterfeit goods, n.d.).

Freight tracking is an important part of the supply chain. The transportation of merchandise accounts for a large portion of operating expenditures for businesses. However, accurately monitoring items in real time is a difficult operation. Blockchain-based live tracking systems give the whole supply chain visibility into all ongoing transportation activities and send out warnings as soon as a cargo is delayed (Case study: IOT and blockchain-based real-time location tracking system, 2019).

Breaching a centralized network with a single server, tampering with data, and influencing audits is a challenging operation for determined hackers, but it is feasible. Once records have been hacked, they are vulnerable to fabrication, alteration, and illegal access. To provide a high degree of network security, blockchain-based decentralized networks spread the digital ledger among numerous servers of authorized stakeholders.

Organizations may take into consideration using artificial intelligence-driven data analytics to offer valuable information about fleet maintenance schedules, car sensors, bad weather, and gasoline prices. This would help businesses lower their logistics costs by providing drivers with crucial data points that would help them move more effectively (Dorota-Owczarek, 2022).

Moreover, the importer may have 100% confidence from artificial intelligence that they are receiving exactly what they anticipated.

For instance, artificial intelligence systems can carefully watch the loading of freight, keeping an eye out for items that might be fragile or that are very expensive.

Pre-shipment inspections can (and often do) happen on the importer's end, but they seldom ensure that the goods placed into the containers are the ones that have undergone the inspection. After an inspection, the supplier, for instance, can swap the products.

Implementing container loading monitoring helps hold suppliers accountable if there is a lack of confidence between the parties.

Artificial intelligence is being used in the transportation sector to swiftly and precisely detect flaws discovered during container load monitoring. The technology can identify, for example, the following common flaws: discarded carton boxes, splintered wooden pallets, incorrect stacking of pallets, uninspected parcels (AI in transportation: 9 disruptive use cases, 2020).

Artificial intelligence software uses image processing and machine learning to determine how products should seem before automatically giving a warning when anything is wrong.

Items that are damaged might also be caused by poor packing. Products have a lower chance of being damaged during supply chain activities if they are correctly wrapped.

When items are properly packaged, they are handled with care, especially during loading and unloading. As a result, the customer experience is enhanced, and there are also (among other things) less returns.

Using artificial intelligence algorithms, the packaging of products may be improved. Artificial intelligence may assist logistics businesses in creating better packaging for certain items and selecting the ideal materials and sizes for each box. It can also give a notification before a cargo is dispatched if it has been tampered with. Further ensuring there are no delays along the way effectively lowers the likelihood of supply chain issues (AI in supply chain and logistics [20+ practical applications], n.d.).

The fleet management process is one of the most undervalued components of the supply chain. Fleet managers are in charge of ensuring a seamless flow of commerce by coordinating the crucial relationship between the supplier and the customer. Fleet managers have to deal with growing fuel prices and a manpower scarcity in addition to ongoing data overload problems. Real-time tracking mechanisms are provided by artificial intelligence in supply chain and logistics to get timely insights, such as the ideal timings by which, when, and how shipments should be made. Additional benefits of such potent multi-dimensional data analytics include improved fuel efficiency, the detection and avoidance of bottlenecks, and a

reduction in unscheduled fleet downtime. It gives fleet managers the armor of intelligence to combat the otherwise constant fleet management problems that arise every day (Jacobs, 2022).

Trucks may be directed to available parking places with the use of computer vision technology, which is used to monitor docks and parking lots.

In order to determine if a parking place is currently occupied by a car or not, neural networks, deep learning models, and security cameras are all employed. The parking lot is monitored by CCTV cameras, and the photos are processed using deep learning algorithms.

The program may then direct truck drivers to a suitable parking area, increasing efficiency, as computer vision systems offer exact positions of the parking space.

Additionally, the system can recognize trucks of diverse sizes and forms. Thus, computer vision systems can facilitate dock management by carefully examining if a dock is fully filled and, if not, where there are vacant places.

The procedure may be carried out in any kind of weather because it is based on real-time data.

Esentially, artificial intelligence can determine how much room is available between two parked cars and whether or not a certain vehicle would fit, optimizing the usage of parking spots in ports (as well as other critical logistical sites, like an airport).

Parking lot occupancy detection is useful in logistics since it reduces shipment delays by informing workers when a truck arrives and routing the truck to an open parking place, even though the transportation sector also uses it to ease traffic congestion (Styles, 2020).

Furthermore, no additional equipment is required because one can make use of the surveillance cameras that are already there at the ports.

One may identify problems using video analytics and confirm them before taking any action.

In essence, artificial intelligence provides actionable information on the activities in the area around a business, enabling one to swiftly identify prospective intruders.

Video analytics can distinguish between the motions of cars and people at a location while disregarding any motion that is pointless. It can support the identification of odd motion and unexpected activities.

Access control systems that integrate with intrusion detection sensors to get real-time notifications each time an unknown individual attempts to enter a facility are important applications of video analytics.

This is really helpful for reducing theft and invasions. One of the most popular implementations of artificial intelligence in logistics is face detection using computer vision, which stores facial data in a database.

In contrast, intrusion detection sensors look for movement before sounding an alert if an intruder has been located.

Data is gathered and labeled, neural networks are trained, and deep learning techniques make it simple (and automated) to highlight things of interest. Typically, a person visiting a certain place quickly recognizes any things of interest.

The choice of locations to watch is crucial for logistics firms. For intrusion detection sensors to be successful, many cameras must be employed (AI in supply chain and logistics [20+ practical applications], n.d.).

3. Research Methodology and Findings

In order to get closer to the objective of the article stated in the introduction, using the method of the case study was deemed as appropriate. A case study refers to both a technique of analysis and a specific research methodology for exploring an issue in the social sciences, both of which may be used to generalize findings across populations. A case study research aims to investigate an individual, location, event, occurrence, or other type of subject of study in order to extrapolate main themes and outcomes that help better predict patterns, enlighten previously undiscovered problems that can be applied in practice, and/or provide a clearer grasp on an important research issue.

The methods employed to investigate a case might be classified as quantitative, qualitative, or mixed-method. In this paper, qualitative research was conducted with the support of various articles and studies. The main advantages of using the method of the case study are that it offers the possibility of intensive research, that it improves a person's analytical ability and knowledge of a social phenomenon, that it is comprehensive and that it allows for data generalization in order to illustrate statistical conclusions. Some disadvantages of using the method of the case study are that there is the possibility of errors, that it is a rather subjective method and that there are no fixed limits of the investigation.

The limit of the research conducted is that the most part of the information used is from 2018. Though, this does not have a big impact on the case study, because the drawn conclusions still stand.

One main actor of the case study is a significant maritime business, NileDutch Africa Line BV (NileDutch), which focuses on establishing connections between

West Africa and the rest of the globe. The business has operated in Africa for more than 30 years and has a broad network of offices and agents. Because of its location in the area, NileDutch is familiar with the demands of the African market, able to adapt swiftly to developments there, and able to provide its clients with a trustworthy service. With a fleet of over 30 chartered container ships and a capacity of 80,000 TEU, NileDutch has developed from a new market entry to one of the world's top shipping businesses concentrating on the Africa area in only a few decades. The German shipping and transportation firm Hapag-Lloyd successfully bought NileDutch in the second half of 2021.

The other main actor of the case study is Transmetrics, a cutting-edge artificial intelligence platform created specifically for the supply chain, platform which enhances transport planning by utilizing the strength of predictive analytics and machine learning. Transmetrics maximizes operational advantages while minimizing the environmental effect of logistics by fusing human and artificial intelligence skills.

Repositioning empty containers in the shipping sector is estimated to cost between €13 and €17 billion annually, or up to 8% of a shipping line's operational expenses, by the Boston Consulting Group (BCG). Transmetrics estimates that the overall cost of empty logistics assets to be greater than 12% of operational costs due to additional expenses for empty container storage and maintenance (*Predictive empty container management for NileDutch, 2018).*

This is a massive, industry-wide issue that has numerous facets, including trade imbalances, lengthy relocation times, high expenses associated with safety stock, and incorrect commercial projections that are mostly reliant on employees' gut instincts. Additionally, there are two other crucial factors that are relevant to many shipping companies.

Excel is often used for planning, and even in modern times, complicated decisions are often made manually and are relied on the knowledge of logistics teams. In this approach, the procedure becomes cumbersome and ineffective, but by utilizing contemporary technologies, it might be readily mechanized and streamlined.

In many cases, the logistics team oversees worldwide empty repositioning while a procurement team monitors vendor expenses. With various fees in place, this might result in circumstances where container shipping lines are aware of the overall sum they paid to a certain vendor in a specific area but are unsure of the reasons for these prices, which leads to a lack of transparency regarding pricing.

NileDutch was managing its operations quite successfully even in these increasingly difficult market conditions with the aid of solid manual tools already in place, but it took a lot of time and effort from the Global Empty Repositioning team to keep these up to current. NileDutch made the decision to equip their Empty

Repositioning team for this reason by implementing a comprehensive, end-to-end, and data-driven planning system. NileDutch's major goal was to cut the logistical expenses associated with handling and moving empty containers. The second goal was to cut down on the fleet of containers they utilized. While maintaining a high level of customer service, both have to occur.

Even though NileDutch works on sea and Transmetrics on land, there are parallels between the two businesses' fleet sizes, as well as the challenges that unutilized assets might provide for both. The same area holds the key to lowering expenses related to idle assets: strengthening businesses' forecasting skills while enhancing their capacity to more effectively reposition their idle fleet. The businesses were able to create custom solutions to save expenses related with empty fleet management by using past data (most of it proprietary) to enter into machine learning algorithms.

NileDutch is now working with Transmetrics Bulgaria to optimize their empty container movements and boost productivity. Transmetrics was chosen by NileDutch as the ideal business to install its logistics software because of its vast experience in demand forecasting and anticipatory management for the cargo transport sector.

Anna Shaposhnikova, Transmetrics' CCO and co-founder, mentioned (Hype, 2018) that the container, which transformed how transportation functions globally, continues to be a symbol of globalization. Empty container management and relocation could be reinvented with machine learning and sophisticated algorithms. The cost of empty container logistics is expected to be reduced by 10-15% as a result of the initiative with NileDutch.

Transmetrics' new product, AssetMetrics, was introduced as a result of this partnership. For the intelligent algorithm to generate accurate forecasts, this program leverages past data and enhances those data sets.

In comparison to demand forecasts from internal customer teams working on other projects, technology has already assisted in achieving up to 25%–50% greater accuracy. This strategy made it possible to rebalance assets throughout the whole NileDutch network at a little cost. It accounts for asset return costs, repositioning expenses, future demand at each site, and maintenance costs. To provide a continuous flow of data, NileDutch's Transport Management System is linked to AssetMetrics (NileDutch, 2018).

A custom artificial intelligence system may assist logistics organizations in making better plans, resulting in fewer traffic jams and more effective use of their resources.

This first led to a more effective plan. By implementing artificial intelligence, businesses are able to produce automatic plans that are also more accurate, therefore

moving away from labor-intensive manual planning using Excel. Both physically, by the rearrangement of assets, and organizationally, through the release of employee time, this relieves congestion.

Storage also became less expensive. The artificial intelligence-powered planning tool can more accurately forecast when and where particular assets will be needed. Containers and trailers from the firms spent less time in storage facilities as a result.

Another great outcome is that departmental transparency increased. All employees are now able to make better informed decisions since the organizations are working with integrated information that is now accessible to all offices across global supply chains.

In the instance of NileDutch, the artificial intelligence solution is able to determine how to prevent container surplus and the most effective ways to reposition its fleet, and it is able to create an ideal empty container plan 10 to 12 weeks in advance. The firm was able to lower the size of its fleet because artificial intelligence-powered planning allowed it to meet the same demand with fewer resources.

Companies must first gather the required data in order to create and train the artificial intelligence optimization system. Although previous data was available, it took many steps to combine the data coming in from different electronic data intercharges into a single, useful collection.

The historical data was cleaned before being put into machine learning algorithms to construct a demand forecasting model, which assisted the businesses in determining how many assets will be required at a specific time and location.

The model was further developed with data from third-party global logistics actors, such as port authorities, storage partners, or freight exchange partners, in order to create the best routes to reposition and store their assets.

Using human inputs in Excel, it would be difficult to take all of this data and produce a workable strategy for a significant shipping firm. It is merely a question of providing data to an artificial intelligence system and utilising the results, not to mention the system's constant learning and improvement that comes with accumulating new data as it is used and matures (AI case study 3: Cost-saving AI in Manufacturing Logistics, 2021).

Although the case study focuses on the impact of artificial intelligence on logistics, there are already many companies that use the technology of blockchain to help with logistics, some also originating from Europe.

Dispatch, a logistics firm recently acquired by Amazon, is working on a six-wheeled urban delivery robot that will provide even more value once it integrates with logistical networks (Alstyne, Choudary, Parker, 2019).

SkyCell, a Swiss tech firm, developed blockchain-enabled refrigerated containers with a temperature deviation rate of less than 0.1 percent (8 Ways Blockchain Is Revolutionizing Transportation and Logistics, n.d.).

Factr, a digital wallet developed by Canadian firm RoadLaunch, is connected with their RoadLaunch Intelligent Digital Logistics platform. Freight carriers, shippers, middlemen, and financing partners may make judgments based on digital documents and transaction history thanks to the solution. Instant cross-border settlement, audit, transaction validation, and reconciliation are all available with Factr (5 Top Blockchain Startups Impacting the Logistics Industry, 2020).

CargoCoin, a British business, uses blockchain technology to connect the physical worlds of commerce, transportation, and logistics by replacing paper contracts with smart contracts and ensuring safe payments throughout the process. CargoCoin is a smart contract and cryptocurrency platform that automates document approval and transaction security, removing the problem of distrust and information barriers.

By connecting their Crypto-Tag and a mobile application with blockchain technology, the US-based business Bonafi creates solutions to alleviate the problem of counterfeit items. This tag may be embedded in almost any form of material. Additional data will be stored into the blockchain when each item passes through the supply chain through the tags. Consumers and third-party vendors then use their mobile devices to scan merchandise to verify their validity and register the items they have purchased.

QUASA, a German business, creates an open blockchain platform for cargo transportation, as well as a monitoring system that allows clients to follow the progress and location of their goods. It keeps track of every halt, diversion, and other manipulations in real time, which is then stored in the blockchain.

Curv, a firm established in the United States, offers a cloud-based Institutional Digital Asset Wallet Service. Curv, which is based on cryptography, eliminates the blockchain's irrevocable single point of failure by removing the idea of private keys, allowing for safe, distributed transaction signing. Curv's mathematically proved multiparty computation protocols guard against cyber assaults and insider collusion by guaranteeing that every user is verified and every transaction is checked against a set of rules.

4. Conclusions

In conclusion, artificial intelligence and blockchain have many potential benefits in the logistics industry and applications such as traceability and transparency, smart contracts, authenticity verification, freight tracking and cybersecurity. However, there is still skepticism and misunderstanding about these technologies and their uses. Because blockchain is an underlying technology and everything happens behind the scenes, it is difficult to explain how it may provide a new type of infrastructure and a new way to digitise assets through tokens. Artificial intelligence also needs a certain degree of knowledge for its advantages to be even partially understood.

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