HOW DOES BLOCKCHAIN TECHNOLOGY IMPACT SUPPLY CHAIN MANAGEMENT?

Table of Contents

Table of Figures

1. Introduction

Everyday millions of products are being manufactured through the supply chain and distributed across the world (Rejeb et al., 2021). Supply chain management (SCM) contains of various operations, varying from planning, designing, controlling, monitoring the flow of goods, services and information from the departure to the final destination to ensure customer satisfaction (Bartsch, 2021).

Successfully integrating and organising all the operations is a mean of achieving competitive advantage in inventory turnover, flexibility, reliability, speed, revenue optimisation and customer satisfaction (Rejeb et al., 2021). However, effectively achieving these objectives is challenging due to the complexity in supply chain processes. Supply chain does not have a shared universal database therefore it is not transparent as companies do not have access to information even from their own suppliers (Mahyuni et al., 2020). Due to a lack of transparency, buyers are not satisfied as they aren't able to trace the quality control or ingredients in the product. SCM cannot keep with the changing customer requirements as it cannot be changed overnight nor possesses the ability to forecast customer demand (Varriale et al., 2021). Moreover, Gurtu et al. (2019) pointed out that traceability is an issue in SCM as information is passed from one department to another or from person to person, therefore, if an important detail is not communicated, it can jeopardise the whole supply chain.

To overcome the challenges in supply chain, many researchers have attempted to highlight the importance of digitisation in supply chain management (Rejeb et al., 2021). Digitalisation in supply chain refers to the method of implementing a system or process with use of computers and internet along respective supply chain (Hong et al., 2021). Through digitalisation, Rejeb et al. (2021) argue that organisations can collaborate, attain visibility, retrieve key information, resulting in effectiveness in supply chain network. Companies have begun adopting digitalisation technologies such as internet of things (IoT), cloud computing (CC) and blockchain technology (BT) (Hong et al., 2021).

Wang et al. (2019) highlighted that BT is one of the digitalisation technologies that is rapidly becoming a need amongst businesses due to its ability to tackle most of the challenges in supply chain management. Blockchain is a decentralised, distributed ledger that enables the creation of a new block when transactions between two parties incur (Ghode et al., 2021). Every block in the network is connected in series and contains the details of the previous block, enabling permanent and tamperproof records (Bartsch, 2021). The transactions entered in the block can be shared with everyone, therefore directly achieving transparency. Moreover, the transactions cannot be reversed, therefore, increasing accuracy and efficiency. BT has the ability to store the entire operational processes and provide real-time data pertaining to materials, inventory level, shipment date or location, invoice details, and product quality to supply chain stakeholders (Rodrigues et al., 2021). Blockchain surely has opened new doors for organisations by improving product traceability, transparency, security and improved customer relations (Ghode et al., 2021). Hence, blockchain is considered as a gain changer for achieving efficiency in supply chain management.

However, it is also important to consider the negative impacts of BT on supply chain. Ghode et al. (2021) shed light on privacy concerns as supply chain is a complex environment and most parties do not wish to exchange information due to confidentiality. Blockchain surely requires high level of energy which requires acceptance from the people in supply chain. Participants in supply chain can be reluctant to adopt such a change which can slow done the processes due to people's negative behaviour (Varriale et al., 2021).

Therefore, this report articulates to identify the ways blockchain impacts supply chain management, being it positive or negative. To fully answer the research question, 12 peer-reviewed articles has been selected to justify the report. The remaining of the paper is organised as follows: Section 2 discusses the process used to select the 12 articles. Section 3 compares the similarities and differences between the articles and section 4 critically analyses the methods used in the articles. Section 5 identifies the limitations whereas section 6 presents the gaps in the articles. Lastly, section 7 focuses on conclusion and recommendation for future researchers.

2. Selection of Articles

The Robertson Library was used to carry out the search for 12 articles using the following search string: summary(blockchain) AND summary(supply chain management). To ensure quality of the articles the following was selected: (1) Limit to: peer-reviewed and full-text, (2) Source type: journal articles, (3) Document type: articles, (4) Language: English. After selecting the following predecessor, 82 publications resulted. From the result, the title, authors name and year were verified since blockchain is a contemporary topic. Finally, the abstract, methodology and conclusion were briefly read to determine 12 articles.

3. Literature Review

All the articles have highlighted that blockchain technology (BT) improves supply chain management (SCM) either through transparency, traceability, security, agility, speed, reliability, or flexibility. However, two themes that were consistent in all articles were transparency and traceability. Researchers had similar and contrasting views regarding transparency and traceability as stated below:

3.1. Transparency

Ghode et al. (2021), Rodrigues et al. (2021) presented that SCM does not require a middleman to operate therefore it eliminates human intervention, making transactions between parties visible and transparent. Bartsch (2021), Hong et al. (2021), Rejeb et al. (2021), Wang et al. (2019) argued that due to decentralised database, customers can acquire the product information from production to delivery. Bartsch (2021) and Wang et al. (2019) further investigated the link between transparency and customer satisfaction. The authors set out to explore how does transparency build more trust amongst customers. The authors had examined food industry to illustrate that customers are satisfied when they are able to acquire detailed information regarding the safety, packaging, and quality of product that they will consume.

Gurtu et al. (2019), Keresztes et al. (2022), Mahyuni et al. (2020), Varriale et al. (2021), Zekhnini et al. (2021) intention was to discover the relationship between transparency and businesses. The authors presented here that even if the workers in the network do not trust each other, BT will guarantee the final product is safely produced. Mahyuni et al. (2020) and Zekhnini et al. (2021) reminded us how complex supply chain is and BT introduces transparency whereby the distributed ledger is transparent, enhancing business to monitor and verify every step without any disruptions. Gurtu et al. (2019), Keresztes et al. (2022) reminded us of the importance of transparency to ensure businesses meet legal compliance and focus on risk reduction. However, Gurtu et al. (2019) further elaborated that since all information is transparent to anyone, the possibility of fraud is eliminated, hence security is attained. The author shed light on the shipping company as the documents are uploaded instantly allowing participants to know the shipment progress from the departure to the destination.

Apart from highlighting good impacts of transparency, 4 researchers convince us that transparency can also have negative impacts on SCM. Although all users can be identified as transactions are recorded in a distributed ledger, user privacy is compromised (Rejeb et al., 2021; Varriale et al., 2021). The authors further highlighted that in SC, especially in food industry, privacy is utmost important due to competition. Rejeb et al. (2021) made an important distinction between participant behaviour and BT transparency. The researcher convinces us that BT transparency surely is a new change and

participants do not always welcome change wholeheartedly. Therefore, the unwillingness to adopt to this change will unnecessarily cause delay in SCM processes. On the other hand, Ghode et al. (2021), Wang et al. (2019) clearly emphasised that transparency makes business vulnerable as participants in SC do not wish to share valued information.

3.2. Traceability

The researchers had themed traceability with trust, safety and reliability. Bartsch (2021), Ghode et al. (2021), Gurtu et al. (2019), Rodrigues et al. (2021) highlighted that due to blockchain technology, trust is achieved in SC as tracking time of products has been reduced from days to seconds. Bartsch (2021) gave importance of traceability in pharmaceutical companies whereby BT can be fully trusted upon to ensure that the medical products will be in its original condition. Ghode et al. (2021), Gurtu et al. (2019), Rodrigues et al. (2021) persuades us that the blockchain has made tracking easier in the food supply chain as suppliers are able to make real-time checks to measure product quality. Ghode et al. (2021) further convinces us by stating that suppliers can trust BT to verify if any food has been damaged while in transportation or has gone bad which can assist them to prepare for another delivery to maintain customer relationship.

Keresztes et al. (2022), Mahyuni et al. (2020), Rejeb et al. (2021), Wang et al. (2019) analysed how blockchain-enabled traceability enhances safety and ensures suppliers provide safe and quality products. Keresztes et al. (2022), Rejeb et al. (2021) only focused on the BT's ability to trace for risk and deliver high-end food product to customers. The authors drew connection between safety and legality by highlighting that BT can pick out illegal food easily. Contrary, Mahyuni et al. (2020), Wang et al., (2019) reflect the significance of traceability and safety in food and pharmaceutical industries. The authors reflected the importance of traceability to boost safety in both the industries as BT can identify the exact default product without endangering the entire batch. Wang et al. (2019) set out to further investigate on pharmaceutical industry and underlined how BT allows pharmaceutical supply chain to check on the moisture and temperature of medical products during transportation.

Hew et al. (2020), Varriale et al. (2021), Zekhnini et al. (2021) presented that reliability is guaranteed when BT is implemented for traceability. All authors had also emphasised on food industry by stating BT-enabled traceability removes accountability and disclosure issues. However, Varriale et al. (2021) also highlighted reliability within pharmaceutical industry as BT is relied upon to trace the medicines history and determine which are sensitive to climate, changes in environment to improve procurement management. Contrary, Hew et al. (2020) set out to explore whether BT is reliable enough to trace Halal (permissible) food and beverage for manufacturers. The author set out to determine if BT can trace every single ingredient in production to ensure food reliability and integrity is upheld.

The researchers also drew connection between BT-enabled traceability and complexity (Rodrigues et al., 2021; Wang et al., 2019). The researchers identified that though BT can trace transactions, it could not always provide the correct movements of materials in SCM, resulting in errors, conflicts and even

malicious attacks. Varriale et al. (2021) persuades us that participants in SCM may not have confidence to understand traceability which poses as a major barrier to companies.

4. Review of Research Methodology

The methodology of 12 articles were critically analysed to determine the creditability and relevancy within applied management. The articles were based on Qualitative (6 articles), Quantitative (1 article), and Mixed (5 articles) research methods which will be discussed below:

4.1. Qualitative Research Method

4.1.1. Literature Review

Figure 1: Summary of Qualitative Methodology – Literature Review

Authors / year	(Bartsch, 2021)	(Varriale et al., 2021)	(Mahyuni et al., 2020)	(Gurtu et al., 2019)	(Zekhnini et al., 2021)
Data Collection	Systematic Literature Review	Systematic Literature Review	Systematic Literature Review	Structured Literature Review	Structured Literature Review
Databse Used	Science Direct (SD), Web of Science (WoS)	Scopus	Google Scholar and Science Direct (SD)	EBSCO Premium	Scopus, Google Scholar and Science Direct (SD)
Data Source Creditability:	Rating of the journals	Reading title, author, year,abstract	Reading of the titles and portions	Rating of the journals (A* & A)	Rating of the journals (A* & A)
Year	Not Specified	2008 – 2020	2015 – 2019	2015 – 2018	1994 – 2020
Articles	32	60	52	66	176
Sampling Method	Judgement/Purposive	Judgement/Purposive	Judgement/Purposive	Judgement/Purposive	Judgement/Purposive
Data Analysis	Qualitative Content Analysis (QCA) - deductive	QCA - deductive	QCA - inductive	QCA - inductive	QCA - inductive and deductive
Standing within applied management	Help researchers to apply theory or conceptual frameworks	Help researchers to apply theory or conceptual frameworks	Establishes concepts / doesn't extablish a framework	Establishes concepts / doesn't extablish a framework	Suitable as it proposes a Conceptual framework

5 researchers had selected literature review as a means of data collection under Qualitative research. Gurtu et al. (2019), Zekhnini et al. (2021) performed a structured literature review, whereby, steps were identified clearly to ensure BT and SCM are analysed objectively as possible, however, Bartsch, (2021), Varriale et al. (2021) and Mahyuni et al. (2020) conducted a systematic review of the literature which is a well-established method by providing transparency, verifiability ease in auditing the researchers decisions, methods and conclusion (Wang et al., 2019). The number of database selected by the researcher varied, however, the most frequently used database was Science and Scopus. Mahyuni et al. (2020) convinces us that Science Direct provides a high-quality journal, books, and reference content across multiple topics, enabling researchers to work effectively and efficiently, however Varriale et al. (2021) shed light on Scopus being one of the largest database containing peer-reviewed literature from all around the world.

2 researchers had selected the search period of articles which had more than 10 years of range (Varriale et al., 2021; Zekhnini et al., 2021). Varriale et al. (2021) drew connection between the importance of year selection and finding a vast range of relevant articles. Contrary, Gurtu et al. (2019) and Mahyuni et al. (2020) search period started from year 2015. Mahyuni et al. (2020) highlighted that 2015 was the initial search period as it was the growth of research paper of using blockchain with supply chain management. Bartsch (2021) does not seem to highlight the search period which surely can be ambiguous for future researchers.

Bartsch (2021), Gurtu et al. (2019), Zekhnini et al. (2021) selected the final articles by determining the quality through journal rating. However, Gurtu et al. (2019), Zekhnini et al. (2021) disclosed a full breakdown of journals with A* and A rating. Zekhnini et al. (2021) reflects on the significance of journal ranking to determine the quality and impact the paper has within its field.

The articles used judgement sampling (non-probability) technique to finalise the articles. The researcher has chosen the articles based on their knowledge and their own opinion. Mahyuni et al. (2020) pointed out that this technique is less time consuming and cost-effective, however, West (2016) argues that since researchers exercises their own judgement, there is room for biasness.

The researchers have used qualitative content analysis to interpret articles. Bartsch (2021), Varriale et al. (2021) used deductive content analysis which is a top-down approach, whereby the researchers had predetermined codes (themes) and had analysed the data to sort it accordingly into respective codes. Deductive approach is suitable for future researchers to stay focused and maintain alignment with research question (Behling et al., 2022). On the other hand, Gurtu et al. (2019), Mahyuni et al. (2020) has used inductive content analysis which is a ground-up approach whereby the researchers looked at the data to derive codes which will be appropriate for the data. The researchers were able to develop concepts relevant to the research, however, did not establish framework. Behling et al. (2022) underlined that Inductive research method is suitable for coming up with new framework, however, the researchers do not seem to follow the importance of inductive content analysis. Zekhnini et al. (2021) utilized both deductive and inductive content analysis, whereby the researcher used deductive strategies to organise his data and inductive to fully understand the content of the data to form a conceptual framework. The approach taken up the researcher is rigorous, organised and derives meaningful implications.

4.1.2. Interview

Keresztes et al. (2022) visited logistic and supply chain management field websites to draw a list of interview questions to conduct in-dept interview of 2 companies that uses blockchain technology. The interview was semi-structured, and questions were exploratory in nature to ensure further research questions could be formulated on (Keresztes et al., 2022). The researcher had only interviewed 2 companies that uses blockchain technology, however, did not state the characteristics of the company. The data gathered from only 2 researchers to make further analysis is not reliable, hence not suitable for applied management. However, the researcher used qualitative comparative analysis to design expert qualitative framework whereby different characteristic of blockchain technology is identified.

4.2. Quantitative Research Method

Hew et al. (2020) identified 700 participants from manufacturing company and only 143 responses were collected through online survey. A Likert-scale was used to measure the response received from the participants. Simple random sampling was used to select the manufacturers, to ensure validity and unbiases of the responses. Accessing a full list of 700 participants was difficult and specific participants did not disclose data due to confidentially or was happy to hand over their information (Hew et al., 2020). The researcher made it clear that statistical analysis is important to prove the 5 hypothesis that was developed. Consequently, we see that the researcher successfully answered all the hypotheses that was established which can assist future researchers.

4.3. Mixed Research Method

Figure 2: Mixed Research Method

Authors	(Rejeb et al., 2021)	(Rodrigues et al., 2021	(Hong et al., 2021)	(Wang et al., 2019)	(Ghode et al., 2021)
	Equal - Concurrently	Unequal - Sequentially	Unequal - Sequentially	Equally - Concurrently	Unequal - Sequentially
Data Collection: 1	Literature Review - primary	Literature Review - secondary	Literature Review - secondary	Literature Review - primary	Literature Review - secondary
Databse Used	Scopus, Web of Science (WoS)	Scopus, Science Direct, Web of Science	Not specified	10 Public Database: Scopus, Wos and Science Direct etc	Not specified
Data Source Creditability:	Peer reviewed and English Language	Peer-reviewed and abstract	Not specified	Peer-reviewed scholarly articles	Not specified
Year	2016 - 2020	2008 - 2019	Not specified	2008 - 2018	Not specified
Articles	628 articles	31 articles	Not specified	227 articles	Not specified
Data Collection: 2	Questionnaire - primary	Questionnaire - primary	Questionnaire - primary	Questionnaire - primary	Survey Interview - Primary
Pariticipants	100 participants	200 participants	10 participants	Not specified	5 participants
Characteristics	Identified based on expertise/knowledge	Identified based on expertise/knowledge	Top management positions	Industrial , EU Blockchain Observatory	More than 50 publications in BT and SCM
Sampling Method	Judgement/Purposive	Judgement/Purposive	Convenience	Judgement/Purposive	Judgement/Purposive
Data Analysis	Bibliometric Analysis (BA) / Quantitative Analysis (QA)	Bibliometric Analysis	Exploratory Factor Analysis (EFA)	Qualitative Content Analysis - deductive	Cross-Impact Matrix Multiplication Applied to Classification
Suitability of Methods	Provides good starting point for conceptual foundations	Establishes model which would assist researchers	Holistic framework helps organizations to have a road map	Identify main drivers of BCM within SCM-future researchers	Implications for the successful adoption of BT in SC management

Rejeb et al. (2021) & Wang et al. (2019) equally collected data using literature review and questionnaire in a concurrent order. However, Ghode et al. (2021), Hong et al. (2021) & Rodrigues et al. (2021) carried out the data collection sequentially but treated it unequally. The researchers set up

to collect data from literature review which was treated as a secondary source to draft questionnaires which was treated as primary source. However, Ghode et al. (2021) drafted survey interview questions. Response was measured using a Likert-scale which is effectively used to measure the responses of the participants.

Rejeb et al. (2021), Rodrigues et al. (2021), and Wang et al. (2019) identified the number of database, year and articles selected. Wang et al. (2019) reminded us of the significance of searching through multiple databases to avoid missing out on the best results by going through 10 databases. All 3 researchers also selected the articles which were peer-reviewed to maintain the accuracy and validity of the research. Rejeb et al. (2021) selected the starting period from 2016, however, Mahyuni et al. (2020) reminded us that blockchain usage in supply chain management grew in 2015. Therefore, the research has missed out on 1 years' worth of articles which could have made a huge impact on his questionnaires.

Ghode et al. (2021) and Hong et al. (2021) does not seem to follow transparency which is an important aspect in research by not disclosing database, year, and article quantity. The researchers had identified the number of participants except Wang et al. (2019). The researchers did not reveal a detailed information regarding the participants but had stated that they have knowledge and expertise in BT and SCM field. All researchers had selected the participants based on judgement which assisted the researchers to deliberately select participants to answer the research questions. Hong et al. (2021) drew connection between convenience sampling and time as the technique allowed the researcher to get responses from the nearest experts in a short span of time. Though judgement and convenience sample assisted the researcher to gather timely results, biasness existed in both the techniques.

The data analysis was conducted using bibliometric and quantitative analysis, exploratory factor analysis, qualitative content analysis and Cross-Impact Matrix analysis. The results by the researchers either developed a framework or provided a roadmap for conceptual foundation for future researchers.

5. Limitation

Some researchers utilised one or two databases to look for relevant articles which would miss out on relevant papers that other database could have offered. The keyword search may have also excluded relevant BT and SCM articles. Convenience and judgement sampling to select participants or articles can be bias as the researcher exercises his/her final judgement. Moreover, some researchers only used limited number of participants to carry survey whereby, detailed results cannot be captured from a small number of participants.

6. Gaps

The following gaps has been identified from the articles:

1. Researchers do not fully disclosure the negative impacts that BT could bring to companies. It is vital for companies to comprehensively understand every side of BT, whether its positive or negative before deciding to adopt it.
2. None of the articles explicitly stated the impact of BT on each step of SCM. The researchers do advise on the impacts, however SCM comprises of a big network from raw materials to final products.
3. Researchers mention in their articles that BT will bring about challenges in SCM, however, they failed to mention ways in which companies could adopt to eradicate these obstacles.

7. Conclusion and Recommendation for Future Researchers

To conclude, a critical analysis of 12 articles were undertaken to fully answer the research question. All the papers highlighted that supply chain management is not flexible, reliable, unsafe and cannot meet customer demand. Therefore, the researchers highlighted that companies should consider adopting BT in SCM. The two popular concepts that the articles highlighted were transparency and traceability. Due to its advanced technology, BT enables all parties in SCM to view information without any disruptions. Moreover, it also allows companies to accurately trace products and determine the exact location. Hence, BT brings about customer satisfaction as customers get their product on time and can also view the quality of product (Hong et al., 2021).

On the other hand, a handful of researchers also reminded us that BT will also have negative impacts on SCM. Participants may not feel comfortable to share information due to confidentiality of documents. Therefore, participants will be reluctant to this new change will eventually slow the process of SCM (Wang et al., 2019).

Moreover, a critical analysis of the methodology of the articles was conducted to determine the studies credibility within applied management. Qualitative and mixed research method as Qualitative research method allows researchers to gather information on what people think and the reason behind it (Gurtu et al., 2019). Likewise, Mixed research assist researchers to use both qualitative and quantitative method to gain greater insight. The 12 articles provided interesting insights, however, has gaps which surely can be used as a roadmap by future researchers. Future researchers can take advantage of the following recommendation:

1. Can examine the negative impacts of BT in SCM which can be used as a framework by companies. Moreover, researchers can introduce guidelines that companies should undertake to mitigate the issues for better operational results.
2. Carry out research on the impact of BT on the various stages of SCM to fully understand the benefits and adverse impact that BT will bring.

3. Researchers can discuss the various obstacles that BT adopting in SCM will bring. It is important for firms to understand the difficulties that they could face when adopting BT as a precautionary measure
4. Researchers can analyse the implementation of BT and sustainability in SCM. For companies to retain competitive advantage, it is essential for researchers to identify the importance of sustainability which will assist companies to consider switching to BT.

Overall, BT in SCM is still a contemporary topic which needs to be studied and developed further for companies to fully understand BT before implementation. However, BT surely does bring both positive and negative impacts on SCM.

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Annexure

Number	Title	Author	Journal
1	Supply chain management 4.0: a literature review and research framework	(Zekhnini et al., 2021)	Benchmarking: An International Journal
2	Mapping the potentials of blockchain in improving supply chain performance	(Mahyuni et al., 2020)	Cogent Business & Management
3	Blockchain Technologies in Logistics and Supply Chain Management: A Bibliometric Review	(Rejeb et al., 2021)	Journal of Manufacturing Technology Management
4	Exploratory Analysis of Blockchain Platforms in Supply Chain Management	(Keresztes et al., 2022)	The Journal of International Management
5	Blockchain in Supply Chain Management: Characteristics and Benefits	(Rodrigues et al., 2021)	Brazilian Administrative Review
6	New organizational changes with blockchain: a focus on the supply chain	(Varriale et al., 2021)	Journal of Organizational Change Management
7	Blockchain performance in supply chain management: application in blockchain integration companies	(Hong et al., 2021)	Industrial Management & Data Systems
8	Potential of blockchain technology in supply chain management: a literature review	(Gurtu et al., 2019)	International Journal of Physical Distribution & Logistics Management
9	Understanding blockchain technology for future supply chains: a systematic literature review and research agenda	(Wang et al., 2019)	Supply Chain Management: An International Journal
10	The blockchain-based Halal traceability systems: a hype or reality?	(Hew et al., 2020)	Supply Chain Management: An International Journal
11	Applications of Blockchain Technology in Logistics and Supply Chain Management—Insights from a Systematic Literature Review	(Bartsch, 2021)	Logistics Journal
12	Blockchain adoption in the supply chain: an appraisal on challenges	(Ghode et al., 2021)	Journal of Manufacturing Technology Management