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Review

Supply Chain Disruption versus Optimization: A Review on Artificial Intelligence and Blockchain

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Abstract: In response to significant disruption, supply chain optimization became sensitive to increasing consumer expectations, unexpected demand fluctuation, and inventory costs. Proactive movement, understanding, and empowerment have fostered the beneficial results of supply chain optimization, cooperation, and operational resilience. These pioneering activities are critical to achieving a paradigm shift in the supply chain, even agility in response to changing demand. However, sophisticated analytics such as artificial intelligence (AI) and blockchain are supposed to overcome these challenges to make smarter decisions on a daily basis. Due to these facts, this study aimed to model AI's and blockchain's role in supply chain optimization by conducting a systematic literature review based on the idealized framework of Rejeb et al. (2022) and the SALSA mechanism. In addition, this paradigm-shifting approach will provide fairer views and options for managing forecasting, planning, monitoring, and reporting across the entire supply chain. The emphasis remains on real-time accuracy, easy access, and optimization of operational indicators such as sales, visibility, and end-to-end supply chain operations at all times and from any location. It will be an eye-opening experience to enable stakeholders and partners to communicate information collaboratively, consistently, and efficiently.

Keywords: artificial intelligence; blockchain; supply chain; optimization; disruption; operations

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1. Introduction

The supply chain is a symbiotic playmaker connecting customers and suppliers [1]. It also brings together a smooth flow of materials and finished products to create value for organizations [2–4]. In general, validation and value addition require a lot of time and effort to materialize [5] and to optimize the supply chain. However, logistics, capital control, and information flow contribute to the optimization [6], seamless operations and operational efficiency as parts of the supply chain [7,8]. Even so, managing information flows and distributing resources and competencies throughout the supply chain [5,6] became an increasingly important foundation for achieving increased flexibility to cope with an unpredictable future [9–13]. In order to accomplish supply chain optimization, these flows and distributions need to be stable in terms of disruption.

To be sustainable in the future, supply networks have to become more adaptable and responsive [14], and more resilient and traceable [15] in response to disruption. However, disruptions from various sources have caused businesses to reconsider the supply chain policy [8,16]. In addition, unprecedented disruptions in the supply chain have illustrated a significant movement toward rising customer expectations and unpredictable changes in demand and inventory costs [17]. In contrast, a proactive, data-driven supply chain ecosystem is more equipped to adapt and minimize such actions [18–20] Nevertheless, technology and innovation work at the heart of the ecosystem for supportive supply chain success [8,21]. Thus, supply chain revolutions ought to focus on supply chain solutions and optimization.

However, leading providers use advanced analytics and artificial intelligence to derive answers across distributed data sets for solutions [7,22,23]. In addition, these processes, variations and movements are subject to securely and transparently intelligent management of information [24]. Nevertheless, these variations can also proceed with absolute rationality through artificial intelligence [25,26] and create options for sustainability with the advent of the blockchain [21,27]. More specifically, blockchain technology can drastically minimize the requirement for verification, thereby enhancing the effectiveness of supply chain management [28] with the aim of functional coordination, inter-firm collaboration and ultimately improving service quality [29,30]. This allows businesses to encrypt and store transaction records in digitally transparent, shared databases that are secure against deletion, manipulation, and change through interconnected trends and technologies [29,31].

With these ideologies, this study reveals how the supply chain optimizes operations through minimizing bottlenecks in information flow and addressing difficult problems in real time. It also strives toward proactive insights through the use of blockchain and AI to improve supply chain visibility. A few studies have addressed the intricacies and advancements of AI and blockchain integration for supply chains, but they have missed the optimization emphasizing best practices. As a result, the purpose of this study is to fill that research vacuum by analyzing the utility of combining blockchain and artificial intelligence for supply chain optimization. Furthermore, this article aims to identify research breakthroughs in the disciplines of blockchain and AI concerning supply chain operations and to demonstrate how the integration of artificial intelligence and the blockchain may improve many aspects of the supply chain.

2. Supply Chain Disruptions

A supply chain disruption is defined as any scenario that inhibits the manufacturing, sale, or distribution of commodities [32]. To measure real-time interruptions, decision support in the supply chain is needed to track and determine actions, and optimize and establish contingency and recovery plans and simulation models [33]. Nonetheless, supply chain disruption resulted in significant delivery delays, decreased income and sales, and production shutdowns [28]. As a result, with the deployment of reaction planning activities and recovery plans, current data-driven resilient supply chain architecture, including reactive control, is becoming an increasingly important concern in supply networks [15].

However, supply chain disruptions indirectly influence operations since they primarily rely on remote decision-making while ignoring credible data on interruptions [34]. These interruptions create perplexing supply chain interruption situations and delay recovery policy arrangements [35] As a result, businesses are looking into ways to leverage databases to improve supply chain operations and how to use massive amounts of data to predict issues and increase supply chain flexibility [36]. Therefore, allowing comprehensive end-to-end real-time supply chain visibility at any point is essential to increase supply chain agility, flexibility, and alignment [37]. This helps to increase supply chain operational performance. Under the circumstances, modifications to existing supply chain models must be included in planning and real-time management adoptions based on demand, inventory, and transportation data [23]. Consequently, supply chain visibility should focus on technology-integrated, data-driven technical operations and intelligent decision-making.

3. AI and Blockchain in Supply Chain

AI and advanced analytics can analyze enormous and varied data volumes from all operations, including the supply chain, to increase visibility [23,38]. Furthermore, contemporary supply chain management uses AI technologies to optimize inventories [36] Nevertheless, using AI may reduce the burden of making supply chain optimization decisions and speed up conversations while maintaining exceptionally high precision, dependability, and authenticity [8]. As a result, accessible information will be available at all times, enabling AI systems to coordinate work sharing, negotiate with suppliers, and accomplish jobs at a high rate in an organized, rapid, and secure manner [8]. Despite increasing security alternatives, a supply chain access control innovation system is critical for authenticating individuals, allowing secure access, and enforcing access restrictions [37]. In essence, artificial intelligence (AI), a significant factor in the 4IR (Industrial Revolution) [39], is capable of outperforming human talents under challenging jobs that demand actual human intellect [20]. This talent, it is said, would allow organizations to swiftly revise plans and react to changing situations with considerable flexibility, even in a disrupted environment.

Blockchain fosters trust by enabling multi-party visibility of digital events throughout the supply chain. It ensures creative solutions by improving data quality, integrity, and visibility in a volatile environment [40]. However, this movement decreases errors in communication or data transfer [41], ensuring access to the same information for all supply chain parties. As a result, it can be used for managing, processing, and storing massive amounts of data, as well as authenticating users, maintaining data access histories, and limiting user access as necessary [42]. Though blockchain technology has advanced a lot, there are numerous challenges when applying it to supply chains [43]. However, performance, sustainability, and scalability [44] help improving quality and cost reductions [45] through quick data verification.

Using artificial intelligence, supply chains can become robust and sustainable. Supply chain management using AI has improved the accuracy of demand forecasts and inventory projections [46]. It integrates software and business intelligence tools with existing data for improved decision-making and work efficiency [47]. However, it also responds to increased consumer demand and more revenue streams by evaluating large amounts of data [48]. In addition, AI demand forecasting can assist businesses in making exact plans for seasonal product changes and estimating the supply chain costs using machine learning algorithms [49]. Nevertheless, these data will be used to create automation, forecasting, and robots that will replace the current supply chain management system in the future [50].

Companies currently use virtual innovation of faster technologies in response to shortening product life cycles and intense competition [51]. As a result, the involvement of AI advances the supply chain with tailored purchasing, fraud protection, and voice assistants [52]. For instance, the right flow of goods into and out of warehouses is one of the business advantages of AI in the supply chain [53]. It is possible through AIs integration with proper inventory management. Based on inventory stock levels or longer wait times, AI can forecast when shortages will impact businesses once it has identified which specific nodes in the supply chain are clogged [54]. As a result, it helps lower logistics costs, inventory, and service levels.

In a situation like extreme volatility, supply chains become an enabler of flexible operations and information sharing with audiences. However, there are considerable concerns about the security of personal information and the reliability of technology [39]. However, blockchain solves the problem of solid privacy and authentication [38]. It is a tamperproof system that can eliminate issues with record maintenance, transparency and traceability. Evidently, the integration of blockchain and AI has created manifold possibilities in supply chain optimization [55]. For example, coordination can be beneficial in terms of speed and reliability between teams [4], the sharing of data and transactions [21], and even in enhancing agricultural decisions [16]. For smooth transaction flow, blockchain informs a secure distributed ledger in terms of cryptographically signed [21] and immutable records of transactions that are followed with absolute authenticity and agreement. Indeed, it facilitates the recording and sharing of data across multiple ledgers by a secure distributed network based on trust [32]. This trust has ensured supply chain transparency and record validity, such as the IBM Food Trust blockchain [8]. With the advancement of technology, doubting the authenticity of information and real-time information flows in the supply chain for optimization is no longer an unidentifiable answer.

4. Methodology

This study uses a qualitative approach focusing on AI and blockchain-based adaptations toward optimization in the supply chain against disruptions. However, this study is conceptualized with the ideology of a bibliometric analysis framework adapted from literature [56] being suggested by Fosso Wamba and Mishra [57]. This reinforced the structure of this article under the dimensions of the Systematic Reviews concept. In addition, the entire study proceeds by accentuating research questions along with the revised model of the supply chain with the advent of AI and Blockchain technology. This supply chain movement is also accelerated by the network analysis with the progression of research contribution.

As for the progression of the methodology, databases and keyword justification consider to identify the literature, especially for the review analysis. In this case, highly cited quality publications intended to cover the network and bibliometric analysis for initial document analysis. In addition, the authors' collaboration also materialized from different countries perspectives in this study. Again, the most cited publications are provided as references to acknowledge authors. For revealing the intellectual structure of the research fields, incorporating the most influential authors is also considered for broadening the visibility.

As justification, this study considers a systematic qualitative review because it summarizes previous supply chain management research in response to research questions with a well-defined search method, a reliable database, and clear inclusion and exclusion criteria. This study also fits within the SALSA framework, which stands for Search, Appraisal, Synthesis and Analysis, to provide a detailed look at how blockchain and AI technologies work best. The SALSA framework ensures logic-based items with set exclusion and inclusion criteria for evaluation, such as searching for the correct string in a specific database such as Google Scholar. However, this entire process supports and follows a similar SALSA study [58].

This study focuses on supply chain visibility through artificial intelligence and blockchain application. For the transition to supply chain digitalization and optimization, the study separates the roles of AI and BT technologies based on a combination of network analysis. Such analysis is a part of the bibliometric analysis and a predictive literature-based model. The research questions (Table 1) set on how the role of blockchain and artificial intelligence affects supply chain operations.

Table 1. Research Gap, Research Question and Contribution.

Research Gap	Research Question(s)	Research Contribution
Existing literature on AI-blockchain integrated supply chains and their commercial applications is lacking	RQ1. What is the throughput of AI and blockchain-integrated scientific manuscripts in the field of the supply chain? RQ2. What are the most noteworthy articles on using AI and blockchain in supply chain optimization?	Insights into publication distribution by year and analysis of highly cited research papers
There is a lack of research in many areas of supply chain optimization that benefit from using AI-integrated blockchain systems	RQ3. What are the most potential operational platforms for supply chain operations combining AI and blockchain?	Incorporate the most manuscripts combining these two technologies simultaneously in the supply chain context and draw a dummy model for adding value to the supply chain process and optimization

This bibliometric study is based on Wamba and Mishra [57] suggestions for isolating the search database and keywords. In this study, VOSviewer [59] is used for graph visualization in addition to proposed data analysis and network analysis. Literally, network analysis provides a comprehensive overview of the study topic and its prospects [60]. However, examining academic collaboration networks among authors led to information dissemination and knowledge exchange for an intelligent organization [61]. Here, we investigate the clusters among the authors in the sense that comparable research ideologies are divided into clusters in order to acquire unique insights into the information that belongs to each cluster [62] (See Table 2).

Table 2. Systematic Literature Search and Bases of Inclusion and Exclusion.

Keywords/Search String	Search Engine	No. of Papers	Inclusion and Exclusion Parameters
supply chain blockchain artificial intelligence	Google Scholar	49,400 (incorporating citations)	Anywhere in the articles
"supply chain artificial intelligence blockchain" OR "supply chain blockchain" OR "supply chain artificial intelligence"	Google Scholar	17,100	Anywhere in the articles Year: (2016–2022)
"supply chain artificial intelligence blockchain" OR "supply chain blockchain" OR "supply chain artificial intelligence"	Google Scholar Google Scholar	504	Title of the article Year: (2016–2022)
"supply chain artificial intelligence blockchain"	Google Scholar	5	Title of the article

Initially, the supply chain, blockchain, and artificial intelligence search terms were considered, and 49,400 documents were exposed in Google Scholar. Table 2 shows the keywords used in Google Scholar followed by paper numbers and parameters. Here, the authors exclusively used this Google Scholar database due to its ease of use for the citation and wide coverage for all types of research. Business-oriented articles are preferred over non-English, highly technical, and scientific publications for citation and exclusion-inclusion parameters. However, author information, titles, abstracts, and keywords were also acquired for the initial bibliometric data. According to the systematic review, blockchain technology and AI development between 2016 and 2022 are considerably ahead of schedule. The initial search therefore focused on those years, and a total of 17,100 records were retrieved using the keywords "supply chain artificial intelligence", "supply chain blockchain", and "supply chain optimization". After focusing on keywords, abstracts and manuscripts, a total of 504 articles were well-thought-out for network analysis (Figure 1). Preliminary network analyses for two authors in a group and for each of the authors were illustrated in Figures 2 and 3, respectively.

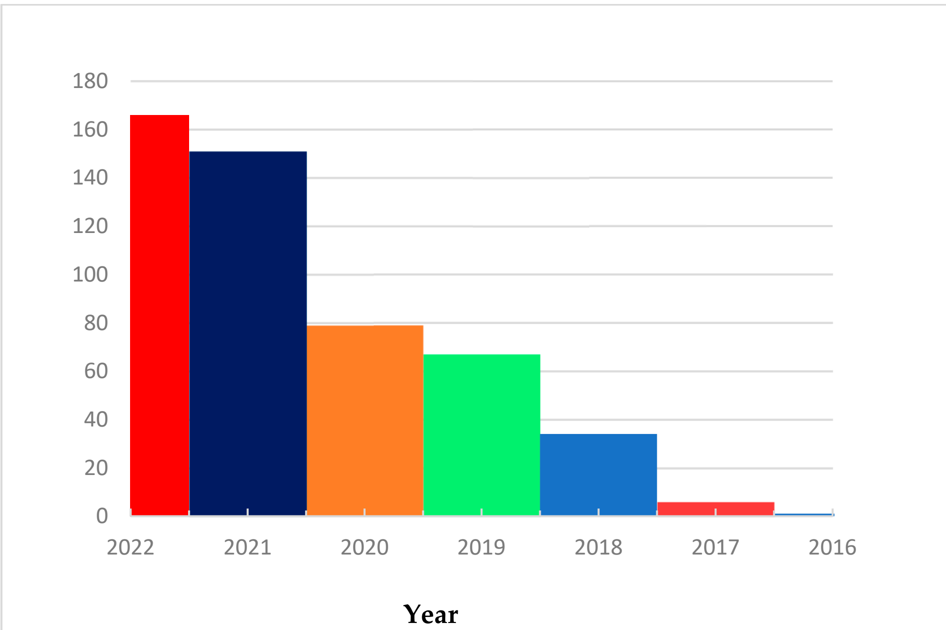

Figure 1. Number of papers cited as per year 2016–2022.

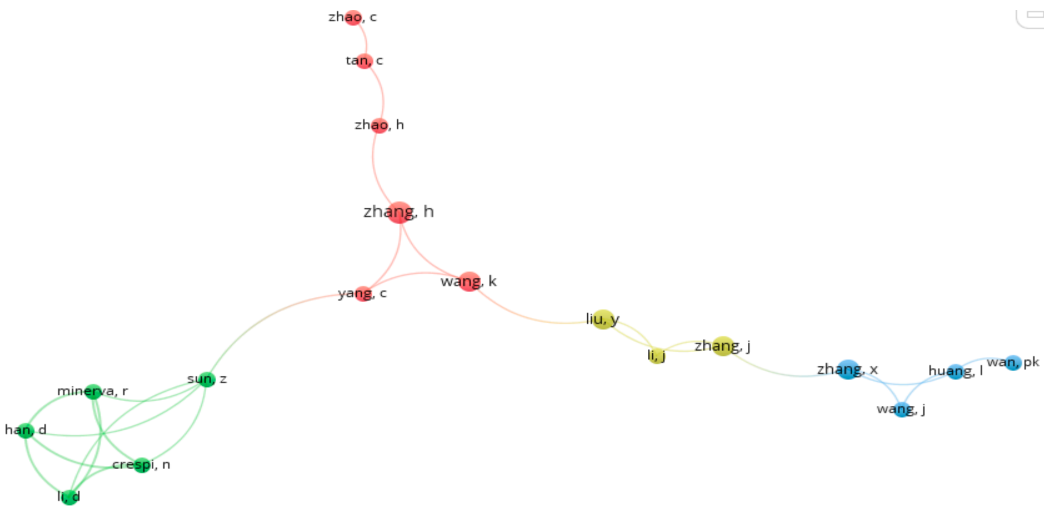

Figure 2. Network views among the 504 articles (at least two authors in a group).

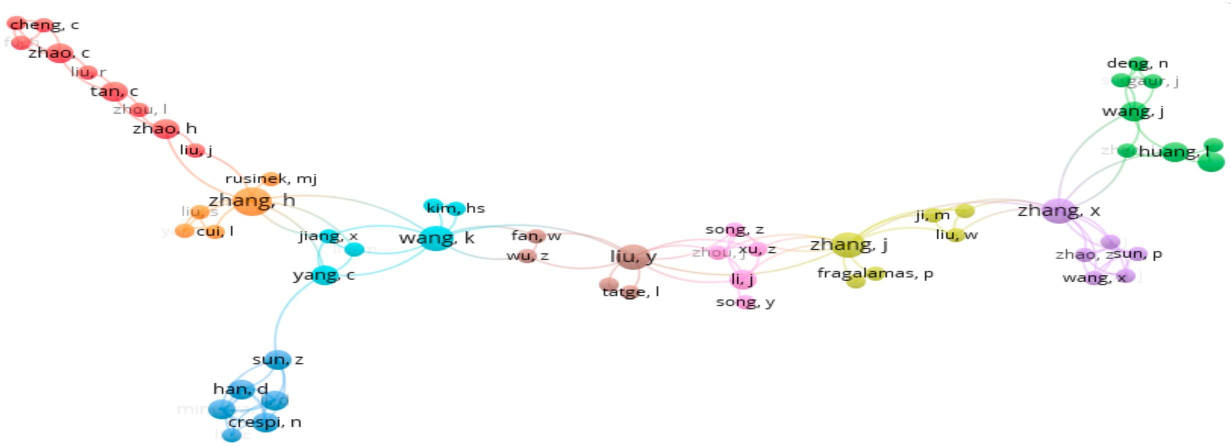

Figure 3. Network Visualization among the 504 articles (for each author).

As a result, the poor level of homophily among the nodes of the author's cluster indicates the weak ties between the clusters and distant proximity. It also resulted in multidimensional views of the emerging technologies having limited chances of "similarity breeds connection" by the citation analysis. For the novelty review, the common paradigm-shifting of both blockchain and artificial intelligence was embodied and tabulated for a better understanding of these technologies in the tentative areas of the supply chain operation.

Table 3 shows the citations for 2016–2022, and the average number of citations per document was 2.80. Furthermore, citations per author were 18.38 with an H-index of 45 and a G-index of 90. In addition, top-cited publishers and journals on network visualization analysis, supply chain, blockchain and AI shown in Table A1. During the introductory period from 2016 to 2017, only one paper was published in this specialized field, compared to six in 2017. In 2018, these research topics attracted the attention of scholars, resulting in an increase in the number of publications (Table A2) The most cited papers (Table A3), publishers (Table A4) and journals (Table A5) were included in the Appendix A. Moreover, the authors included in the Appendix A are Francisco and Swanson [63] (Logistics, MDPI), Kamble, Gunasekaran, and Sharma [64] (International Journal of Information Management, Elsevier), Kouhizadeh, Saberi, Sarkis [65] (International Journal of Production Economics, Elsevier), Salah, Nizamuddin, Jayaraman, and Omar [66] (IEEE Access, IEEE).

Table 3. Citation Metrics.

Publication Year	Citation Year	Papers	Citations	Cites/Per Year	Cites/Per Author	Author/Paper	h-Index	g-Index
2016–2022	2016–2022	504	9263	1543.83	18.38	2.80	45	90

Literature review traced five relevant papers on blockchain and AI-integrated supply chain optimization. Those papers did not consider the ideologies of supply chain disruptions and optimizations. From these, Zhang, Shi, and Pan [67] addressed risks associated with supply chains, while Martinčević, Sesar, and Žunac [68] investigated digital supply chain management including logistics. Again, several studies have focused on multidimensional perspectives, such as operational partnerships with supply chain communities [8] and intelligent supply chains for traceability [69]. A few others talked about system security and timely dataset acquisition for supply chains [9] and logistics services in the supply chain [67]. In addition, there have been few studies on systematic literature reviews and on the bibliometric analysis of blockchain with supply chain, AI with supply chain, or the integration of these two technologies on the supply chain. Moreover, citations, network analysis, and a predicted supply chain model that incorporates blockchain and AI are included in this paper. In a tabular format, however, this analysis discovered the best-case scenario of both AI and the blockchain-based supply chain.

Though the advancements in the blockchain-oriented supply chain are articulated in separate views [69], the limitations of AI for privacy and trust concerns have been addressed and mitigated by the amalgamation of blockchain by this revised model of supply chain optimization. Furthermore, AI improvements to facilitate blockchain-based supply chains have to update and synergize in this paradigm. Evidently, with these bibliometric analyses and supply chain optimization models, this work adds to the advancements of AI and blockchain on a larger scale, which may be fitted with the applicable business model. As a result of these modifications, supply chain operational improvements, notably in logistics, sales, and global supply chains, have been identified as essential benefits of technological advancement [14].

In terms of model estimation, a fair model was projected depending on the existing literature on supply chains, blockchain and artificial intelligence. In fact, this model was developed in response to the research question. The way the block's nodes were programmed means that it can be used with any element of the supply chain. Although the roles of artificial intelligence and blockchain differ in application, the artificial intelligence movement emphasizes supply chain operations and then optimization with blockchain. Thus, the draft model is based on blockchain's transformative vision with the advent of artificial intelligence. More specifically, the involvement of artificial intelligence will expand supply chain capabilities to end-to-end visibility, leading to supply chain optimization [20].

5. AI and Blockchain Incorporated Supply Chain Framework

This study was developed following the revised model/framework to implement a distinguishable and automated supply chain. Figure 4 depicts an advanced scenario with blockchain installation and an intelligent supply chain adapted from the literature [69].

Blockchain and artificial intelligence (AI) technologies made significant contributions to this model. Traceability, transparency, security, automation, and efficiency—integrated blockchain efforts—contributed to the movement of materials and the flow of information. However, AI's involvement was distinct due to its multidimensional approach. End-to-end tracking, recognizing discrepancies and resolving them, identifying dangers, identifying errors, and improving accurate forecasting, particularly demand forecasting and inventory management, were the primary contributions of this AI. Additionally, it expedites 360-degree visibility and real-time monitoring of the entire supply chain.

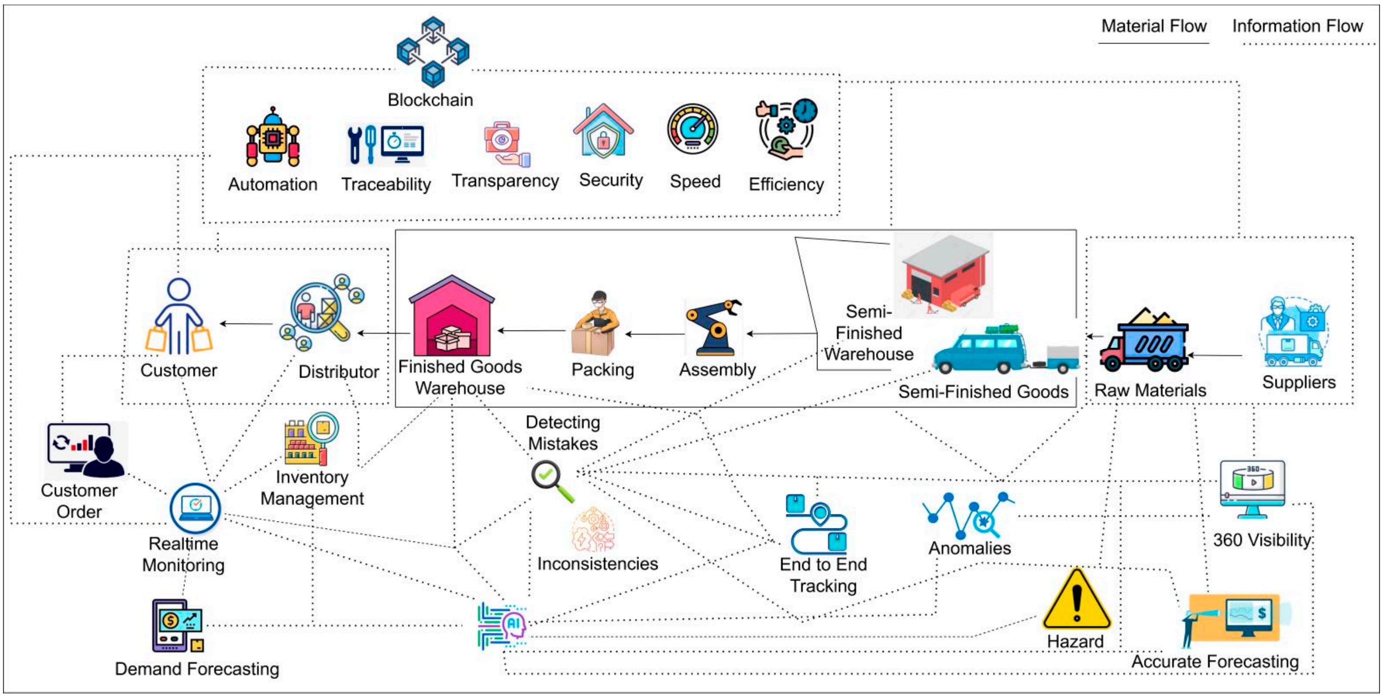

Figure 4. AI and blockchain incorporated supply chain framework.

This model describes integrating enterprise entity traceability as a crucial supply chain component. Each supply chain participant must internally implement a process automation platform with a blockchain extension [10]. More specifically, each participant in the supply chain has access to the information flowing through it and may employ AI to glean new understandings (Hassija et al., 2020) [28]. In a general supply chain, the data provided to stakeholders only gives a limited perspective. However, all parties have access to stakeholders' data through the blockchain, which significantly clarifies the process [70]. Thus, this will make it easier to implement an automated supply chain. Once again, smart manufacturing uses artificial intelligence to maximize manufacturing companies' capabilities to improve various goals like cost, delivery, and quality [69]. Business cycles with efficient information flows must be used in order to optimize supply chain operations, production systems, and product development. Using blockchain, purchases may be completed more rapidly, securely, and without using middlemen and the related expenses [4]. On the other hand, AI aids in delivering higher-quality data and analytics by utilizing algorithms to offer a comprehensive picture of the warehouse and supply chain [23], as well as information on an optimal stock vs. demand [71]. Furthermore, AI and Machine Learning (ML) can determine optimal supply levels by driving several scenarios to fulfill demand [28].

In logistics, the blockchain provides seamless communication across complex production networks [6] by boosting credibility, security, and efficiency. It also has the potential to build platforms where transportation suppliers provide the real-time availability of trucks or vessels [19]. In the case of purchases, blockchain may enable the establishment of tamperproof smart contracts that automatically enforce the terms of multi-party agreements [2]. However, smart contracts can be self-verifying and self-executing by disbursing funds to the appropriate parties. AI-powered supply chain optimization application enhances critical choices by leading to improved forecasting and recommending the best course of action [23]. This can improve overall supply chain performance by assisting manufacturers in determining the potential outcomes of various situations in terms of time, expense, and income [37].

In the global supply chain, blockchain optimizes worldwide supply chains by enabling firms to deal directly with each other and without the participation of a third party [10]. This enables greater financial and logistical services integration and more data exchange across stakeholders [19]. In addition, AI can properly forecast demand at a look, minimizing supply chain inventories and waste [20]. Furthermore, AI-powered by big data may increase supply chain efficiency and resilience [15].

As a product goes through the various stages of shipment, it can be difficult to accurately monitor large volumes of products, which are eventually transported to unique final destinations. Based on AI, in advance IoT or blockchain, real-time data about the location of goods with the proper status with all relevant information, as with theft and delays, could be ideally recognized and traced easily in between. Again, using AI in supply chain management allows companies to anticipate demand and supply provision of fast-moving consumer goods. From stock order to the final shipment, the entire process can be optimized to reduce costs while boosting overall profits.

The use of AI technology has also been shown to improve overall warehouse management. Space management is often identified as a key area in inventory control, whereas the deployment of smart sensors/devices allows companies to optimize space and locate specific packages [72]. Partnering to install sensors/devices in the warehouse is an optimal way to automatically trigger orders when the current supplies reach a minimum amount while assisting with space management [73]. Through RFID sensors/devices tagged on products, warehouse staff are automatically notified of dispatch and can continue to monitor its ongoing journey [24].

In the case of tentative areas of disruption in the entire mechanism and material flow, logistics operation, inventory and warehouse management, predictive maintenance, real-time information flow and tracking and monitoring were considered to be optimized supply chain operations. The starting point for the deployment of IoT in fleet management used sensors/devices (e.g., RFID) to collect information about product conditions, temperature and monitoring delays. Real-time access to this critical information ensures that required maintenance can be easily detected and carried out. Depending on patterns and repetitive scenarios in real-time with more advancement of AI for predictive maintenance, the machine learning integrated tracking and tracing mechanism is workable against most errors. This mechanism ensures the maximum optimization of systems and devices. In another case of transparency, the observation regarding different materials used, traded, and reported opens up new avenues for saving time and resources to ensure smooth operations. In this case, RFID sensors/devices use radio waves to determine the stock's current position, along with relevant product details and destination information [74]. This enables real-time access to inventories from anywhere and the monitoring of real-time information on whether the customer's product is being shipped properly. Thus, progress data can be added to the database in this manner.

6. Intelligence in Supply Chain

Supply chain management is one such industry that has the potential to utilize blockchain technology fully. In addition to improving supply chain transparency, blockchain can increase company profits by reducing administrative costs. Fortunately, AI has proven to be a disruptive technology capable of transforming supply chains by eliminating inefficiencies and generating insights that enable more effective planning and decision-making. As a result, the supply chain paradigm shift is summarized as follows (Table 4):

In this case, technological integration has the potential to boost and conclusively demonstrate a revolutionary innovation that can transform supply chains, in addition to increasing supply chain optimization. Correspondingly, the primary and secondary advantages of blockchain have been outlined in Table 4 for resource tracking, product delivery traceability and transparency, as well as the resolution of compliance concerns and fraudulent practices with the involvement of all relevant parties. On the other hand, Table 5 clearly outlines the function of AI in supply chain operations, including precise forecasting, inventory management, seamless data and information flow, and general responsive behavior. These advantages and functions were taken into account as a whole in the model, and these tables represent partial views of the blockchain and AI's highlighted specialties.

Table 4. Paradigm Shifting through Blockchain.

Broad Areas	Specific Areas of Changes
Primary potential benefits	Improving supply chains by enabling faster and cheaper product delivery, enhancing product transparency, improving partner cooperation, and making finance more accessible [32,75]
	Enhancing resource supply chain tracking to ensure compliance with corporate needs [76]
	Decreasing losses as a result of black trade [28]
	Improving insight and adherence in the context of outsourcing manufacturing and distribution [77]
	Minimizing of paperwork costs [28]
Secondary potential benefits	Boosting of the company's image by providing information on the materials used in its products [78]
	Enhancing the authenticity and public confidence in the data provided [71]
	Lowering the likelihood of supply chain mistakes causing public relations damage [79]
	The including of stakeholders [80]

Table 5. Paradigm Shifting through Artificial Intelligence.

Broad Areas	Specific Areas of Changes
Sales and Distribution Inventory	Communicate with the supply chain and sales teams on stock-out [15]
Track Real-Time Performance	Track forecasted sell-in and sell-through to balance channel inventories [32]
	Schedule exact restocking and ordering with important distributors and suppliers [68]
	Provide sound guidance and recommendations in addition to analysis of the company's influence [23]
Smart Reporting	Generate and publish reports on sales and operational performance data such as order cycle time, and channel inventory automatically [81]
360° Visibility for the AI-Driven Supply Chain	Transform heterogeneous data into workforce warnings and suggestions [36]
	Provide answers to complicated business issues [82]
	Flag anomalies and hazards proactively before they become costly blunders [79]
Accessible Insights for AI	Responding in seconds using a single search box for queries related to product order, etc. [83]
True Estimation	Achieving goods prediction and planning to minimize excess inventory in outlets that take up valuable space despite fluctuations in demand and periodic requirements [70]
Accelerate Growth and Minimize Disruption	Detecting mistakes and inconsistencies early, avoiding costly interruptions, and gaining particular insights from dispersed data systems [84]

7. Theoretical and Managerial Implications

As technology advances and is adopted in the supply chain, maintaining data and records become more accessible, especially when an environment of trust concerning the information is created. Such practices enhance efficient decision-making while focusing on real-time transparency. This study uncovers the relationship between information, security, and disruption modeling with undeniable proof for digital supply urgency to enable visibility to manage supply chain interruption. This study was expanded to include supply chain visualization to ensure complete visibility. Ultimately, the entire paper gives information on AI and blockchain integration, notably for supply chain efficiency, that has yet to be realized, even though such insights are vital to dealing with the digital era with a high priority. This paper analyzes the adaptation and advantages these technologies may offer to supply chain optimization, which is essential for academics and industry.

The potential of these technologies (AI and Blockchain) can internalize an overoptimistic situation with significant advancement in materials and information flow. For the sustainable movement of supply chain operations with the appropriate and less costly usage of resources, the involvement of these modern technologies over the traditional and less optimized views is materialistically advantageous for the overall supply chain operation. Even though replacing traditional practices and policies with innovative technologies can reduce the adverse effect assumed on supply chain optimization. Thus, this research justifies the potential for AI and blockchain to balance resources and operational outcomes or smoothness for the sake of revitalized and transformed views of the future supply chain management, which might work against the less eventful margins for the investors.

Organizations can digitally transform transactions by tracking the delivery from the manufacturing plant to the final user. To enhance the management of the supply chain, blockchain-based supply chains improve traceability throughout the whole network of the supply chain by instantly updating the data transaction records whenever a change is made, in contrast to traditional supply chains. As a result, blockchain technology is a tremendous blessing for supply chains, where it can significantly improve logistics, analytics, marketing, and more in addition to data security and financial record keeping.

By using AI-driven data analytics to estimate client demand, logistics can be used to manage warehouses more effectively with real-time automated routing in addition to quickly taking note of warning signs, dealing with problems, and forecasting issues. Machine learning and Big Data tools can predict supply chain problems and give early warning signs as things start to go wrong, such as weather negatively affecting logistics in some places, when used to assess global events in real time. Future vendors may utilize AI to build simulations based on bottlenecks and disturbances to control the supply chain.

8. Conclusions

The study was primarily concerned with supply chain disruption mitigation through the use of AI and blockchain. This study addressed how the adoption of blockchain technology impacted the validating and documenting of transactions among numerous parties in a transparent, tamperproof manner. The model capitalized on the role of both blockchain and AI to connect anonymous participants to conduct private and secure transactions with one another without the need for a middleman. This study also intended to secure the operations against malicious actors while promoting greater performance in supply chains. With these adoptions, the model showed how supply chains extend firms' ability to integrate and analyze market knowledge and take immediate measures to alleviate the effects of a specific disruption. On the other hand, maintaining alternate supply chains for anticipated supply interruptions is costly. With that consideration, the future research agenda might address blockchain's scalability and sustainability issues, as well as AI's ambiguity and short-term optimization problems. Thus, customization in the form of modification and personalization by these technologies can mitigate the disruption in the supply chain at the highest level.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Network Visualization Analysis.

Min. No. of Documents of an Author	Total Authors in the List	No. of Authors Meet the Criteria	No. of Authors Selected	No. of Items (No. of Clusters)
4	1142	4	4	4 (4)
3	1142	21	21	5 (3)
2	1142	115	115	18 (4)
1	1142	1142	1000	56 (9)

Table A2. Number of Papers Cited as per Year.

Year	Number of Papers
2016	1
2017	6
2018	34
2019	67
2020	79
2021	151
2022	166

Table A3. Top 20 Cited Papers on Supply Chain, Blockchain and AI.

Rank	Cites	Authors	Year	GS Rank	ECC	Cites Per Year	Cites Per Author
1	686	K Francisco, D Swanson	2018	190	686	171.5	343
2	432	SS Kamble, A Gunasekaran, R Sharma	2020	216	432	216	144
3	369	M Kouhizadeh, S Saberi, J Sarkis	2021	414	369	369	123
4	356	K Salah, N Nizamuddin, R Jayaraman, M Omar	2019	35	356	118.67	89
5	310	LW Wong, LY Leong, JJ Hew, GWH Tan	2020	496	310	155	62
6	267	DE O'Leary	2017	126	267	53.4	267
7	264	C Bai, J Sarkis	2020	241	264	132	132
8	214	JH Tseng, YC Liao, B Chong, S Liao	2018	87	214	53.5	54
9	210	J Chod, N Trichakis, G Tsoukalas . . .	2020	43	210	105	53
10	192	F Longo, L Nicoletti, A Padovano, G d'Atri . . .	2019	329	192	64	38
11	188	A Di Vaio, L Varriale	2020	338	188	94	94
12	186	KA Clauson, EA Breeden . . .	2018	129	186	46.5	62

Table A3. *Cont.*

Rank	Cites	Authors	Year	GS Rank	ECC	Cites Per Year	Cites Per Author
13	184	TM Fernández-Caramés, O Blanco-Novoa . . .	2019	351	184	61.33	61
14	178	D Mao, F Wang, Z Hao, H Li	2018	306	178	44.5	45
15	176	KS Hald, A Kinra	2019	486	176	58.67	88
16	171	A Banerjee	2018	488	171	42.75	171
17	167	SF Wamba, MM Queiroz, L Trinchera	2020	74	167	83.5	56
18	155	J Duan, C Zhang, Y Gong, S Brown, Z Li	2020	206	155	77.5	31
19	132	R van Hoek	2019	291	132	44	132
20	127	A, J Johny	2019	281	127	42.33	64

Table A4. Top Cited Publishers on Supply Chain, Blockchain and AI.

Name of the Publisher	No. of Top Cited Papers (Out of 504)
ieeexplore.ieee.org	54
Springer	48
Elsevier	45
mdpi.com	41
emerald.com	18
researchgate.net	18
Taylor & Francis	18
papers.ssrn.com	11
Wiley Online Library	10
academia.edu	7
hindawi.com	7
igi-global.com	7
arxiv.org	6
iopscience.iop.org	4
journal.oscm-forum.org	3
lup.lub.lu.se	3
politesi.polimi.it	3
ntnuopen.ntnu.no	2
preprints.org	2
core.ac.uk	2

Table A5. Top 20 Cited Journals on Supply Chain, Blockchain and AI:.

Rank	Title of the Journal	Rank	Title of the Journal
1	Logistics	11	Sensors
2	International Journal of Information Management	12	International Journal of Physical Distribution & Logistics Management
3	International Journal of Production Economics	13	Advances in computers
4	IEEE Access	14	International Journal of Operations & Production Management
5	Intelligent Systems in Accounting, Finance and Management	15	Robotics and Computer-Integrated Manufacturing
6	International Journal of Production Research	16	Journal of cleaner production
7	International journal of environmental research and public health	17	IEEE Transactions on Engineering Management
8	Management Science	18	Supply Chain Management: An International Journal
9	Computers & Industrial Engineering	19	Sustainability
10	Blockchain in healthcare today	20	Journal of Business Logistics

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