

The Impact of Blockchain on the Value Chain

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Abstract

Today, businesses are operating in an increasingly complex and competitive environment. They are continuously challenged by the need to increase value chain efficiency, reduce operating costs, improve organizational processes, and consolidate business relationships with supply chain partners. To attain these multiple goals the integration of new technologies into the business value chain is a critical factor for ensuring competitiveness and strengthening the market position. In this regard, blockchain technology gains special attention from both industry and academia. Beyond its first use in cryptocurrencies, blockchain technology proves to be a workable solution for a multiplicity of supply chain application areas and responds to several emerging business needs. In this paper, we set out to provide comprehensive insight into the potentialities of blockchain technology by unifying its value-creating abilities in the well-known Porter's value chain framework. Through the lens of the framework it is possible to gain a deeper understanding of how this technological phenomenon disrupts the value chain and reshapes existing business practices.

Keywords

Blockchain Technology, Value Chain, Competitiveness, Supply Chain Management, Porter

1 Introduction

Broadly, businesses are operating in a very dynamic and competitive environment (Nelson & Orton, 2016; Prasad & Green, 2015). The global structure of supply chains changes the business landscape, redefines relationships between the partners, and ushers in the redesign of existing business models. All firms are witnessing new waves of changes in both needs and practices. The objectives are, in most cases, the increase in efficiency, the reduction of costs, the improvement of operations, and the integration of relationships among supply chain partners (Krmac, 2011). The search for a competitive advantage and the expectation of improved supply chain metrics are a strong impetus for driving the adoption of new technologies in many firms (Alshawhi et al., 2010). To some extent, the competitive edge is derived from the rapid integration of new technologies into the business. Technologies have become a cornerstone in supply chains and logistics as they play a critical role in the modernization and rejuvenation of the infrastructure necessary to ensure seamless flows of products,

information (Pieter van Donk et al., 2008) and value across the network.

The geographic dispersion of businesses, operations, supply and demand raises many needs in the supply chain. From the downstream supply chain, customers are increasingly demanding more visibility and transparency in the way products are sourced, produced, distributed, and sold. There is still uncertainty of how, when and where the products were originated, produced and used through the life cycle (Abeyratne & Monfared, 2016). The journey of the product is still in every scenario unseen and beyond the supply chain partners' possession (Rejeb, 2018a). Moreover, the upstream partners are challenged to constantly satisfy customers' requirements and meet their expectations. There is a particular focus on shortening the lead time (Pan & Yang, 2002), perfecting order fulfilment, offering high product availability, achieving cost efficiency, and creating better coordination with stakeholders. In between these two stages (downstream and upstream) it is necessary to adopt a technology that fits the globalized supply chain topography while streamlining processes and leveraging collaboration.

Simply put, it would be of great value to embrace a technology that addresses the decentralized nature of supply chains and supports the interoperability among all partners. The latest advancement in new technologies reveals a very promising paradigm called *blockchain*.

Recently, blockchain technology has come into the limelight and has gained special attention from both industry and academia (Rejeb et al., 2019b; Rejeb & Rejeb, 2019). The first implementation of the technology dates back to 2008 when a mysterious character named Satoshi Nakamoto laid the groundwork for a peer-to-peer electronic cash system based on the cryptocurrency of Bitcoin (Nakamoto, 2008). The main idea of the new system lies in the obliteration of any central authority or intermediary between the partners involved in the business transaction. Likewise, the system allows the parties who do not fully trust each other to perform and reliably control mutual transactions without relying on the service of any trusted middlemen (Risius & Spohrer, 2017). The Bitcoin-based blockchain provides in an elegant and ingenious way a solution to the double spending problem. This is done by consensually validating, documenting and recording all the monetary transactions in an open and distributed ledger. Besides leaving a landmark in finance, blockchain technology spills over into many other fields and shows the richness of its adaptability to a variety of market sectors and industries (Fosso Wamba et al., 2020; Keogh, Dube, et al., 2020; Keogh, Rejeb, et al., 2020; Rejeb & Rejeb, 2020). To put this into perspective blockchains are seen as a catalyst for change in supply chain management and logistics.

Studies on the possibilities of blockchain technology in supply chain management are steadily progressing in terms of application areas and business needs. Nevertheless, academics have approached the topic of blockchain-enabled supply chains in a scattered manner proposing a set of solutions that address particular value chain issues while ignoring other equally important activities in the supply chain. To address this gap, we set out to provide a comprehensive insight into blockchain potentialities by unifying all the value-creating abilities of blockchain systems in the well-known Porter's value chain framework (Porter, 1985). The reason why we

chose the value chain methodology is its popularity and usefulness in systematically analysing the activities required to handle a product or service from conception, through various phases of production (transformation process of input from different supply chain actors), to delivery to the final consumers, and finally to its disposal after use (Simatupang et al., 2017).

The paper is structured as follows. Section 2 provides a general overview on blockchain technology. Section 3 is the most important part of the paper as it details the framework and discusses how the emerging blockchain technology could disrupt the firms' value chain. The last section concludes the paper and provides potential research directions.

2. Overview on blockchain technology

Blockchain technology owes its origin to a seminal paper written by a mysterious author named Satoshi Nakamoto. Subsequent to the global financial crisis and the declining trust in the conventional banking system, a peer to peer electronic cash system based on the digital currency of Bitcoin was introduced (Nakamoto, 2008). The main idea consists of using an alternative online payment method that removes intermediaries and ensures transaction integrity. To achieve this aim a set of underpinning concepts such as linked time stamping, verifiable logs, digital cash, proof of work, byzantine fault tolerance, public-private key cryptography and smart contracts (Narayanan & Clark, 2017) were used and Bitcoin became the first successful application of blockchain technology. In its simplest term, a blockchain is a "digital, decentralized and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamperproof records" (Treiblmaier, 2018). Blockchain technology is comprised of a decentralized and distributed database which enables it to hold any form of information including transactions, records, and events regulated and updated by specific rules (Sikorski et al., 2017). These transactions are grouped in a bundle called a block in a logical and chronological order. Each block contains a header and a body. The network continuously grows in terms of blocks as more transactions (information and data) are added (Kamble et al.,

2019). The back-end database of blockchain maintains an open distributed shared ledger that can be inspected at any time and from any location by the registered nodes (Mougayar, 2016). Fig.1 depicts in a simple way as to how blocks of transactions constitute a blockchain network.

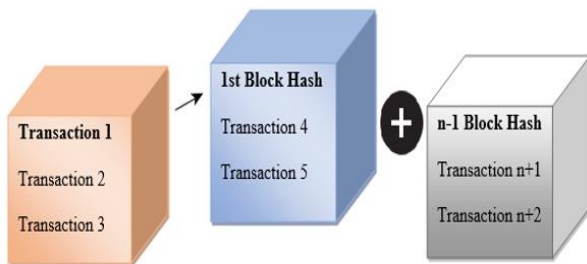


Fig. 1 Blocks in a blockchain

3. Analysis of blockchain-impacted value chain

The value chain framework is a very useful instrument that helps understand the sources of the competitive advantage (Porter, 1985). As an activity level analysis, it is one of the most applied analytical tools by managers to diagnose and improve their firms' competitive stature (Sheehan & Stabell, 2010). The approach distinguishes between the business activities, dividing them into smaller and more manageable pieces and then analysing each activity's impact on cost and value in order to optimize the value chain (Hedman et al., 2008). It does aggregate a company into strategically relevant and interconnected activities. The choice of the framework is explained by its instrumental usefulness as an analytical tool to diagnose and improve the firms' competitive position. In our present research the framework will explicitly represent possible blockchain application areas within the value chain. Moreover, it will appeal to managers and decision makers who seek to understand how blockchain technology could disrupt not only the company itself but also the entire supply chain.

A simple visualization of the framework shows that the activities of the firms are divided into two main groups, as shown in Fig. 2.

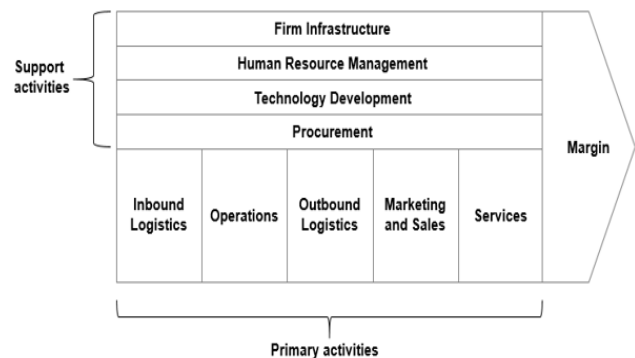


Fig. 2 Porter's value chain model
Source: (Porter 1985)

- *The support activities:* These activities support the primary activities and help to differentiate the product or service offerings. They encompass the firm's infrastructure, human resource management, technology development, and procurement.
- *The primary activities:* They involve inbound logistics, operations, outbound logistics, marketing and sales, and services. They revolve around the creation and generation of value across the supply chain.

To get a better insight into the way in which blockchain technology can disrupt the value chain we shall take a precise look at how the different activities will be impacted accordingly.

3.1. The support activities

Firm Infrastructure

The infrastructure of the firm is an important enabler for supply chain management. It involves the physical premises of the company, such as the company's main building, warehouses and distribution centres. In addition, the infrastructure is regarded as the 'lubricant' for performing many activities within the value chain. The firm needs to commit resources (e.g., physical, financial, and human resources). Of importance, the infrastructure

is not a static instead it needs to be continuously adapted to new market and business conditions to sustain the company's effectiveness for value creation (Lev & Daum, 2004). Blockchain technology will significantly impact the infrastructure of the firm by introducing a new way of building up capabilities and improving processes. The peer to peer design of the technology involves different sizes of supply chain partners (i.e., big and small and medium-sized enterprises) and aggregates the technological solutions as "Lego" instead of being standalone (Frank et al., 2019).

The technology holds promise for unleashing its full potential in new collaborative infrastructure. Any firm involved in a blockchain ecosystem might have the possibility to expand and improve its infrastructure by making more efficient use of the available resources and capabilities. These resources might be a wide range of physical items (e.g., goods, manufacturing equipment, facilities, empty warehouse space, trucks and vehicles) and extend to intangible elements, namely, know-how capabilities, information sharing, skills and expertise. Thus, businesses would have the opportunity to benefit from a sophisticated and tightly knit infrastructure while reducing the strain on the entire supply chain. For example, blockchain could help businesses store massive amounts of sensor data without burdening the networking infrastructure of the firm. A vastly simplified blockchain-enabled infrastructure and smooth inter-operations would allow services to be "mashed up" (combined) to unleash exciting potential business opportunities that were previously possible only through cumbersome cross-industry partnerships (Wood & Steiner, 2016). Blockchain could mitigate the risk of information leakage and tampering that are often used to increase the firm's bottom line. Therefore, blockchain results in an integrated supply chain information system that is able to create a closed loop from supply chain strategy to information systems architecture and to infrastructure (Crandall et al., 2014).

Human Resource Management

The organization's performance and competitiveness greatly depends on the management of human resources (HR) (Hecklau et al., 2016). It is

the driver of increased operational efficiency and performance. Developing human resources involves many tasks such as recruitment, training, workforce motivation, career development, etc. When it comes to effectively managing human resources, blockchain technology represents a paradigm shift and a move from the centralized Human Resources Management (HRM) systems. More specifically, blockchain protocol promotes more trust in hiring by providing immutable and verifiable copies of CVs of potential employees. To lower the risk of bad recruitment and biased human resource management system, Onik et al. (Onik et al., 2018) proposed a blockchain-based recruitment and human resources management system. Their proposed model is able to verify and store recruitment and HRM-related information; driving down the costs and eliminating the need for third parties. Blockchain would replace existing HRM systems, which are inefficient, dependent on paperwork, and susceptible to fraudulent practices. It could help businesses to enhance their productivity, save costs, and optimize the allocation of human resources. For instance, a blockchain-based HR department can easily specify conditions and criteria for payroll and bonus-performance schedules on a blockchain and enclose these terms in a configured smart contract (Sabeti et al., 2019). Cryptocurrencies could be used in the payment of salaries; thus rooting out any third party intermediaries and decreasing fees (i.e., banks fees). For example, Bitwage has combined blockchain with mobile and cloud technology to facilitate cross-border payments by using Bitcoin as a payments rail. Finally, in the case of employee migration from one firm to another, blockchain could provide a solution to the incompatibility in database management and acts as a standardized and secure reservoir for all HR-related data.

Technology Development

To cope with increasing global competition and innovation trends businesses have to develop organizational capabilities and absorb new technological developments (Cohen & Levinthal, 1990). The advantage of blockchain in this regard is its ability to simplify the ways to establish proof of ownership and streamline patent registration thereby creating more efficient methods to monitor intellectual property (IP) rights and opening the door

for managing IP rights globally. A range of IP materials such as trademarks, domain names, brand recognition, reservations, patents, copyrights, and goodwill could be stored, managed, and secured using blockchain technology (Kumar & Mallick, 2018). As such, the two features of "hashing" and "proof of existence" make blockchain relevant and suitable for patent protection. For example, blockchain could facilitate the innovation process by allowing to record a hash of patent description and through proof of existence it could publically record the fact that a patent document exists without having to reveal its content (Di Gregorio et al., 2017). Blockchain technology could be used to improve anti-counterfeiting and copyright procedures for additive manufacturing. In a study by Kennedy et al. (Kennedy et al., 2017) blockchain technology is harnessed for developing a physical anti-counterfeiting approach that can verify the authenticity and quality of 3D-printed parts. The suggested approach reflects the ability of the technology to protect the intellectual capital of the firm, its copyrights and patents from imitation.

Blockchain technology is not standalone. Aside from providing a decentralized mechanism for data management in the supply chain, blockchain technology could consolidate existing legacy systems and many other information technologies. It complements the need for maintaining consistent data provenance that describes the source of data while retaining privacy and confidentiality. For example, blockchain technology is perfectly aligned with distributed cloud storage. Blending the technology into the cloud environment can lead to achieve the task of data provenance where cloud nodes record data in a distributed network with a fault-tolerant approach and strong cryptographic security (Shetty et al., 2017). The same goes for the benefits brought by blockchains in the IoT (Internet of Things) ecosystem. In addition, secure and real-time information sharing could foster research and development by providing the company with an updated vision over the changing needs of customers and their requirements. The massive streams of information stored on a blockchain could assist in the assessment of products and equipment performance, provide a starting point

for product improvement and further technological developments.

Procurement

Apart from presenting a great potential to disrupt many industries and organizations, blockchain technology is forcing businesses to rethink their strategies and organizational capabilities. An interesting new way to look at the possibilities of blockchain technology is to examine its leveraging impact on procurement function. There is now wide recognition that procurement is an important capability for businesses to succeed in a more complex, dynamic and networked business environment (Provines, 2017). This implies that there is a need to attain higher levels of efficiency in the procurement process and to drive down related operating costs. As procurement technologies and tools continue to improve and the skills and professionalism of procurement organizations grow continuously (Provines, 2017), blockchain technology proves to be a possible solution for several procurement issues and a new embodiment of sophistication.

To cope with the growing complexity in buying decisions and to respond to the pressing needs for greater transparency in procurement decisions (Carter et al., 2000), blockchain presents the necessary technological capabilities to fundamentally leverage the procurement function and create sustainable buyer-supplier relationships. Drawing on the key features of the technology, the technology allows the transacting parties to access an immutable, secured and shared database. Operating in a common platform, businesses could use the accumulated data and the transactional history associated with the suppliers' portfolios, the service level agreements, and complaints (Rejeb et al., 2018) to support their decision making and suitably select their contracting suppliers. The permanent availability of data sets and the efficient data processing onto blockchain networks offers opportunities for flexible and easy governance. This would in turn help to streamline the procurement process from the recognition of needs to the release of payments. As such, the use of blockchain technology enables procurement

professionals to easily identify the existing inventory of raw materials, to schedule the timing of procurement, to set service level agreements, and to negotiate business deals based on total ecosystem volumes instead of individual purchasing quantities. Moreover, the procurement department could hinge on blockchain to build an internal E-commerce platform, where managers and professionals would be able to use their benefit points to purchase a wide range of goods offered by suppliers (Ying et al., 2018).

The likelihood of ineffective relationships with vendors is significantly reduced since the procurement managers could rely on the transactional history of suppliers to gain an insight into the suppliers' identity and reputation.

Blockchain technology constitutes a workable and viable solution for the many problems raised by the central systems for procurement and compliance with external business partners (Rejeb, 2018b). Blockchain facilitates and secures the exchange of sourcing documents, warranties, and specifications as immutable, time-stamped, certified and accessible to the interested entities. Thus, this would guarantee that global procurement and contractual practices are in accordance with stringent requirements and best practices. The smart diagnostics is another blockchain-enabling application, which permits the monitoring of the state of equipment and diagnosing problems and smart contracts between the procurement of MRO (maintenance, repairs, and overhead) supplies and the service of machinery (Bahga & Madiseti, 2016). Similarly, smart contracts embedded in a blockchain system could automate the negotiation process and optimize the prices and deals according to a set of specific conditions and business objectives. The enforceability of these contracts established under blockchain could effortlessly transfer the ownership of products and services from one party to another and the outcome could be used in the audit trail to prove if terms of legal agreements were convenient and altogether respected (Rejeb et al., 2018). Therefore, blockchain technology promises to mitigate several inefficiencies in the procurement function by making the process more streamlined, automated, and efficient.

3.2. The primary activities

Inbound Logistics

Inbound logistics activities include the receiving, storing, and distributing of raw materials, goods and products in the value chain. More specifically, it is the process of moving components and parts from supplier to manufacturer (Suthikarnnarunai, 2008). Inbound logistics is supported by supplier management and supply chain management technologies (Bharati & Chaudhury, 2015). These latter might include *EDI* (*Electronic Data Interchange*), *CRP* (*Continuous Replenishment Program*), *ERP* and *VMI*. The importance of blockchain, here, lies in integrating these systems and supporting the secure access and sharing of sensitive information between supply chain partners. Moreover, the technology synchronizes the data between the different nodes involved in the supply chain ecosystem. A high level of synchronization drives more control over the inbound logistics and reduces the asymmetry between the firm and its suppliers. For instance, the technology is proven very valuable for improving the tracking of inventory, monitoring product ingredients or components, and tracing their global footprint (Omran et al., 2017).

Many answers to questions related to the origin of raw materials, the quality and the source from which it is derived are easily provided through the use of blockchain. This increased control over the materials intake is the precondition of high quality products thereafter. Moreover, blockchain applications with respect to tracking the state of raw materials in the warehouse should not be overlooked. Blockchain technology secures and guarantees an enhanced level of traceability of raw materials status (Fosso Wamba et al., 2020). For example, combined with *Wireless Sensor Networks* (*WSN*) and *RFID*, blockchain technology could bolster the productivity of firms in terms of costs and time allocated to remotely monitoring and controlling the status of raw materials in the warehouse. This is often achieved by attaching the items and stock keeping units (*SKUs*) with *IoT* sensors that monitor not only the physical location of raw materials but other variables such as environmental parameters (temperature, humidity, light intensity, etc.). This information will be

aggregated and stored in a blockchain on a real-time basis and securely. More importantly cost savings might be achieved because the system is fully digitized, eliminating all problems resulting from fraudulent practices or archaic manual paperwork delays. Arguably, the paperwork in many processes, and particularly in the warehouse systems, is very labour intensive and time-consuming. As a result, blockchain could smooth workflow and speed up procedures related to warehousing activities.

Operations

Operations management is simply the process of transforming and converting a set of input or resources (e.g., raw materials, labour, energy, etc.) into outputs or finished goods. Intriguingly, blockchain has a great potential to disrupt the manufacturing activities of the businesses and bring in a new manufacturing business model. Scholars note that optimizing the manufacturing activities with blockchain technology create new capabilities and value-generating activities, such as the real-time synchronization of decisions (Watanabe et al., 2016). Any firm involved in blockchain ecosystem is by nature subject to an increased level of control for ensuring the authenticity of its products and the sustainable manufacturing practices (i.e., credence claims and compliance). Moreover, the technology creates new opportunities for sharing manufacturing resources and leveraging capabilities and assets.

The emergence of smart factories has resulted in the generation of massive sets of data throughout the manufacturing process. Smart factories are challenged with increasing needs for trustful exchange of data, authentication of cross-organizational digital identities, and the seamless value shifting between people and their organizations (Zhang et al., 2017). Based on the technical characteristics of blockchain technology, manufacturers would be able to digitize their assets, efficiently circulate the information related to the production process, and exchange resources. Records related to the manufacturing tasks (e.g., quality of cutting and drilling, welding, surface treatment, assembly) could be securely stored on a blockchain (J. Wang et al., 2017). As a result, the availability of such information assists the interested parties in performing audit checks on quality issues

encountered on the downstream side of the supply chain. Key manufacturing data could be captured on a blockchain from the Industrial Internet of Things (IIoT) (e.g., machine embedded sensors) and could serve the company by managing plant equipment, setting target Key Performance Indicators (KPIs), anticipating failures, and scheduling appropriate proactive measures before a breakdown or a potential process disruption occurs. In turn, regulators, suppliers of machinery and spare parts, and repair and maintenance service providers gain greater visibility to the state of the machinery and could provide timely inspections and instant certification services in order to maintain high equipment availability and utilization (Miller, 2018). The use of blockchain and Industry 4.0 technologies (e.g., cyber-physical systems) advance remote machine diagnostics, reciprocal data analytics, and machine-to-supplier interactions and result in improved spare parts replacement and overall maintenance practices (Dogo et al., 2019). Operational benefits of this approach involve the reduction of lead times, tamper proof processes, reduction of operating costs and possible economies of scale (Mondragon et al., 2018).

Outbound logistics

Outbound logistics is the actions related to the storage and physical distribution of final products to the customers.

Apart from providing a clear image of the final products, blockchain technology enables the businesses involved in the downstream supply chain to receive reliable information on the products and their movements from the manufacturing firm to the last actor in the chain. The traditional *one up/one down* approach for products traceability is extended to cover the entire value chain. Moreover, the master data and transactional data related to the suppliers and their products will be immutably and permanently recorded in the blockchain. Hence, they become 'indices' and free up the businesses to focus on what could change, such as the physical product during in-transit handling and shipping. This is partly because the human manipulation of data or information in a blockchain is extremely rare and it could be straightforwardly flagged and detected. Interwoven with the IoT blockchain technology at the

inbound logistics stage offers traceability and geographic provenance in complex supply chains, as well as product authentication and auditing (Chandy et al., 2017; Rejeb et al., 2019a). In a similar strain, a system incorporating RFID, sensors and blockchain would be very effective in supply chains allowing to curb the infiltration of substandard and counterfeit products identified with genuine tag information into the distribution chain if the seller does not confirm the ownership of these products in a blockchain system (Toyoda et al., 2017).

All registered downstream actors will have the opportunity to monitor the product online, in-store, or on-pack. By being well-informed about the movement of the products, blockchain leverages the *distribution management systems* and empowers the supervision of the products' mobility along the supply chain (Rejeb & Bell, 2019). For example, A GPS system linked to a blockchain network could provide instant visibility to the customers, help position refrigerated trucks from remote distribution centres and optimize both routing and delivery time while preserving the quality of the product (Rejeb, 2018a). The data streamed from any device used in transportation activities could be gathered in a blockchain system and used to assist the analysts in improving the forecasting of delivery times, fleet availability and routing efficiency.

Marketing & Sales

Marketing and sales activities are aimed at attracting customers to buy a product and to provide the means for doing so (Jelassi & Enders, 2005). Initially, the internet has revolutionized the way companies market their products and services. Digitization has also changed several aspects of marketing including product, price, place and promotion. Similarly today, there is an emergence of so-called digital marketing that allows customers to have a better insight over the products and this significantly impacts the purchasing decision-making process.

Blockchain technology has remarkable implications for marketing and sales. As commonly hailed for its disintermediated approach, the technology will allow marketers of the company to access the customer-related data and information without the need for

paying third parties like Facebook and many other social media platforms. Drawing on the traceability capabilities of the technology it would be easy for businesses in the supply chain to track their ads and marketing teams' performance and actions, to gain more control over all the automation practices, and to ensure a better allocation of resources to marketing activities (e.g., promotional campaigns) (Ertemel, 2018). Stakeholders in the supply chain would benefit from the transparent data-driven marketing as it is possible to validate and analyse every consumer's journey through verified ad delivery, confirming that a real person saw the ad as per the specifics of a media contract (Ghose, 2018). The problems related to customers' privacy in many marketing activities could be easily solved by blockchain technology. The reason is that the technology could enable a new marketing model where customers' personal information is completely secure and their privacy is preserved. More control and scrutiny are facilitated in the sharing of information; thus driving more verifiability, in-depth and accurate analytics, and better marketing decisions.

Given that loyalty programs are critical customer relationship marketing tools that are used to boost customer share and refine customer retention (Anuar et al., 2015), blockchain-based rewarding systems in the business ecosystem would substantially benefit the customers and the firms involved in loyalty programs. A company utilizing blockchain features to design its reward and loyalty programs would certainly create a competitive edge over other competitors and increase the quality of its services and its ability to reach new potential customers segments. As such, the new technology could leverage the reward programs by integrating traceability, tradability, reliability, and convertibility capabilities in the system. For instance, firms could build loyalty programs on a blockchain platform and issue loyalty tokens as rewards to their customers. More than that, the loyalty points could be exchanged between the customers; thus laying the groundwork for the development of a C2C market. The customers could easily maintain both instant tracking of their loyalty points and a flexible and wide convertibility base of those points. Quite simply they would no longer be cluttered and overwhelmed with

untraceable reward points, bounded by restrictions on their redeemability, and limited to specific convertibility ranges. In sum, blockchain technology will reshape how brands create and deliver value and enable the firms to improve the image of their products and services and consequently bring vast improvements over current marketing and sales practices.

Services

These activities deal with the after-sale phase. In the normal course of action they involve, but are not limited to, the installation of a product, the supply of spare parts, and the exchange of faulty products.

Given the dynamic nature of ecosystem and the need of businesses and suppliers to adapt and respond to consumers' expectations, blockchain technology could significantly facilitate the provision of after-sale services. While today's customers are demanding fast, timely and accurate services, putting serious pressure on the company, blockchain technology allows to automate and monitor the after-sales activities. As we have previously stated, the technology could provide full visibility to the supplier of the company regarding the state of its machinery, resulting in high responsiveness and agility in the case of machine breakdowns. Instead of being reactive to potential disruptions in the supply chain, a blockchain-based solution for after-sales services (here, repairs and maintenance taken as an example) drives the approach of proactivity. The technology could provide the supply chain exchange partners with a satisfactory redress mechanism and enables them to solve warranty problems. This is facilitated by the traceability capabilities of the technology. By maintaining the tracking of after-sales transactions, manufacturers can contact the current owner of the product in order to combat grey market operations (i.e., the sales of authentic products by unauthorized retailers) and to orchestrate appealing warranty policies and reward programs.

4. Conclusions

In this paper we have comprehensively analysed the possibilities of blockchain technology in the business value chain. Considering the newness of the topic in supply chain management and the lack of

literature in this area we unveiled the potential of blockchains as distributed ledgers serving to record all transactions performed by supply chain partners. Ranging from simple to complex value chain operations, the technology enables firms to attain an unprecedented level of automated processes and real time visibility into the movement of resources (e.g., money, information, raw materials, finished products, etc.) across the supply chain. A potential improvement in the firm's infrastructure lies in the ability of blockchain to induce a new collaborative-enabled business model and to effectively interplay with other technological phenomena (e.g., IoT, cloud computing, EDI, etc.). The application of blockchain technology in the domain of HRM could mitigate several problems emanating from the conventional management of HR such as bias in recruitment, inefficiencies in HR allocation, and the lack of transparency (Onik et al., 2018). Furthermore, the technology is anticipated to spur innovation through the protection of intellectual capital of businesses and secure access to real-time information and to provide an updated version of what a set of customers' demands and changing needs look like in the future. Procurement is another area where blockchain shows promising implications in terms of flexibility, responsiveness, and sustainable buyer-supplier relationships.

Blockchain technology opens the way for extended and efficient traceability, unlike the one-up one down approach (Y. Wang et al., 2019). More precisely, it could significantly reduce response time to product recalls, thwart the infiltration of counterfeits, and locate the footprint of products for several provenance-sensitive industries (e.g., foods, pharmaceuticals, diamonds, etc.). In addition, blockchain provides a high level of transparency in the inbound and outbound logistics activities. The intrinsic disintermediation enabled by blockchain adds value to the value chain in that it allows the partners to transact and share information directly and without recourse for trusted third parties. The whole manufacturing process could be automated and no longer require human intervention. The introduction of blockchain to the management of production operations enables several new end-to-end business models including the provision of

connectivity or managed services for factories (e.g., predictive maintenance, controls and monitoring, etc.), as well as, IT infrastructure, data collection or its pre-processing as-a-service (Backman et al., 2017). For the marketing and sale of products or services, blockchain technology serves as the missing trust layer in the evolution of the Internet (Ertemel, 2018), as it allows customers to benefit from the transparent data-driven marketing. Marketers could rely on blockchain technology to better profile their customers, identify their needs, and tailor their marketing strategy more precisely and in a personalized manner. The benefits that could be derived from a blockchain-enabled marketing model are the improvement of loyalty programs, the ability to expand the C2C market for exchanging loyalty points and reaching to new customer bases. Lastly, the after-sale services could be significantly improved and this would enhance the customer perception of the product or service quality. In this respect blockchain technology equips businesses with the necessary sound joint problem solving mechanisms and strengthens their position to provide better after-sale services, resolve customers claims, and offer warranty and maintenance services.

Although this paper is theoretical in nature and attempts to contribute to the existing and increasing body of knowledge regarding blockchain applications in supply chain management and logistics, there remains several limitations. First, the study theoretically extends the analysis of blockchain-impacted value chain and provides timely and useful information to both practitioners and academics; however, it neither provides an exhaustive nor systematic review of the literature. Therefore, future research work might prove fruitful by engaging rigorously in the application of these methodologies to comprehensively answer questions as to how blockchain technology can reshape and impact the value chain. We envisage that the use of qualitative and quantitative approaches might result in a deeper understanding of the blockchain phenomenon in supply chain management. Thus, scholars are encouraged to empirically test the relationship between technology and value chain activities. The impact of blockchain on the operational performance of supply chains, the challenges of blockchain

technology in each value chain activity, and the antecedents of blockchain adoption in these organizational functions leave an interesting avenue for future research directions.

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