Transnational Marketing Journal
April 2021
Volume: 9, No: 1, pp. 3 – 16
ISSN: 2041-4684 (Print) | ISSN 2041-4692 (Online)
TransnationalMarket.com

TRANSNATIONAL PRESS® LONDON

Received: 29 May 2020 Accepted: 18 January 2021
DOI: https://doi.org/10.33182/tmj.v9i1.1021

Barricades in the Adoption of Block-Chain Technology in Supply Chain Management: Challenges and Benefits

Pervez Akhtar[1], Nora Azima[2], Abdul Ghafar[3], and Shahab Ud Din[4]

Abstract

Blockchain technology, as a distributed digital ledger technology which ensures traceability, security and transparency is displaying potential for easing some comprehensive supply chain problems. Scholars have started analyzing systematically the potential benefits and effects of block-chain on numerous activities of an organization. This paper presents the barricades in the adoption of block-chain technology in supply chain management. The potential benefits of block-chain adoption such as, quality, cost, speed, transparency, durability and immutability are also discussed in this paper. We present the early literature discussing the use of block-chain in the field of supply chain to enhance the accountability and transparency. This study explains the several mechanisms by which supply chain managers can prepare their organizational structure to adopt the latest technology. It further highlights the mechanisms to achieve supply chain objectives. Part of this paper also discusses how blockchains, a potentially disruptive solution which is on its early evolution, can overcome several potential barricades. The future research directions are proposed which can further provide insights into overcoming barriers and adoption of blockchain technology in the field of supply chain management.

Keywords: *Barricades; Technology; Blockchain; Supply Chain Management*

Introduction

Modern supply chains are multifaceted and complex having multiple geographical locations with multi-echelon competing to serve customers (Johnson, 2006; Lambert & Enz, 2017). The emergence of new markets, different regulations, trade policies, cultures and ultimately the human behavior involved in supply chain networks create complex situation where risk management and evaluation of information becomes challenging in supply chain networks (Sarpong, 2014). Fraud, pilferage, inefficient transactions and poorly performance supply chains, lead to trust deficit over the recent years. Therefore, for the emergence of proper information sharing, traceability and verifiability has become a pivotal requirement and a central differentiator in supply chains across the industries including agri-food (Costa, 2012), pharmaceutical (Rotunno et al. 2014) and highly valued good. Especially, the high value luxury goods whose attribution might otherwise be contingent on paper-based receipts and certificates can easily be altered or lost. In fact, the shortage of transparency in the supply value of a product limits the customers and other supply chain stakeholders to verify and validate the true value of that product. Higher costs involved in handling the intermediaries, their transparency and reliability further complicates traceability and the management of

[1] Pervez Akhtar, Faculty of Business, Higher Colleges of Technology, UAE. E-mail: pakhtar@hct.ac.ae.
[2] Nora Azima, Faculty of Business, Higher Colleges of Technology, UAE. E-mail: nazima@hct.ac.ae.
[3] Abdul Ghafar, Faculty of Business, Higher Colleges of Technology, UAE E-mail: aghafar@hct.ac.ae.
[4] Shahab Ud Din, Faculty of CIS, Higher Colleges of Technology, UAE E-mail: suddin@hct.ac.ae.

supply chains. It has been noted that strategic and reputational issues also arise from the lack of transparency and traceability.

Current supply chains are heavily based on stand-alone and centralized information management systems which are within in the organizations, i.e. enterprise planning systems that has its own pitfalls. Supply chain systems require substantial belief for relying on one single firm or broker to store their highly sensitive and valuable information. Another big disadvantage of centralized information system is single point failure. This leaves the overall system susceptible to corruption, errors, attacks and hacking (Dong et al., 2017).

These issues further raise important concerns re regarding the strength of current supply chain management and information systems. The extent to which current systems support information required for the delivery of goods and services, in a secure, clear, robust and trust worthy manner has been highlighted as an important area of investigation. The resolution of these complex problems is possible by improving the transparency, durability, security and process integrity of supply chain systems. Block-chain technology has been perceived a viable solution to tackle such problems. The development of new technologies and applications with the concept of block-chain technology make these improvement goals more feasible technologically and economically (Abeyratne & Monfared, 2016; Swan, 2015). Block-chain technology as a potential disruptive technology characterized with decentralized database allows for transactions at global scale among numerous parties (Crosby et al. 2016).

Some evidences demonstrate the potential use of block-chain technology in the supply chain. The popular cases include Maersk and its partnership with IBM for its maritime container management through block-chains. According to IBM, in this case, billions can be saved by attaching more accurate and trustworthy bills of landing to the containers. Fascinatingly, though billions of savings were stated, it is not clear if a large-scale implementation was possible keeping in view the scaling issues. From a sustainable supply chain perspective, a block-chain service provider tried to incorporate block-chain technology in the seafood supply chain. In this case, legitimacy and transparency of sustainable practices were critical (Steiner & Bakar, 2015). Although there are apprehensions related to economic, environmental and social issues, block-chain's latent uses have seen significant discussion in the potential literature.

Although, there are an increased number of cases using block-chain technology over the past years. However, just like any potentially disruptive technology or information system, supply chain networks are facing numerous hindrances and hurdles in the adoption and implementation of the block-chain technology. Block-chain is still in very early stages of development with various difficulties from technological, organizational, behavioral and policy-oriented aspects (Crosby et al., 2016; Lemieux, 2016; Yli-Huumo, 2016). These issues are important and will remain a point of discussion among the scholarly literature in coming years. These issues have yet to be addressed effectively. In this article, we inductee the debate focusing not only on block-chain based supply chain challenges and hurdles but also on the benefits of block-chain adoption and application in the supply chain management.

Past studies have presented some integration of blockchain and supply chain, with the application of internet of Things (IoT) (Tian Feng , 2017, 2016) , by applying case studies (Verhoeven et al., 2018), or Survey methods (Hackius & Petersen, 2017) . These studies discussed few benefits, such as progressing traceability efficiency, improving supply chain

straightforwardness and confidentiality. Whereas there are few challenges like, versatility, need of legislation, and juvenile technology (Tian Feng , 2016). In any case, few studies have been carried out to explore this theme in a precise way, particularly with an administrative focus. Hence, this paper aims to fill this gap. In this way, the essential point of this paper is to examine how blockchain has been used within the supply chain area, and how it can offer assistance to address supply chain issues. Therefore, this paper answers the following research questions:

• **Question 1:** What research has been carried out on blockchain adoption in supply chain management?

• **Question 2**: What benefits can blockchain offer to the field of supply chain?

• **Question 3:** What are the challenges of blockchain adoption in supply chain management?

• **Question 4:** How firms can overcome the potential challenges of Block chain?

In order to answer these questions and enable to accomplish the aim of this study, we will collect and outline related papers, and give a more profound examination of the literature. More particularly, this paper applies the content-analysis based literature technique to back this analysis.

Literature Review

This section provides a brief review of the relevant concepts, including supply chain, Blockchain, and barricades in the adoption of supply chain, to provide some background information as the basis for this study

Block-Chain Technology

Block-chain technology is a distributed database of records or shared public/private ledgers of all digital events that have been executed and shared among block-chain participating agents (Crosby et al., 2016). History of block-chain technology can be traced to distributed ledger technology. This technology differs from the existing information system designs in four aspects, decentralization, security, smart execution and auditability (Steiner & Bakar, 2015).

In block-chain, an agent performs/creates a new transaction to be added to the block-chain. The new transaction is transmitted to the network for audit and verification purpose. If the majority of nodes in the chain approve this transaction based on pre-specified approved rules, this transaction will be added to the chain as a new block. The transaction record is saved in multiple scattered nodes to ensure the security of the data. Meanwhile, the smart contract allows the performance of reliable transactions without the involvement of third parties. The main difference between the present design of internet and block-chain technology argues that the internet was created to transmit information, not value, to transfer copies of things not original information. In block-chains, the value is transferred in the form of recorded transactions on a shared ledger. It is further secured by providing time stamped and verifiable record of transactions which contain auditable and secure information (English et al., 2016). These transactions are verified by the existing network rules. Once, verification of the record

is completed it is added to the block-chain, several copies are created and stored in a decentralized manner to create a trustworthy chain for all the stakeholders involved.

Figure 1. Steps in block-chain information and transaction (Saberi et al. 2019)

Block-chain technology has also become a popular platform in the field of digital cryptocurrency Bitcoin. With its prime function of digital currency, block-chain has become a new computing and information flow paradigm with its comprehensive associations for future developments in the field of logistics and supply chain management (Abeyratne & Monfared, 2016; Tian, 2016).

Decentralization is the key feature of block-chain technology. It is used as a check on any alteration of the information which increases information validity. This removes the need for collectively maintained records. It provides the verified access to participants via distributed private or public ledgers for each transaction (Crosby et al., 2016). A centralized database is vulnerable to crashing, hacking and corruption (Tian, 2016). Trust is the key of decentralization as it does not require the trustworthiness of the intermediary of other stakeholders in the network and information can be viewed, compared and verified very easily (Nofer et al. 2017).

No particular behavior is required from the stakeholders, instead, the block-chain technology promises the *truthfulness* of the system in-case of any fraudulence or redundancy from the participants. Participants can view the ledgers and perform their analysis on each transaction. This feature ensures transparency (Tian, 2016) while concurrently certifying anonymity through preserving records behind crypto graphics (Crosby et al., 2016). Block-chains guarantee the generalization of agreed-upon rules that no stakeholder, operator or users of the system can break. They trust on inimitable system architecture involving several stakeholders who require little trust in each other; i.e. fragmented supply chains.

Block-chain design can have different forms of public or private networks and ledgers primarily depending on the underlying technology. Public and private design differs in terms

of the network players and procedures to maintain the block-chain (Ølnes et al. 2017). The public or open block-chain allows the users to enter in the network and record their transactions. However, to ensure trust with several anonymous users, cryptographic methods are at the forefront in terms of its use and application. While, in the private block-chain, anonymity is no more required as the parties know each other, such as in a supply chain network among known parties who work to produce and distribute the products. In this network, a new role of certifiers is required, who deliver the certificates to supply chain networks stakeholders and maintain the private network (Pilkington, 2015).

Block-chain applications are managed by a so-called smart contract. In a smart contract, the terms and conditions of the agreement are already agreed among the parties. The sets of terms and conditions are stored in the system to monitor the status of the conditions in order to facilitate the contract to take place. The smart contract also outlines the penalties and rules of a contract and automatically implements and imposes the obligations in the contract (Ølnes et al., 2017).

A smart contract can be defined as "a mechanism involving digital assets and two or more parties, where some or all of the parties put assets in and assets are automatically redistributed among those parties according to a formula based on certain data that is not known at the time the contract is initiated" (Buterin, 2014). According to a smart contract it can be defined as a program running on the block-chain with its own correct execution prescribed by the agreed-upon protocol (Luu et al. 2016). A smart contract holds the complete information of a contract and only executes it when all the condition are authenticated by all nodes in the network (Luu et al., 2016).

Table 1. Key variations in BC Applications

BC Applications	Permissioned	Permission less
Public	No restricted data access or transactions. Only a restricted set of nodes can participate in the consensus mechanism.	No restriction on access, transaction (data writing) or validation.
Private	Restricted access, data writing and validation. Only the owner determines who can participate.	Restrictions on access and who can transact. No restriction on participation in the consensus mechanism.

Source: (Ølnes et al., 2017)

Table 2. Comparing open and closed BC applications

Features	Private/Open BC	Public/Closed BC
Who can update	Everybody	Appointed entities
Who can produce data	All users	Customers and/or partners
Incentive to follow rules	Economic	Reputation
Storage	Distributed	Centralized
Trust central actors	No	Yes
Transaction costs	Varies from low to high	Low
Capacity/throughput	Low/slow	High/fast
Immutability	Strong	Unclear

Currency/token	Yes	No
Examples	Bitcoin, Ethereum	Hyper Ledger, Corda

Source: (Ølnes et al., 2017)

Technological Advantages of Block-Chain Technology

Essentially block-chain offers multiple key technological benefits to its users. The four key benefits of block-chain are transparency, process integrity, durability and immutability (Bogart & Rice, 2015).

Transparency: In the block-chain all stakeholders can have an indistinguishable copy which is maintained on network nodes. The data set can be inspected and audited in real-time. This transparency level makes all the activities highly visible on the network, this reduces the need for trust among the stakeholders.

Process Integrity: Circulated open-source protocols are completed precisely as written in the codes. Users can trust that actions defined on the protocols are completed timely and accurately with any human interference.

Durability: Decentralized networks are immune to hacking, fraud or any tempering compare to centralized systems. This scattering nature of risk to its different nodes makes block-chains durable as opposed to centralized systems. This protects the records against any malicious access attempts.

Immutability: The dispersed data stored on the public block-chain is virtually irreversible due to the validation need by all other nodes and traceability of changes. This builds trust among users to operate with a higher level of confidence that chain of data is infrangible and correct.

Block-Chain-Based Supply Chain

Block-chain seems a suitable and disruptive technology for the organization, design, operations and general management of supply chains. The key features of block-chain include authentication of information, reliability, traceability and smart contracts for a trustless atmosphere all contribute to rethinking about the traditional way of management of supply chains (Saberi et al. 2019). This section presents the value proposition of block-chain, its application to supply chains and potential new components for supply chain management. As emphasized, there is a requirement of traceability and transparency in the supply chains. It can be achieved by focusing on the transparency of the entire chain, where correct data should be collected and should be stored in a secure environment (Azzi et al. 2019)

The functions of block-chain in the context of the supply chain are still at the entail stage which needs further interpretation and development. In contrast to bitcoin and other crypto currency block-chain applications, which are public, block-chain based supply chain may need a closed, permissioned, private block-chain application where several players can have access to the network. Arguably, there will always be an opportunity and debate for a more public set of relationships.

According to Steiner & Bakar, (2015) there are four main players in block-chain based supply chains.

Registrars: Providers of unique identity to the actors in the network.

Standards Organizations: The defining authority of standard schemes, technical requirements and policies.

Certifiers: Providers of certifications to actors for supply chain network participation.

Actors: Which include customers, retailers and manufacturers. They are certified by a certifier or registered auditor to uphold the trust in the system.

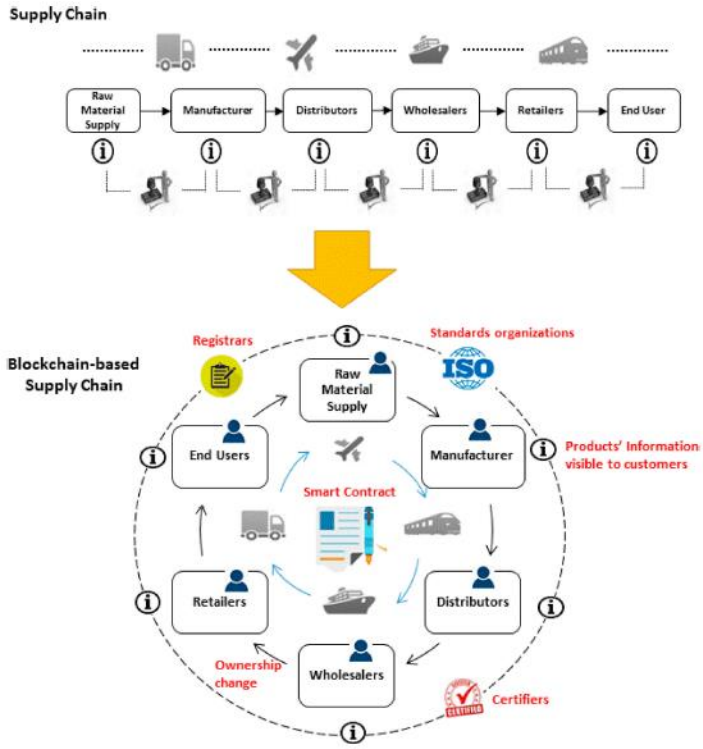
Block-chain tend to affect quality, cost, speed, risk reduction, dependability, flexibility and sustainability which are the main objectives of supply chain management. Specifically, block-chain technology can improve several facets of the traditional supply chain to transform it to block-chain based supply chain. The ability of block-chain to ensure the reliability of information through smart contracts in a trustless environment improves the supply chain intensely (Kshetri, 2018).

The flow of material and supply chain of products can be influenced by the block-chain dramatically. The products are attached with an information tag that is called the identifier, which links products with their simulated identities in network (Abeyratne & Monfared, 2016). All actors in the supply chain, consumers, retailers, and manufacturers have a certification from the certifier or auditor to have direct access to the product profile (Steiner & Bakar, 2015; Tian, 2016). Before transfer of goods both parties should fulfill the smart contract requirements to validate the exchange. Smart contracts ensure the real-time execution of logistics monitoring and transaction can be completed automatically as the product ownership changes based on predefined and agreed rules between the parties (Reyna et al. 2018).

Smart contracts, as a set of written rules, kept on the block-chain helps to outline network actor's communication between each within in a system. Smart contracts affect the data sharing on the network between supply chain stakeholders and improves the process continuously. For example, standards organizations and certifiers are responsible to verify and approve the digital profile of each actor and products on the network. Actors and products also have a digital profile on the network, which shows the relevant information such as location, product description, certifications and other association of the products. Each supply chain stakeholder can update the key information of a given product and its status on the block-chain network (Tian, 2016).

Governance of smart contracts and processing rules in block-chain based supply chain can decide what processes and approval are required to allow the actors access to the network for the execution of a contract. Actor's data can change depending on the position, type of supply chain and rules defined by the smart contracts. Actors are not allowed to change the rules without a consensus among all the stakeholders. Smart contract features and processes can facilitate continuous improvements in supply chain processes. Block-chain technology has the potential to capture performance metrics in ledgers and link them to the already agreed-upon rules. This approach and information have the capability to redesign the traditional supply chains besides just concerns in governance and product delivery (Saberi et al., 2019).

Figure 2. Supply Chain Transformation through Block-Chain (Saberi et al., 2019)



Block-chain influences not only supply chain processes but also product management and financial transactions between stakeholders (Hofmann et al., 2017). One of the major advantages of block-chain technology is the removal of financial intermediaries, such as stock exchange, money transfer agents and payment networks (Tapscott & Tapscott, 2017). It can potentially improve the overall trading process among supply chain players. Furthermore, financial inefficiencies in supply chain can be minimized through different techniques and instruments such as, dynamic discounting and reverse factoring. Smart contracts have the capability to organize financial arrangements to ensure that there are enough funds to finance the project and that all parties are paid on time (Hofmann et al., 2017). It can also facilitate the transactions between different currencies or a mix of currencies in the global supply chain in a timely and secured environment (Eyal, 2017).

Barriers in the Adoption of Block-Chain Technology in Supply Chain

As explained above block-chain has the potential to revolutionize the supply chain field. However, there are certain barriers to block-chain adoption in the supply chain. In the following part, we will explain the key challenges in the adoption of block-chain technology in the field of supply chain management.

Immaturity of Block-Chain Technology: Currently, Block-chain technology has been evolving and perceived to be in the development stage. The practical adaptability can have a negative

impact on the company's business due to block-chain immaturity. There are cases where companies encountered complex challenges when adopting block-chain technology primarily due to the defects in block-chain itself. As more than fifty percent of the nodes should agree to each transaction so the transaction capacity cannot be termed as efficient (Gervasi et al., 2018; Tian, 2016). Block-chain is unable to store large amounts of data. Therefore, it is mandatory to detect the amount of data on the chain (Tian, 2016). In addition, data privacy is protected by asymmetric encryption, with the use of public and private keys. However, if any of the keys is lost, it cannot be recovered. Therefore, security of private and public key itself is a prime challenge at the moment. Due to the issues related to the practical adaption of block-chain, some school of thoughts have argued that organizations need to educate them regarding the benefits and complexity surrounded the block-chain technology, and thus requires serious time commitment and resources in its adoption. (Bettín-Díaz et al., 2018).

Requirements of Higher Investment: Block-chain technology needs infrastructural investments and continuous financial support to incorporate all the key functions of the firm into the system (Menon, 2018). Other concern is regarding small suppliers, who may need to spend a large amount of time. The possible solution can be financial support and subsidies by the government. Traceability which is the key feature of block-chain in supply chain sometimes costs more than the original cost of the product. In addition, the records cannot be tempered on the block-chain, it means higher cost to modify the inaccurate data (Tan et al. 2018).

Impediment of incorporating different systems: It is very crucial to ensure the data quality for a successful block-chain based supply chains. To implement the block-chain based supply chain systems it is mandatory that all the stakeholders take part in it. If any party (manufacturer, supplier, whole seller, retailer or customers) exhibit lack of interest to participate, some important information can be missing and not available on the chain (Edmund, 2018; Kravitz & Cooper, 2017). Since, block-chain should be applied at the production process levels, some manufacturer may not be ready to share their date because of missing information. There is another problem at the same time, in order to endorse information sharing among stakeholders in the chain, it requires a healthy ecosystem of firms. It is a challenging job, as friendly cooperation environment is mandatory for the effective information sharing system and all stakeholders in the chain may not enjoy the equal rights (Menon, 2018; Tan et al., 2018). Besides this, products can have sensitive information, which can further increase the complexity to integrate multiple firms/systems. It is a difficult task to balance confidentiality and transparency at the same time.

Lack of Legislations, Regulations and Global Standards: Since block-chain technology is at its development stage, there is a lack of legislation, regulations, global standards and other laws for block-chain adoption. In the year 2018, 20 states in the US were considering to formulate the legislation for block-chain technology. However, there is a lack of such laws on the global scale as most of the developing and underdeveloped countries have not made any serious progress towards this direction. In the 21st century, one product is produced and delivered by various suppliers from multiple countries, hence supply chain is increasingly transforming into a global supply chain. Therefore, a need for global agreement to format and clarify the construction of block-chain based supply chain has become pivotal given the vast nature of the global supply chain.

How to Overcome the Barricades

Although the above challenges seem difficult to handle, however it is possible to handle them in an efficient way with proper analysis and business design. The supply chain managers and companies at large should have a deeper look into the issues and take necessary steps. Few of the proposed steps are as under.

Automate Existing Technologies: As discussed above block-chain is data and network concentrated. Therefore, mangers are the key players and should concentrate to automate the existing technologies in their firms as automation will be playing the crucial part in the adoption of block-chain technology in the supply chain. This will allow the seamless integration of block-chain.

Conduct a Business Review: An intensive business review can help the supply chain stakeholders to identify the key competencies and weaknesses of their systems. The **b**usiness review will help them prepare for the adoption of new software and technology. Since, block-chain is on its development stage, knowing where existing operations stand is the first and most important step in the journey.

System Integration: Integrated supply chains can help firms to overcome the future challenges of consistency in block-chain data. The systems which are not well integrated and not compatible many leads to inaccuracy and instability of data in the chain.

Data Analytics: Data analytics is the future, supply chain managers should start using data analytics. This will help them to aggregate and clean the data to drive maximum value. The analyzed information will be an important step towards the adoption of block-chain based processes.

Stay Educated: As stated above block-chain is on the development stage. The software development houses, like Microsoft, are on the ball. The early adopters like Walmart, Amazon, will have the capability to radicalize the playing field. They will enjoy massive competitive advantages. Therefore, firms should stay educated on the developments, use and availability to minimize the competitive advantage of early adopters.

Table 3. Summary of the Barricades, Reasons and Suggested Actions

Barricades	Reasons	Suggested Actions
Immaturity of Block-Chain Technology	• Defects in block-chain • Lack of capacity to store large data • Inefficient transaction capacity • Lack of cryptographic keys security • Adaptation barrier due to decentralized nature	• Automate Existing Technologies • Conduct a Business Review • System Integration • Stay Educated
Requirements of Higher Investment	• High infrastructural investments and continuous financial support • Unavailability of large spending for small suppliers • Traceability can cost more than the original cost of the product	• Financial support and subsidies by the government

Impediment of incorporating different systems	• Missing information and lack of data quality can lead to failure • Fair and friendly cooperation environment for effective information sharing • Sharing of sensitive product information can violate confidentiality	• Automate Existing Technologies • Conduct a Business Review • System Integration • Data Analytics • Stay Educated
Lack of Legislations, Regulations and Global Standards	• Lack of legislations, regulations, global standards and other laws for block-chain adoption at global scale	• Ensure global agreement to format and clarify the construction of block-chain based supply chains • Stay Educated

Conclusion

This paper presents a broad literature review of blockchain based supply chain. A larger part of the explored papers conceded to the potential advantages that blockchain may bring to the supply chain. From building conceptual systems or analysing case studies, blockchain is found to be able to bring straightforwardness, improved data genuineness, and speed up contracts. Combining with current IOT innovation, such as RFID, blockchain can assist to move forward the proficiency of supply chain administration and traceability framework. However, in spite of drawing expanding consideration from analysts, blockchain is in its earliest stages with numerous challenges. The challenges are holding up to be addressed before technology can be put in use publicly. For technology adopters, there's a need of profound understanding of the technology, which can compromise the benefits of blockchain. In another words, innovation ought to be chosen for the issues instead of another way around. It has become evident that block-chain technology has a great potential to facilitate and revolutionize the supply chain management techniques. It can create great opportunities for stakeholders to build a system of trust and mutual benefits. The adoption of block-chain technology can prevent human intervention in the supply chain to meet the goals.

Managerial Implications

Although, certain hurdles cannot be removed without proper coordinated cooperation among the stakeholders. Adoption of block-chain at the firm level has become a challenge for the supply chain managers.

1. The need is to focus on the up-gradation of the existing systems so that future technology can be adopted and adjusted within the system without much disturbance. For this, firms need to conduct a proper review of their existing systems and should try to stay educated so that the technological changes taking place in the market can be observed and necessary step may be taken to stay in the market with a competitive attitude.

2. For technology developers, the low adaptability is additionally an issue, which can cause a transaction crowed due to a huge number of clients and exchanges in supply

chain. For third parties, such as governments and organizations, there's no common conceded standard on blockchain appropriation in supply chain yet.

3. The advancement in block chain, can grant assurance to companies on exchanging insider secrets and information capacity. In this case, third parties are proposed to be more supportive in technology adoption, including technology education to the public, the development of certain policies and rules, and engagement with blockchain by pilot projects. Overall, blockchain shows a significant potential that might address future problems of supply chain in more secured and qualitative way.

Research Limitations

This paper is one of the primary to explore how blockchain impacts supply chain particularly. The paper gives an essential and comprehensive understanding of blockchain and its potential impacts, which will not only be a useful guide for new researcher in relevant area, but can also provide some deeper insights for practitioners, such as company decision-makers. By distinguishing and examining the foremost related papers, this work lays a strong ground for future research on this area and points out some future research directions. The barriers identified in this research can be investigated empirically in the future models.

This paper also gives innovation adopters a higher understanding of blockchain and clarifies to them a few conceivable appropriation challenges and reminds them to utilize blockchain wisely. In spite of the commitments put forward by this paper, we would like to point out a few confinements and future research areas. To begin with of all, the paper is based on 32 papers review, which might not be sufficient to anticipate the research predisposition. This is because of immaturity of block chain technology, studies with most of the theory based research articles are included. As there was enormous hype of blockchain application in finance division, the "hype" of blockchain is increasing and it picks up a part of consideration in other sectors. This may lead to possibly positive viewpoints of blockchain instead of questioning the technology.

Future Research directions

In this case, future researchers can focus on blockchain execution within the real world and provide more observational prove instead of speculations. Since, supply chain is endless and complicated in different sectors. Future research is conceivable to focus on particular sector and show more realistic results. Understanding the complete implications of blockchain innovation within the supply chain will require transdisciplinary endeavors. Proficient organizations got to be involved and work with the scholarly world to create measures and provide practical performance measures on blockchain technology implementation. Undoubtedly, there is a substantial amount of work in this area for future research direction.

References

Abeyratne, S. A., & Monfared, R. (2016). Blockchain ready manufacturing supply chain using distributed ledger. *International Journal of Research in Engineering and Technology*, *05 (09)*, 01–10.

Azzi, R., Chamoun, R. K., & Sokhn, M. (2019). The power of a blockchain-based supply chain. *Computers & Industrial Engineering*, *135*, 582–592. https://doi.org/10.1016/j.cie.2019.06.042

Bettín-Díaz, R., Rojas, A. E., & Mejía-Moncayo, C. (2018). Methodological Approach to the Definition of a Blockchain System for the Food Industry Supply Chain Traceability. *Computational Science and Its Applications, 8* (19–33). https://doi.org/10.1007/978-3-319-95165-2_2

Bogart, S., & Rice, K. (2015). *The Blockchain Report: Welcome to the Internet of Value*. Needham & Company, LLC.

Buterin, V. (2014). A next generation smart contract & decentralized application platform. *Ethereum.Org (White Paper)*, 01–36.

Costa, C. (2012). A Review on Agri-food Supply Chain Traceability by Means of RFID Technology A Review on Agri-food Supply Chain Traceability by Means of RFID Technology. *Food and Bioprocess Technology*, *6*(2), 353–366.

Crosby, M., Nachiappan, Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). BlockChain Technology: Beyond Bitcoin. *Applied Innovation Review*, *2*, 6–19.

Edmund, M. (2018, February). On the Fast Track? *Quality Progress; Milwaukee*, *51*(2), 10–12.

English, M., Auer, S., & Domingue, J. (2016). Block Chain Technologies & The Semantic Web: A Framework for Symbiotic Development. *The Semantic Web*, 15.

Eyal, I. (2017). Blockchain Technology: Transforming Libertarian Cryptocurrency Dreams to Finance and Banking Realities. *Computer*, *50*(9), 38–49. https://doi.org/10.1109/MC.2017.3571042

Feng Tian. (2017). A supply chain traceability system for food safety based on HACCP, blockchain & Internet of things. *2017 International Conference on Service Systems and Service Management*, 1–6. https://doi.org/10.1109/ICSSSM.2017.7996119

Feng Tian. (2016). An agri-food supply chain traceability system for China based on RFID blockchain technology. *2016 13th International Conference on Service Systems and Service Management (ICSSSM)*, 1–6. https://doi.org/10.1109/ICSSSM.2016.7538424

Gervasi, O., Murgante, B., Misra, S., Stankova, E., Torre, C. M., Rocha, A. M. A. C., Taniar, D., Apduhan, B. O., Tarantino, E., & Ryu, Y. (2018). *Computational Science and Its Applications – ICCSA 2018: 18th International Conference, Melbourne, VIC, Australia, July 2-5, 2018, Proceedings*. Springer.

Hackius, N., & Petersen, M. (2017). Blockchain in logistics and supply chain: Trick or treat? *Proceedings of the Hamburg International Conference of Logistics (HICL)*, 3–18. https://doi.org/10.15480/882.1444

Hofmann, E., Strewe, U. M., & Bosia, N. (2017). *Supply Chain Finance and Blockchain Technology: The Case of Reverse Securitization*. Springer. https://link.springer.com/book/10.1007/978-3-319-62371-9

Johnson, M. E. (2006). Supply Chain Management: Technology, Globalization, and Policy at a Crossroads. *Interfaces*, *36*(3), 191–193.

Kravitz, D. W., & Cooper, J. (2017). Securing user identity and transactions symbiotically: IoT meets blockchain. *2017 Global Internet of Things Summit (GIoTS)*, 1–6. https://doi.org/10.1109/GIOTS.2017.8016280

Kshetri, N. (2018). 1 Blockchains roles in meeting key supply chain management objectives. *International Journal of Information Management*, *39*, 80–89. https://doi.org/10.1016/j.ijinfomgt.2017.12.005

Lambert, D. M., & Enz, M. G. (2017). Issues in Supply Chain Management: Progress and potential. *Industrial Marketing Management*, *62*, 1–16. https://doi.org/10.1016/j.indmarman.2016.12.002

Lemieux, V. L. (2016). Trusting records: Is Blockchain technology the answer? *Records Management Journal*, *26*(2), 110–139. https://doi.org/10.1108/RMJ-12-2015-0042

Luu, L., Chu, D.-H., Olickel, H., Saxena, P., & Hobor, A. (2016). Making Smart Contracts Smarter. *Proceedings of the 2016 ACM SIGSAC Conference on Computer and Communications Security - CCS'16*, 254–269. https://doi.org/10.1145/2976749.2978309

Maurer, B. (2017). *Blockchains Are a Diamond's Best Friend: Zelize*R *for the bitcoin moment*. https://escholarship.org/uc/item/22w2n6c8

Menon, S. (2018). Applications of blockchain platform in agri-food supply chain. *Bio Voice*. https://www.biovoicenews.com/applications-blockchain-platform-agri-food-supply-chain/ Accessed 20 April 2020.

Nofer, M., Gomber, P., Hinz, O., & Schiereck, D. (2017). Blockchain. *Business & Information Systems Engineering*, *59*(3), 183–187.

Ølnes, S., Ubacht, J., & Janssen, M. (2017). Blockchain in government: Benefits and implications of distributed ledger technology for information sharing. *Government Information Quarterly*, *34*(3), 355–364. https://doi.org/10.1016/j.giq.2017.09.007

Pilkington, M. (2015). *Blockchain Technology: Principles and Applications* (SSRN Scholarly Paper ID 2662660). Social Science Research Network. https://papers.ssrn.com/abstract=2662660

Reyna, A., Martín, C., Chen, J., Soler, E., & Díaz, M. (2018). On blockchain and its integration with IoT. Challenges and opportunities. *Future Generation Computer Systems*, *88*, 173–190. https://doi.org/10.1016/j.future.2018.05.046

Rotunno, R., Cesarotti, V., Bellman, A., Introna, V., & Benedetti, M. (2014). Impact of Track and Trace Integration on Pharmaceutical Production Systems. *International Journal of Engineering Business Management*, *6*, 25. https://doi.org/10.5772/58934

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135.

Sarpong, S. (2014). *Traceability and supply chain complexity: Confronting the issues and concerns* [Text]. https://doi.org/info:doi/10.1108/EBR-09-2013-0113

Steiner, J., & Bakar, J. (2015). *Blockchain: The solution for supply chain transparency*. Provenance. https://www.provenance.org/whitepaper

Swan, M. (2015). *Blockchain: Blueprint for a New Economy* (1st ed.). O'Reilly Media, Inc.

Tan, A., Xuan, D., Thanh, & Cottrill, K. (2018). *Is blockchain the missing link in the Halal supply chain?* https://www.thefreelibrary.com/Is+blockchain+the+missing+link+in+the+Halal+supply+chain%3F-a0541524819?

Tapscott, D., & Tapscott, A. (2017). How Blockchain Will Change Organizations. *MIT Sloan Management Review; Cambridge*, *58*(2), 10–13.

Tian, F. (2016). An agri-food supply chain traceability system for China based on RFID blockchain technology. *2016 13th International Conference on Service Systems and Service Management (ICSSSM)*, 1–6. https://doi.org/10.1109/ICSSSM.2016.7538424

Verhoeven, P., Sinn, F., & Herden, T. T. (2018). Examples from Blockchain Implementations in Logistics and Supply Chain Management: Exploring the Mindful Use of a New Technology. *Logistics*, *2*(3), 20-33. https://doi.org/10.3390/logistics2030020

Yli-Huumo, J. (2016). *Where Is Current Research on Blockchain Technology? A Systematic Review*. PLoS ONE 11(10). 71-77. https://doi.org/10.1371/journal.pone.0163477