Blockchain Technology: The Role of Integrated Reverse Supply Chain Networks in Sustainability

Luai Jraisat
Talal Abu-Ghazaleh University College for Innovation (TAGUCI), Amman, Jordan
LJraisat@taguci.edu.jo

Mohannad Jreissat
The Hashemite University, Jordan
drjreissat@hu.edu.jo

Arvind Upadhyay*
University of Stavanger Business School, University of Stavanger, Stavanger, Norway
arvind.upadhyay@uis.no

Anil Kumar
London Metropolitan University, London, UK
a.kumar@londonmet.ac.uk

*Corresponding author

ABSTRACT

This research explores the role of Blockchain Technology (BCT) integrated with Reverse Supply Chain Networks (RSCN) and evaluates the relationship between BCT and sustainability performance in multi-industries. A qualitative research design was employed to develop a conceptual framework for BCT in RSCN for multi-industries. This research collected and analysed primary and secondary data from four case studies as focal actors. These focal actors are from industries in Jordan, namely food, pharmaceuticals, electronics, and toys. These actors are lead firms in their RSCNs and have experience working with RSCNs and technology applications such as BCT. Primary data were acquired from interviews with managers working in various industries. Analysis of secondary data has identified two types of the key BCT-influencing themes: internally focused and externally focused BCT-integrated drivers of RSCNs. The analysis also identified how they leverage sustainability performance improvements, including their use of RSCN approaches and features. This research is one of the few attempts to explore BCT integrated into RSCN for better sustainability performance through understanding the implementation and evaluation that contributes to the theoretical and practical knowledge of supply chains within emerging economies. All types of actors-as-stakeholders involved with national programs and projects can adopt the new framework that provides the changes required for RSCN. The key findings contribute to the field of RSCN where the adoption of BCT as a broad-based strategy to attain sustainability goals and reverse chain activities along the supply chain is a goal.

Keywords: blockchain technology, reverse supply chain networks, sustainability performance, multi-industries, emerging economy.

Paper Type: Research Paper

Introduction

Blockchain is a relatively new technology, referred to as a decentralised digital transformation technology, that is becoming an increasingly hot topic of interest for different domains and multidisciplinary fields. The concept of blockchain technology (BCT) is holistic enough to cover the importance of having an integrated shared information system and assure the integrity and security of shared information (Ferrer, 2018; Saberi et al., 2019; Mathew et al., 2021; Lage et al., 2022).

From the logistics point of view, the supply chain consists of several integrated and connected components, from sourcing and procurement of raw materials, production of finished products, order processing and inventory control, shipping and transportation, and afterward, storing and distributing to customers and consumers. The use of BCT can be a great advantage for systems that include users approaching the problem from different perspectives and coping with more than one interrelated operation within the system, such as are seen in reverse supply chain networks (RSCN) (Cricelli et al., 2021; Flygansvær et al., 2021; Rehman et al., 2021; Koshta et al., 2022). Moreover, capital and information flow are major challenges in any value chain system if not properly integrated. Adopting BCT will play a major role in changing the RSCN of any company, helping to enhance its efficiency and accuracy (Nikolakis et al., 2018; Saberi, et al., 2019; Mathew et al., 2021). Ledlow et al. (2017) stated that the RSCN incorporates the ability to manage upstream and downstream relationships between actors (buyers and providers) to bring the greatest added value to the customer at a reduced cost to the supply/value chains. Additionally, process coordination is done to meet customer requirements more efficiently and effectively and create a competitive advantage by competing as a total system (Prajogo et al., 2016; Bai and Sarkis, 2020).

RSCN is a chain network that consists of at least three actors: "*collection centres where consumers return used products, recovery facilities where reprocessing (remanufacturing or recycling) is performed, and demand centres where customers buy reprocessed products, viz., outgoing goods from recovery facilities"* (Pochampally and Gupta, 2008,p. 72). These three elements of the chain are referred to as a triadic relationship. For example, in any RSCN, strategic, tactical, and operational activities are applied by different actors along the chain network. Among these actions, strategic planning should involve the following phases: selection of the most economical product to reprocess, leading to the identification of potential collection centres and potential demand in the region where an RSCN is to be designed; identification of potential facilities in a set of candidate recovery facilities; and minimisation of overall cost across the RSCN.

Prior researchers, such as Casino et al. (2019) and Laroiya et al. (2020), have explained the taxonomy of BCT-based applications. This taxonomy identifies several potential application fields: business and industry, privacy and security, health, education, data, financial platforms, governance, Internet of Things (IoT), and distributed device management. A critical analysis of the BCT applications in multi-industries was debated according to Laroiya et al. (2020). These industries include supply chain, healthcare, banking, agriculture, financial services, insurance, and retailing. Previous studies (e.g., Mathew et al., 2021; Mubarik et al., 2021; Rehman et al., 2021; Koshta et al., 2022; Lage et al., 2022) have highlighted the importance of adopting BCT for transparency, reverse logistics, green applications, security, inexpensiveness, replacement policy, trust, creating a better contribution economy, preventing payment scams, and performing financial transactions in minutes.

This research explored the challenges in operational processing across various actors along the supply chain, especially the return of goods for digital transactions and the key internal and external drivers of BCT (Lage et al., 2022). The literature review identified pain points in cross-border returns and how they leverage sustainability performance improvements, including the use of RSCN approaches and feature forms. To explore the operational bottlenecks and drivers of BCT, we conducted interviews with focal management actors involved in BCT of RSCN from the analysis of their triads (Jain et al., 2017). These focal actors are from industries in Jordan, namely food, pharmaceutical, electronics, and toys. These actors are lead firms in their RSCN and have at least two years of experience in RSCN and technology applications such as BCT. The conceptual framework of BCT describes a method of providing proof of action that would enhance digital document transactions, enabling product traceability and transparency along the RSCN. This research contributes to the theoretical and practical literature on cross-border digital platforms, RSCN, document reversal, re-export issues, and how BCT deployment will help these key actors overcome the challenges and sustain their operations in a fiercely competitive environment. The research was conducted based on a belief

in the theoretical benefits of the technology for RSCNs where BCT plays a key role in RSCN in multi-industries. The key findings have provided a definition of the real value of BCT for researchers and managers in different fields and industries. This research addresses the following Research Questions (RQ):

RQ1. How are the key external and internal drivers of BCT integrated into RSCN?

RQ2. How do these drivers influence sustainability performance improvements, including RSCN approaches and governance forms?

This research is intended to provide an original study to explore BCT integration into RSCN for better sustainability performance through understanding the implementation and evaluation procedures that contribute to the theoretical and practical knowledge of supply chains within emerging economies. It defines the associations between key identified themes of 14 drivers as internal and external factors that are jointly required for current and potential applications of BCT in RSCN. This can help scholars to understand the complexities underlying focal actors in the triadic research in RSCN. Indeed, this research has contributed to BCT and RSCN by establishing a novel conceptual framework associated with these drivers, approaches and features, and sustainability performance.

Literature Review

Blockchain Technology (BCT)

In its simplest meaning, BCT is a database that stores transaction-based records, continually recording all completed transactions in a block of data. More importantly, database systems, known as chains within a network of linked peer-to-peer nodes, are usually called digital ledgers in business (Bai and Sarkis, 2020; Haque and Rahman, 2020). The digital ledger can be linked to a large, distributed, secure spreadsheet that is tied to many computers on the network. It is responsible for recording transactions based on each completed purchase. It can be viewed by anyone who accesses it to learn how the whole supply chain was implemented for putting the final finished goods in the consumer's hands. This whole process comprises BCT (Bai and Sarkis, 2020; Hassan et al., 2020). This process enhances the transparency and traceability of the shared data. It was decentralised to build trust between the customer and the provider of the goods. This technological development proved to be an innovative aspect of the value chain, leading to a proven, digitalised traceable system, and a secure communication and information technology. Blockchain technology helped to solve the existing commercial transaction problems (Demestichas et al., 2020; George et al., 2019; Mezquita et al., 2021; Rehman et al., 2021).

An analysis of about 100 investment contracts for BCT applications, in the period 2017 to 2020, has shown great growth in BCT investments in multiple sectors (Lage et al. (2022). Those contracts were tailored to the same project in which several entities involved were grouped. The maximum number of partners was seven, and the number of research participants was four, on average. This analysis has also described individual and consortium projects that significantly targeted the main economic sectors as key investments. Figure 1 shows the sample of contracts and investments, by sector, analysed to show how BCT is important and applied across multi-industries.

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Reverse Supply Chain Network (RSCN)

Few studies have explored and researched BCT recently in several industries. It is defined as a digital ledger, or a database, that keeps unchangeable records of all operations and transactions (Drescher, 2017). This chain is decentralised, which means that all information about these operations and transactions is stored across the network and not in one centralised place. It contains blocks linked together through networks such as RSCN

and reverse logistics (Flygansvær et al., 2021; Rehman et al., 2021; Koshta et al., 2022). It has been established that availability and access to supply information can improve performance in decentralised scenarios (Jain et al., 2017; Nikolakis et al., 2018). This pattern allows for better communication, which solves a huge gap between the firms and industries.

According to Khan et al. (2022), RSCN is a kind of supply chain with a focus on sustainability and reverse activities linked to a circular economy. Currently, supply chain actors are increasingly facing the challenge of integration and sustainability, but BCT can play a ground-breaking role in improving the traceability, accountability, and sustainability of complex supply chain networks (Nikolakis et al., 2018; Bai and Sarkis, 2020).

In RSCNs, BCT can be used to improve sustainability performance with a focus on the reverse value chain. This requires that users have experience and knowledge of how the supply chain actors can be mapped, which is a big challenge for both practitioners and researchers (Khan et al., 2022). The second challenge is that the supply chain actors need to face the growth of sustainability, which is closely connected to their visibility and traceability (Saberi et al., 2019; Jraisat et al., 2022b). In doing so, mapping of RSCNs is important to attain local and global sustainability across all actors, where BCT can offer real opportunities for better performance.

Technology companies are trying to set global standards for BCT and design applications that serve all types of administrative processes in various sectors, including mining. The BCT supports applications such as smart contracts and digital ledgers. Smart contracts are written to include term limits and a contractual agreement to implement the agreement while ensuring trust and transparency. A smart contract can be designed so that the sender does not pay until the shipping company confirms the delivery, to address the risk of loss. The blockchain ledger helps reduce the costs of transactions and makes them more transparent throughout the RSCN (Cricelli et al., 2021; Flygansvær et al., 2021; Rehman et al., 2021). Therefore, the blockchain may lead to greater corporate value by solving problems, preserving information, and authenticating user identity (Jabbari and Kaminsky, 2018; Mathew et al., 2021). Having BCT incorporated in the RSCN will assure faster and leaner processes and improve traceability and transparency of materials moving through the supply chain. Finally, the BCT will strengthen the automation of commercial and financial processes and the exchange of reliable information within the RSCN for all actors, for better sustainability of social, environmental, and economic benefits.

At the beginning of the introduction of the blockchain concept, it was referred to as the digital integration of actors in supply chains. This technology permits the ease of extracting information related to different chain actors and sharing clean information and data that can offer the users a holistic strategic approach to planning and controlling the chain variables. Moreover, such technology enhances the financial performance of different activities within the supply chain system (Che et al., 2017; Lisa Laforet & Gisèle Bilek, 2021). Drivers for BCT investments were identified by a blockchain survey with 447 actors in 2018, as shown in Figure 2.

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At a deeper level of BCT importance, many articles discussed the opportunities and challenges, and the urgent need to implement BCT in healthcare and pharma supply chains (Mackey et al., 2019). Such a blockchain, when implemented in the health sector, must adopt a fit-for-purpose base rather than being generalised (Mackey et al., 2019). A recent article, in 2020, highlighted the importance of BCT in pharma supply chain security, which is now a hot topic worldwide because of the very high percentage of counterfeit drugs entering the pharma supply chain on different levels, up to 10% worldwide and 30% in emerging markets (Lage et al., 2022).

In recent studies (e.g., Cricelli et al., 2021; Flygansvær et al., 2021; Rehman et al., 2021; Koshta et al., 2022), nine significant factors have been identified as key BCT applications across the RSCN in various industries. These factors are explained as follows:

The first factor is the concept of the decentralisation process (George et al., 2019; Mezquita et al., 2021; Rehman et al., 2021). It relies on the distributed architecture of the blockchain to establish reliable relationships between actors (buyers and providers, i.e., peer-peer dyads) without a mediator as a trusted third party between them (Mathew et al., 2021).

The second factor is the decentralisation of business models makes it possible, using Internet applications, to create novel business models (George et al., 2019; Mezquita et al., 2021)). One of the key examples is how digital platforms develop ecosystems where products are supplied to markets to match various customers' needs with the availability of different contracting methods.

The third factor is traceability, combined with other key features, connecting actors across the supply chains to track changes at operational and communication levels (Mezquita et al., 2021). This has helped key operators and other businesses in supply chains to anticipate new events, new demands, and new completion demands (George et al., 2019; Rehman et al., 2021). Furthermore, this factor has helped many actors share information about the details of products, automates guarantees and claims with no hardcopies, and allows new certification approaches such as certificates of origin or certificates of materials or products (Mathew et al., 2021).

The fourth factor is theinternal or external processes related to circular economy certifications and quality standards as used by the various organizations (Shih and Yang, 2019; George et al., 2019; Rehman et al., 2021). This factor is important to ensure regulatory compliance in various sectors for better processing across focal points and other actors in supply chains.

The fifth factor is transparency. This is important for better visibility and credibility and is linked to traceability across all actors in supply chains (Batubara et al., 2018; Mathew et al., 2021). This factor is enhanced by key stakeholders involved with technology, contracts, operations, and procurements along the chain for better performance.

The sixth factor is automated actions applied by many firms to facilitate connections and the flow of products and information between them (Ferrer, 2018; George et al., 2019; Mezquita et al., 2021). There is no need to have manual actions; instead, a BCT application that is based on third-parties or robotic swarm system management implements the action without user interaction.

The seventh factor is smart contracts, one of the latest technologies based on BCT, to effectively bond key actors along the chain with automated processes (Gatteschi et al., 2018; George et al., 2019; Mezquita et al., 2021; Rehman et al., 2021).

The eighth factor is Self-Sovereign Identity, a new identity concept called "digital identity" (Mezquita et al., 2021; Rehman et al., 2021). This new identity helps any user or actor involved in the blockchain supply chain to control their identity information using zero proof of their knowledge (Jarke, 2019).

The ninth factor is machine economy or Machine-to-Machine (M2M) as a new portfolio in linking a sharing economy to the IoT (George et al., 2019; Rehman et al., 2021). It reflects the link between decentralisation and tokenisation, via BCT, along the supply chain to share information via machines and operate with tokens among actors (Lage, 2019).

BCT and Reverse Digital Marketing

Due to its significance in understanding the algorithms defining consumer behaviour, it plays a vital role in digital marketing and marketing management scope. Reverse digital marketing, defined as a proactive role in communication and understanding, is leading and reshaping consumers due to the shift in the traditional marketing mix because of the IoT and digital transformations (e.g., e-commerce and digital platforms). Big brands like IBM, Amazon, eBay, and Walmart have already integrated the blockchain into their operations to offer adaptive marketing solutions that might be affecting their marketing programs (Andriotis et al., 2019; Shivam Gupta et al., 2020). The RSCN is known for its complexity, creating many challenges that the industry must face (Rehman et al., 2021; Koshta et al., 2022). BCT took an innovative step to improve the supply chain by offering traceable and transparent solutions (Demestichas et al., 2020). Consumers lost their trust in the quality and origin of the products, and because of the rising demand for reliable certifications and traceable systems, it became a necessity (Ariyawardana, 2020). BCT will assist in outbound logistics and green marketing since it enables verification and has a role in improving green marketing by minimising the impacts

of physical actions (Dutta, 2020; Mathew et al., 2021). BCT will become a core concern in the marketing field since corporations and stakeholders recognise it for its ability to address potential market challenges and solve them (Kontsas, 2019).

Although digital marketing in the local and global markets, such as e-commerce, is in great demand in many markets, experience has shown that a number of problems remain to prevent customers from dealing with overseas companies. Prominent examples of these concerns are the anxiety regarding fake products and the trouble of returning the product (Mathew et al., 2021). The challenges are varied for the retailer as well. These challenges involve customs documentation for reversals and mediators' collaborations for reclamation within the RSCN (Flygansvær et al., 2021; Rehman et al., 2021). Thus, an absence of integrated collaborative technology, linked to the multiple partners acting in the networks, is a growing challenge facing the returning of products. Additionally, the source of products received by consumers needs to be visible and verified. Hence, BCT is a game-changing technology that solves the problem of product traceability, identifies fraudulent transactions, and provides digitised transaction details to improve the customer's experience.

Optimising the RSCN lies in the value chain aspect of innovation and processes through production, digital marketing, and capacity planning (Shah, 2004). Today, for the key actors, it is a priority to improve sales and operations planning and new product introduction processes by market and region. These key areas of improvement were identified following a thorough review of the core of Enterprise Resource Planning (ERP) software. Implementing this has positively impacted the working capital and forecasts, driving growth and enhancing the competitive edge and re-exports. Hence, the RSCN will be a primary function of this implementation for better sustainability of performance. The RSCN covers suppliers, manufacturers, wholesalers, distributors, retailers, service providers, and practitioners. Therefore, integrating these links is vital (Mondal and Pingali, 2017).

Research Methodology

Research Design

This research aims to develop a conceptual framework of BCT in an RSCN for multi-industries. This development is achieved using a qualitative methodology that identifies key themes and associations (Miles et al., 2020). This research uses secondary and primary data to explore internally focused, and externally focused BCT integrated drivers on RSCNs and how they leverage sustainability performance improvements, including RSCN approaches and feature forms. For the secondary data, this research has reviewed several academic articles and then synthesised them to identify the key themes. The other thing that the authors explored was background data from websites, newspaper articles, and general document information such as statistical data from the national census directory or governmental agencies and associations. It provides an overall understanding of the organisation's background and context for the case studies and process development. Such documents helped with inquiries for field visits and interviews (Yin, 2018). Secondary data was analysed following an extensive review of peer-reviewed journals and published works. For primary data, a case study method is a rich source for exploring complex emergent phenomena (Yin, 2018). Multiple case-study types are applied in this research, which involves a multi-site study to obtain an in-depth understanding of BCT in RSCNs for multi-industries (Miles et al., 2020). The main source for the primary data is semi-structured, which is the most powerful main tool within the context of a case study. It enables an in-depth understanding and interpretation of sustainability from the perspective of quality in BCT in RSCNs (Yin, 2018). It explains their activities from the viewpoint of people experiencing the phenomena (Easterby-Smith, 2012). Comparable previous research has employed the case study method to generate theoretical and practical insights into BCT in RSCNs (Ferrer, 2018; Ariyawardana, 2020; Mathew et al., 2021; Cricelli et al., 2021; Flygansvær et al., 2021; Rehman et al., 2021; Koshta et al., 2022; Lage et al., 2022).

Case Selection

The number of available firms that apply BCT in supply chains is limited. The cases are focal actors as focal nodes in RSCNs in different industries. The selected cases are based on a purposive sampling strategy to select focal actors who have applied BCT or have real potential for applying BCT in their supply chains to have quality RSCNs. According to Yin (2018) and Miles et al. (2020), two to five case studies are appropriate for a qualitative study to understand a phenomenon in its actual instantiation. Hence, this research selected four cases as four key actors. These focal actors are from industries in Jordan, namely those in food, pharmaceutical, electronics, and toys. These actors are lead firms in their RSCNs and have at least two years of experience in

RSCN and technology applications such as BCT within international companies located in Jordan. This research has applied a unit of analysis for each case (A, B, C, D), a triad of the focal actor in RSCN (Eisenhardt, 1989). For each case, a triad of supplier-focal actor-customer is identified to collect data from managers from the three identified actors in each triad using the same protocol for better reliability. These managers are experts in the field of supply chain and reverse activities for better sustainability. Before the interview, the appropriate manager (the general manager) in the focal actor organization was informed of the study's objectives and was contacted to gain confirmation about conducting the research. This person then suggested interviewees at the focal actor site and suggested the other two tiers in their triad, one supplier (upstream tier) and one customer (downstream tier), to be contacted for participation. The nominated participants in each of the triads were selected based on their job responsibilities and knowledge about the subject, and on the researcher's judgment regarding their ability to provide related information. A research agenda was followed, including interview protocol, fieldwork, and reporting procedures (Yin, 2018). Table 1 illustrates the case studies and their characteristics.

Insert Table 1 here

Data Collection

This research has followed three sources for each case study: semi-structured interviews as a main source with literature reviews and sustainability reports as secondary sources (Table 2). Twelve interviews with managers in each triad of focal actors were based on purposive sampling. In total, 44 face-to-face and online interviews were conducted, each taking one hour, with managers involved in BCT applications in RSCNs in 2022 in multi-industries in Jordan (Miles et al., 2020). Through emails, phone calls, and document exchanges, several contacts were made with those managers to obtain reflective practitioner inputs that created trust and mutual benefits (Yin, 2018). Two researchers conducted and recorded the interviews with all the participants, each of whom was asked the same questions, using the same interview protocol. One researcher transcribed each interview and then sent it to their identified managers for revisions and confirmations. The approved interviews were used to develop the case studies as analysed through cross-case analysis (Eisenhardt, 1989; Miles and Huberman, 1994). After reviewing the available literature on the fields of BCT and RSCN, one researcher analysed the available sustainability reports on the identified actors in each triad, in 2020, to establish triangulation evidence and replication logic (Yin, 2018; Miles et al., 2020). A final case report was validated by experts who were not associated with the study of the five policymakers, based on the AHP triangulated approach, but who are familiar with BCT in RSCN.

Insert Table 2 here

Data Analysis

This research has followed a triangulated analysis method to develop key findings and establish a novel framework for BCT in RSCNs (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Miles et al., 2020). This method encompasses five steps. The first step was a list of key themes generated from the synthesised analysis of the literature review. The second step was a list of coding as sub-themes. They have followed each key theme from data reduction of interview transcripts and sustainability reports across the four cases of focal actors A, B, C, and D. The fourth step was a cross-case comparison to enhance replication logic and commonalities and by providing triangulation data by the AHP result of the analysis done by the five policymakers' experts, who ranked the themes from 1-9 for their impact on BCT in RSCNs. AHP manages the multi-indicator issue. This process involves creating a hierarchical structure and quantifying it using psychological laws and a combination of qualitative and quantitative decisions. The fifth step was that of building explanations to validate the novel conceptual framework of BCT in RSCNs from the perspectives of the focal actors and their triads in multi-industries.

Findings and Discussion

Internal Factors for Drivers of BCT in RSCN

The general manager in focal actor 2B said that "our five main uses of BCT were identified which can be reflected on wholesaler/distributor level: manufacturer supply chain, drug safety standards, inventory management, public safety, and consumer awareness, in addition to clinical trial management."

All of the managers in the four cases indicated that cost savings is the key priority in applying BCT to increase revenue and, at the same time, produce customer satisfaction by reducing risks for both the supplier and the customer and by returning damaged or unwanted products. The findings showed that managers wanted to have a common management strategy for processes. However, for political or economic reasons, they failed to implement the strategy. These managers indicated that having a third-party actor, or relying on an existing actor, was more costly than the benefit of joint transactions. These managers have indicated that one of the supply chain actors could manage all processes. This would give the supply chain power by managing reverse applications based on the information and processes of the rest of the actors in the RSCN. Hence, BCT can support an application to interact with each other in a decentralised approach. Mainly, cases A, B, and C illustrated that traceability is becoming a very important element of the strategy for better value and reverse applications in their triads across their RSCNs. It should be managed by a decisive step by the focal actors as well as the rest of the actors. All of the cases displayed decentralisation as a new theme for all of the actors in each triad; this concept allows for win-win situations across all actors in a network for better sustainability knowledge. Mainly, cases A, B, and C agreed that digital platforms have become more applicable and more commonly used after using BCT, especially in contacting and obtaining feedback from their actors in triads. The same cases demonstrated that quality standards and regulatory compliance are enhanced in association with applying technology such as blockchain and their activities in dealing with local and cross-borders actors regarding re-manufacturing, re-labelling, repackaging, re-exporting, and exchanging sold or damaged products. Table 3 presents the sub-themes coded to be linked to the key themes for the internal factors in BCT in RSCN.

Insert Table 3 here

Figure 3 shows the AHP scores presented based on percentages (100%) for each key theme from the perspectives of managers in each triad as a priority and then ranked for sustainability performance, ranging from (1 to 4), based on the results from the analysis of sustainability reports.

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External Factors for Drivers of BCT in RSCN

The marketing manager in actor 1B said that "the importance of the active involvement of different stockholders in pharma supply chains, which in turn will not only benefit the manufacture, rather the end-user and back to the wholesaler/distributor as well as shipper; increase trust and transparency, add visibility and protect privacy, extend security and availability of database for future statists."

All of the cases, especially those of the other two actors in all triads, indicated low attention and expertise with BCT applications, such as circular economy certifications, transparency, automated actions, smart contracts, new identity concept, and M2M transactions. Many managers, in the same cases, said that they are currently looking for new collaborations, especially concerning focal actors, to apply these new concepts in this transformative age of digitalisation. All the triads, in all cases, showed positive support for the possibilities for future applications for BCT regarding process management, continuous improvement to achieve new certifications for sustainability and circular economy, and support of the sustainable development goals assigned by the United Nations. Most focal actors are not very sophisticated in their management applications addressing automated actions. However, they can assign funds for developing and applying new technology in automated machines and smart contracts by identifying process requirements to meet key needs, such as product quality, reducing waste, improving delivery time, and solving operational problems. Most Managers indicated that transparency is interrelated to process traceability and the circular economy. It also may be

interconnected to the energy source. Indeed, these other applications were presented to show the need for transparency in the ecosystem actors.

Nevertheless, all managers in the four triads have mentioned IT processes, particularly automation and enforcement. Such a case is developed regarding the user's right to be granted access, cyber security actions, including infrastructure isolation from the Internet, and automated closing of network ports due to risks to intelligence information. This case can be exemplified by the automatic removal of user data. The same managers have demonstrated that the need to satisfy contractual conditions between two or more actors is essential, which is one of the main and differential values of BCT, such as a smart contractor.

Table 4 presents the sub-themes coded to be linked to the key themes for the external factors in BCT in RSCNs. In all cases, the managers of focal actors have indicated that they are looking for digital identity with new features, such as the identity of users of products, and other digital services such as loyal digital customers or suppliers. Few cases have shown the importance of M2M transactions that allow the creation of new sharing of electronics among the machines themselves to add value to their data/services in this ecosystem and operate autonomously based on IoT support.

Insert Table 4 here

The following Figure 4 shows the AHP scores presented based on percentages (100%) for each key theme from the managers' perspectives, in each triad, as a priority, and then ranked for sustainability performance, ranging from (1 to 4), based on the results from the analysis of sustainability reports.

Insert Figure 4 here

Approaches and Features of BCT in RSCN

The key findings have provided a governance approach for developing BCT in RSCNs where the focal actors and others, i.e., suppliers, and customers in their triads, will be able to create a communal body of technology to foster a business environment and competitive advantage for digital marketing. The key themes that were matched to analyse the data from the exploratory cases A, B, C, and D were internal and external factors for the drivers of BCT in RSCNs, as shown in Tables 3 and 4 above. The key findings further revealed that these key themes contribute to improved sustainability performance for the focal actors, and many others, in triads in RSCNs. However, it was unclear how these key themes would interrelate, or what their relative importance might be.

This new integrated approach of BCT in RSCNs can offer adaptive marketing solutions that might affect their marketing paradox (Andriotis et al.,2019). The RSCN is known for its complexity and the challenges it presents within the industry. Blockchain technology took an innovative step to improve the supply chain by offering traceable and transparent solutions (Saberi et al., 2019; Demestichas et al., 2020; Mezquita et al., 2021; Rehman et al., 2021). Consumers lost their trust in the quality and origin of the products they were buying, and the increase in the demand for reliable certifications and traceable systems created a necessity to respond (Ariyawardana, 2020). Blockchain technology will assist in outbound logistics and green marketing since it enables verification of transactions and it plays a role in improving green marketing by minimising the energy demands required to carry out the negotiations (Dutta, 2020; Bai and Sarkis, 2020; Mathew et al., 2021). Hence, Table 5 shows a classification of RSCN approaches and features to identify common BCT applications in RSCN dynamics for appropriate positioning to develop sustainability for the actors in each triad and their RSCN.

Insert Table 5 here

Toward a Novel Conceptual Framework of BCT in RSCN

This study explores the key themes of BCT in RSCNs, based on internal and external factors for drivers of BCT in RSCNs, and extends extant works by focusing on the RSCN context for multi-industries. Prior research, such as that of Andriotis et al. (2019), Casino et al. (2019), and Laroiya et al. (2020) has elaborated on the taxonomy of BCT-based applications. However, it has not examined these themes jointly and has not fully uncovered associations amongst the RSCNs. This empirical multiple case study was based on exploring the external and internal drivers of BCT as current and potential applications in RSCNs, and how these applications can impact sustainability performance in using the emerging approaches and features of BCT in RSCNs. Figure 3 illustrates a novel conceptual framework, based on the literature review and case study, by stressing the theoretical association between the identified drivers of BCT as antecedents, approaches, and features as a digital transformation taxonomy and sustainability performance as consequences of applying RSCNs.

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This research provides contributions to the field of supply chains, including reverse networks and technology that can be enhanced by drivers such as risk control, quality standards, regulations, transparency, smart contracts, and traceability, between and amongst the various actors along the RSCN. This research also provides findings on how BCT has recently become decentralised to build a fast-growing movement to build trust between the customer and the provider of the goods. This technological development proved to be an innovative aspect in the value chain area since an increase in innovations was observed, leading to a proven digitalised traceable system in communication and information technology (Queiroz and Wamba, 2019; Queiroz et al., 2019; Mubarik et al., 2021; Jraisat et al., 2022a).

Conclusions and Contributions

Theoretical Contributions

This research has revealed key findings on BCT in RSCN based on empirical aspects of multi-industries to achieve the present research aims and questions. It has presented an attempt to determine what BCT functional values focal actors and their other actors in triads are willing to invest in, regardless of the identified industries and use case. The research was completed based on the theoretical benefits of the technology for RSCNs. The key findings have allowed obtaining the real value of BCT for researchers**.** The earliest studies (e.g., George et al., 2019; Mezquita et al., 2021; Mubarik et al., 2021; Rehman et al., 2021) only had specific usage cases or reviews of potential BCT applications, but in no case did a review nor was analysis based on a set of real projects in which companies have invested. Hence, this research allows the associations between key identified themes, allowing clustering of 14 drivers as internal and external factors demanded jointly as current and potential applications of BCT in RSCN. This can help scholars understand the complexities facing focal actors in the triadic research in RSCN to extend knowledge in the studied fields. As seen in Figure 3, this research has contributed to BCT and RSCN by establishing a novel conceptual framework associated with these drivers, approaches and features, and sustainability performance. RSCN is considered important where the digital supply chain can be defined as *"the development of information systems and the adoption of innovative technologies strengthening the integration and the agility of the supply chain and thus improving customer service and sustainable performance of the organisation*" (Blandine Ageron et al., 2020, p.133).

Practical Contributions

This research offers practical contributions for the managers, especially focal actors along the supply chain. The novel framework offers a guideline to form and describe BCT between actors along their RSCNs, based on current and potential applications of BCT as external and internal drivers. To improve applications of BCT amongst actors in triads, focal actors should establish RSCN approaches and features, and link these to sustainability performance that can be super supportive for their RSCN. Policymakers can also benefit from the key findings and the new novel framework that can help them with national programs and projects and

adopt the changes required for using RSCNs. This might indicate that various actors are making pragmatic decisions and are in the process of learning. This may indicate that they are still in the early stages of BCT adoption and that actors and service providers need to learn more about the technology before undertaking investments of greater uncertainty or risk in establishing better RSCNs (Queiroz and Wamba, 2019; Queiroz et al., 2019 and Jraisat et al., 2022).

This research has applied the findings of the current study to multiple industries such as the food industry, pharma industry, electronic industry, and toys industry. This type of research has provided a novel attempt for all these industries to apply various the drivers of BCT in their adopted RSCNs that can help managers evaluate performance monitoring and management to ultimately improve decision-making and sensitivity analysis. Implementing the two types of drivers in the new framework will help managers to analyse their needs for RSCN's features and approaches and hence their sustainability performance in the area of digitalisation and in such contexts as pandemics, such as COVID-19. Hence, managers and executives can identify which performance indicators most impact their actor's performance. These features assist and enable practitioners to update information about various types of drivers, allowing for each type of actor to manage their RSCN.

Limitations and Future Research

This research raises interesting questions in the area of the study. The conceptual framework indicates significant opportunities for future studies. Although the study results are very promising and show that companies are starting to invest in BCT, we should be aware that BCT still presents different challenges and constraints at the technological level in the examined industries and empirical context of RSCNs. This research is qualitative, and the conceptual framework needs to be tested through further qualitative or quantitative studies involving large-scale surveys. Another potential area of study is the role of short and long supply chains as a comparative study. It is important to know that industries adopt and deploy BCT very early. Researchers may identify new technology uses that we do not know of today in the coming years.

This research also features certain limitations that can be used to drive future research on the circular economy and its relations to sustainability performance. These include the lack of prior research on BCT in circular economies in the context of emerging economies. This study has provided a framework application by analysing a limited number of drivers; thus, future studies could consider various other drivers that affect different local and international actors, and the linkages between these actors.

Reference

Batubara, F.R., Ubacht, J., & Janssen, M. (2018). Challenges of blockchain technology adoption for e-government: A systematic literature review. In Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age, Delft, The Netherlands, 30 May 1; 2018; pp. 1–9.

Bai, C., & Sarkis, J. (2020). A supply chain transparency and sustainability technology appraisal model for blockchain technology. International Journal of Production Research, Vol. 58, pp. 2142–2162. https://doi.org/10. 1080/00207543.2019.1708989

Blandine A., Omar B., & Angappa Gunasekaran (2020). Digital supply chain: challenges and future directions, Supply Chain Forum: An International Journal, Vol. 21 No.3, pp. 133-138, DOI: 10.1080/16258312.2020.1816361

Cricelli, L., Greco, M., & Grimaldi, M. (2021). An investigation on the effect of inter-organisational collaboration on reverse logistics. *International Journal of Production Economics*, Vol. 240 No. 4, pp. 1-28

Chen, Y. (2018). Blockchain tokens and the potential democratisation of entrepreneurship and innovation. Business Horizon. Vol. 61, pp. 567–575

Darryl Mathew, Vinod Kumar Shukla, Anjuli Chaubey, Soumi Dutta, (2021). Artificial Intelligence: Hope for Future or Hype by Intellectuals? Reliability Infocom Technologies and Optimisation (Trends and Future Directions) (ICRITO) 2021 9th International Conference on pp. 1-6, 2021.

Eisenhardt, K.M. & Graebner, M.E. (2007). Theory building from cases: opportunities and challenges, Academy of Management Journal, Vol. 50 No. 1, pp. 25-32.

Ferrer, E.C. (2018). The blockchain: A new framework for robotic swarm systems. In Proceedings of the Future Technologies Conference, Vancouver, BC, Canada, 15–16 November 2018; Springer: Cham, Switzerland, 2018; pp. 1037–1058.

Flygansvær, B., Samuelsen, A. G., & Støyle, R. V. (2021). The power of nudging: how adaptations in reverse logistics systems can improve end-consumer recycling behaviour. *International Journal of Physical Distribution & Logistics Management*, Vol. 51 No. 9, pp. 958-977. https://doi.org/10.1108/IJPDLM-12-2020-0389

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., & Santamaría, V. (2018). Blockchain and smart contracts for insurance: Is the technology mature enough? Future Internet 2018, Vol. 10 No. 20.

George, R., Peterson, B., Yaros, O., Beam, D., Dibbell, J., & Moore, R. (2019), Blockchain for business", Journal of Investment Compliance, Vol. 19 No. 3, pp. 33– 38.

Goldreich, O. & Oren, Y. (1994). Definitions and properties of zero-knowledge proof systems. Journal of Cryptol. Vol. 7, pp. 1–32.

Jraisat, L., Jreissat, M., Upadhyay, A., Sajjad, F., & Balodi, K. C. (2022a). Paradox of strategic partnerships for sustainable value chains: Perspectives of not-for-profit actors. Business Strategy and the Environment, pp. 1–18. https://doi.org/10.1002/bse.

Jraisat, L., Jreissat, M., Sajjad, F., Batistad, L., & Ghalia., T (2022b) "No Actor is an Island: The Role of Partnerships in Sustainable Value Chains, Jordan Journal of Mechanical & Industrial Engineering, Vol. 16 No. 2 pp. 163-174.

Koshta, N., Patra, S., & Singh, S. P. (2022). Sharing economic responsibility: Assessing end user's willingness to support E-waste reverse logistics for circular economy. Journal of Cleaner Production, Vol. 332, pp.

Khan, S. A., Mubarik, M. S., Kusi-Sarpong, S., Gupta, H., Zaman, S. I., & Mubarik, M. (2022). Blockchain technologies as enablers of supply chain mapping for sustainable supply chains. Business Strategy and the Environment, pp. 1–15. https://doi.org/10.1002/bse.3029

Lage, O., Saiz-Santos, M., & Zarzuelo, J.M. (2022). Real Business Applications and Investments in Blockchain Technology. Electronics, Vol. 11, No. 438. https://doi.org/ 10.3390/electronics11030438

Lage, O. (2019). Blockchain: From Industry 4.0 to the Machine Economy. In Computer Security Threats; IntechOpen: London, UK

Laroiya, C.; Saxena, D.; Komalavalli, C. (2020). Applications of blockchain technology. In Handbook of Research on Blockchain Technology; Academic Press: Cambridge, MA, USA, 2020; pp. 213–243.

Laforet, L. & Bilek, G. (2021). Blockchain: an inter-organisational innovation likely to transform supply chain. Supply Chain Forum: An International Journal. Vol 22 No. 3, pp. 240-249. https://doi.org/10.1080/16258312.2021.1953931

Mondal, S.S. & Pingali, V. (2017). Competition and intellectual property policies in the Indian pharmaceutical sector, Vikalpa: The Journal for Decision Makers, Vol. 42 No. 2, pp. 61-79.

Morkunas, V.J., Paschen, J., & Boon, E. (2019). How blockchain technologies impact your business model. Bussines Horizon. Vol. 62, pp. 295–306.

Mezquita, Y., Casado-Vara, R., González Briones, A., Prieto, J., & Corchado, J.M. (2021). Blockchain-based architecture for the control of logistics activities: Pharmaceutical utilities case study. Log. J. IGPL, Vol. 29, pp. 974–985.

Mubarik, M., Rasi, R. Z. R. M., Mubarak, M. F., & Ashraf, R. (2021). Impact of blockchain technology on green supply chain practices: Evidence from emerging economy. Management of Environmental Quality: An International Journal, Vol. 32 No. 5, pp. 1023–1039

Miles, M. B., Huberman, A. M., & Salda~na, J. (2014), "Qualitative data analysis. A methods sourcebook," 3rd ed. Thousand Oaks, CA: Sage Publications, Inc; 2014.

Miles, M., Huberman, A. M., & Saldana, J. (2020). Qualitative data analysis: A methods sourcebook (3rd ed.). Los Angeles, CA: Sage.

Nikolakis, W., John, L., & Krishnan, H. (2018). How blockchain can shape sustainable global value chains: An evidence, verifiability, and enforceability (EVE) framework. Sustainability, Vol. 10 No. 11, p. 3926.

Pochampally, K. K. & Gupta, S. M., (2008).A Multi-Phase Fuzzy Logic Approach to Strategic Planning of a Reverse Supply Chain Network, IEEE Transactions on Electronics Packaging Manufacturing, Vol. 31, No. 1, pp. 72-82.

Queiroz, M. M., & Wamba, S. F. (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. International Journal of Information Management, Vol. 46, pp. 70–82. https://doi.org/10.1016/j.ijinfomgt.2018.11.021

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2019). Blockchain and supply chain management integration: A systematic review of the literature. Supply Chain Management: An International Journal. Vol. 25, pp. 241–254. https://doi.org/10.1108/SCM-03-2018-0143

Rehman Khan, S. A., Yu, Z., Sarwat, S., Godil, D. I., Amin, S., & Shujaat, S. (2021). The role of blockchain technology in circular economy practices to improve organisational performance. International Journal of Logistics Research and Applications, Vol. 5, pp. 1–18.

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019), "Blockchain technology and its relationships to sustainable supply chain management", International Journal of Production Research, Vol. 57 No. 7, pp. 2117-2135.

Shahbazi, Z., & Byun, Y. C. (2020). A procedure for tracing supply chains for perishable food based on blockchain, machine learning and fuzzy logic. Electronics, Vol. 10 No. 1, pp. 20-41.

Shah, N. (2004), "Pharmaceutical supply chains: key issues and strategies for optimisation", Computers and Chemical Engineering, Vol. 28 No. 6/7, pp. 929-941.

Gupta, S., Modgil, S., Gunasekaran, A., & B, Surajit. (2020). Dynamic capabilities and institutional theories for Industry 4.0 and digital supply chain, Supply Chain Forum: An International Journal. https://doi.org/10.1080/16258312.2020.1757369

Shih, C.S., & Yang, K.W. (2019). Design and implementation of distributed traceability system for smart factories based on blockchain technology. In Proceedings of the Conference on Research in Adaptive and Convergent Systems, Chongqing, China, 24–27 September 2019; pp. 181–188.

Siyal, A. A., Junejo, A. Z., Zawish, M., Ahmed, K., Khalil, A., & Soursou, G. (2019). Applications of blockchain technology in medicine and healthcare: Challenges and future perspectives. Cryptography, Vol. 3 No. 3, pp. 1-16.

Yin, R. K. (2018), "Case Study Research: Design and Methods. 5th ed. Thousand Oaks, CA: Sage.

Jarke, M. (2019). Data Sovereignty and Data Space Ecosystems. Bus. Inf. Syst. Eng. 2019, Vol. 61, pp. 549–550

Jordan, A. & Rasmussen, L. (2018), "The role of blockchain technology for transparency in the fashion supply chain", (published master dissertation), Malmo University, Malmo, Sweden.

Van der Aalst, W.M., Bichler, M., & Heinzl, A. (2018). Robotic process automation. Bus. Inf. Syst. Eng. Vol. 60, pp. 269–272

Authors' bio

Dr Luai Jraisat
Dr Luai Jraisat is an Associate Professor in Supply Chain Management and Marketing at Talal Abu-Ghazaleh University College for Innovation (TAGUCI). He is a member of professional bodies such as CILT, CIPS, EurOMA, POMS and has appointed as a senior expert at EU, WorldBank and United Nations projects in different countries. He has published more than 50 journal articles, conference papers, technical papers and chapters in books and appeared in leading supply chain management, logistics and operations management, marketing and business journals.

Dr Mohannad Jreissat
Dr. Mohannad Jreissat is an Assistant Professor in Industrial Engineering at Hashemite University. His research is in the field of food value chain, processing systems and operation research. He has worked on projects with UK universities such as Brunel University London, Cranfield University and University of Northampton. He has a growing record of publications in international journals in the field of industrial engineering, manufacturing and operations management.

Professor Arvind Upadhyay
Arvind Upadhyay is a Professor of International Trade, Supply Chain and Logistics at the University of Stavanger Business School, University of Stavanger, Norway. Professor Upadhyay's research, consulting, and teaching stretch across the management spectrum, with an emphasis on integrating operations and supply chain with other management subject areas. His research has been published in the International Journal of Production Research, Production Planning and Control, Technological Forecasting and Social Change, Business Strategy and the Environment, Journal of Cleaner Production, and Resources Policy, amongst others. He has presented at international conferences, including the European Operations Management Association, Production and Operations Management Society, British Academy of Management, and research lunch research seminars at Cambridge Judge Business School.

Dr. Anil Kumar
Dr. Anil Kumar is a Senior Lecturer (Associate Professor) at Guildhall School of Business and Law, London Metropolitan University (LMU), London, U.K. For the last eleven years, he has been associated with teaching and research. Before joining LMU, he was Post-Doctoral Research Fellow in the area of Decision Sciences at the Centre for Supply Chain Improvement, University of Derby, United Kingdom (UK). He earned his Ph.D. in Management Science from ABV- Indian Institute of Information Technology and Management, Gwalior, India. He did his graduation in Mathematics (Hons) and MSc (Mathematics) from Kurukshetra University, India. He earned his Master of Business Administration (MBA) and qualified National Eligibility Test (NET), June 2011. He has contributed over 175+ research papers in international referred & national journals, and conferences at the international and national levels. He published many research articles in A*/A as per ABDC indexed and 4*/3* as per ABS journals like International Journal of Operations & Production Management (IJOPM), Transportation Research Part E Logistics and Transportation Review (TRE), Journal of Business Research (JBR), International Journal of Production Research (IJPR), Government Information Quarterly (GIQ), Production Planning & Control (PPC), Technological Forecasting and Social Change (TFSC), Business Strategy and the Environment (BSE), Journal of Retailing and Consumer Services (JRCS), Journal of Cleaner Production etc.