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Blockchain Technology in Supply Chain Management: an Empirical Analysis

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Acronyms

AI Artificial Intelligence

CPS Cyber-physical systems

ERP Enterprise resource planning

ES Enterprise systems

KPI Key Performance Indicators

ICT Information and Communication Technologies

IoT Internet of Things

IoS Internet of services

MOBI Mobility Open Blockchain Initiative

NFRD Non-Financial Information Disclosure Directive

OAM Officially Named Mechanism

OEM Original Equipment Manufacturer

OM Operation Management

P2P Peer-to-peer

PoW Proof of Work

SCM Supply chain management

SCRM Supply chain risk management

WMS Warehouse Management System

“Anything that can conceive of as a supply chain, blockchain can vastly improve its efficiency- it doesn’t matter if its people, numbers, data, money.” (Ginni Rometty, CEO IBM).

Introduction

Blockchain is a software technology that was first used for the implementation and for tracking transactions of the cryptocurrency Bitcoin. Initially, it gained traction as a critical FinTech technology (Economist, 2015b) until many experts and scholars noticed that the application of Blockchain could go beyond Bitcoin and other cryptocurrencies, and even the financial industry (Economist, 2015a; Notheisen et al., 2017; lnes et al., 2017; Underwood, 2016).

Blockchain, not big data, robotics, the social web, or even artificial intelligence, according to a Harvard Business Review study (Tapscott and Tapscott, 2016), will drive the majority of organizational transformations in the next decade, successfully driving change in a variety of businesses.

In the manufacturing and the distribution industries, the last decade has seen important changes in its operations management (OM), and more specifically, the acquisition and management of resources dedicated to production combined with the supply of products and services, through the integrated uses of software and of the internet. The ongoing automation of traditional manufacturing and industrial practices, using modern smart technology referred to as the "Intelligent Manufacturing" or "Industrial Internet", are transforming the way goods are designed, manufactured, delivered, and paid for. The impact of digitization is nowadays denoted as the Fourth Industrial Revolution, Industry 4.0, (Hofmann and Rüsch, 2017; Xu and Li, 2018) representing technologies that are becoming embedded within industries, societies and even our human bodies.

Examples include genome editing, new forms of machine intelligence, breakthrough materials and approaches to governance that rely on cryptographic methods such as the blockchain. (Nicholas Davies, World Economic Forum, 2016)

A plethora of speculative theories on the opportunities and benefits of applying blockchain to operations management, manufacturing, and supply chain management (SCM) have arisen. SMC is developing rapidly, thanks to digital transformation, and the application of blockchain technology is being heralded as a radical innovation that the SCM must seize.

Blockchain is based on decentralization, transparency, and visibility (Swan, 2015; Tapscott & Tapscott, 2018). The blockchain is a network technology for streamlining business processes, while using a peer-to-peer (P2P) network to verify and share data (Cole et al, 2019). It can be perceived as a thrustless system since no entity within the blockchain circuit has to rely on the accuracy of the specific counterparty. Indeed, the strength lies in the fact that the technology itself verifies trust in the network through records of immutable transactions and decentralized governance (Mougayar, 2016; Swan, 2015; Tapscott & Tapscott, 2018). In line with this, as companies began to perceive blockchain as an exciting technology, more or less silently, they have practically experimented with such a technology first-hand by rewriting the way to interact both at an endogenous and exogenous level. Blockchain technology represents a significant step forward for supply chains, facilitating the delivery of non-counterfeit products that can be verified from the beginning of manufacturing to the end of the transport. Factories and machines can be connected using blockchain platforms to enable automated processes of added value. Connected partners can analyse big data generated by IoT devices to gain deeper insights into manufacturing processes and improve quality, risk management, and digital threats mitigation. These are just some of the opportunities which, manufacturers from different sectors could seize in blockchain applications (Chang, Iakovou, & Shi, 2019) According to Kshetri (2018), blockchain is to be used to track all supply chain operations, such as conducting the actions, when and where they are being performed. Every supply chain partner may keep track of products, shipments, delivery, and progress.

Conversely, more cautionary voices have raised concerns that, as with any new technology, there are questions about blockchain's dependability, speed, security, and scalability. Concerns have also been raised about a lack of standards and potential compatibility with other blockchains.

And the pace of implementing blockchain has also been remarked upon: If suitably integrated, this technology could revolutionize how a company is defined today, touching all branches of the latter from the production to the sales, passing through wholesalers, distributors, and suppliers. Blockchain possesses the potential to transform global supply chain management, but so far, most companies are in the technology development, adoption assessment, or initial implementation phase through pilot projects (Cole et al., 2019; Pournader et al., 2020).

Many in the industry field have pointed out that blockchain is just a digital technology and that the most glaring limitation is that it cannot eliminate the necessity for quality assurance. "Nothing can replace knowledge and contact with your supplier, random audits by certified supplier organizations, and testing to confirm and authenticate a supply chain", according to IPEC-Americas, a global pharmaceutical industry group (Bocek et al., 2017, p.87). Although the adoption of blockchain technology is intended to make the process faster, more resilient, and reliable, additional stages that slow down the supply chain will continue to exist (Bocek et al., 2017).

Gartner, a multinational that deals with strategic consulting, research and analyses the field of information technology, predicts that blockchain may be able to track $ 2T of goods and services as they move around the world by 2023, and that blockchain will be a business of over $ 3 trillion by 2030. Naturally, these possibilities have generated widespread interest, especially since the end of 2017, as highlighted by Google Trends.

However, blockchain still remains in 2021 just an emerging technology. As a result, there is a significant disconnection between blockchain potential and supply chain implementation. Many companies still have limited awareness of blockchain, and there are few ready-to-use blockchain applications in the supply chain area (Peterson, Young, & Gordon, 2016). A lack of awareness is also adding to the blockchain trust gap. Many CEOs are still unsure what blockchain is and how it can affect different aspects of business. Despite the proliferation of such efforts, the research literature on the current state of blockchain in global SCM and commerce is quite limited, and there is also a shortage of publications on the successful application of technology in the literature (Babich et al., 2019).

Adding further discrepancy between industry initiatives and existing literature, managing global SC and trade flows requires industry-government cooperation. Moreover, none of the existing research has presented a holistic overview of the merits of blockchain technology for both sides (Chang et al., 2019). Specifically, it is unclear what the exact tasks and challenges of this technology requires of each party and how the latter should promote blockchain development and implementation in a concerted manner. The bulk of regulators are still figuring out what blockchain and bitcoin are all about. There are a number of significant legal and regulatory challenges that need to be solved as blockchain threatens many old corporate paradigms (World Economic Forum 2018). More specifically, because each node of a blockchain ledger could be in a different region of the world, determining which laws should be observed and which courts have the authority to decide on what matters for blockchain-related issues is a difficult and even contradictory undertaking (Chang et al, 2019). Many jurisdictions have begun to research and examine such concerns, particularly as they pertain to financial services, although the overall regulatory landscape remains uncertain.

New collaborations, joint ventures, and initiatives are announced regularly, yet few instances of large-scale blockchain use are successfully implemented. Scientific contributions and effective industrial applications in this area are still scarce and mainly in a proof-of-concept phase (Lohmer and Lasch, 2020). Notably, the lack of empirical evidence on implementation challenges and potential use cases in OM and manufacturing (Cole et al., 2019; Pournader et al., 2020) has led the academic literature to demand an evaluation of blockchain technology within OM strategies and principles.

This thesis aims to address some of the lack of empirical evidence through an analysis of data provided by ESSEC Business School of Paris and consider whether blockchain can be successfully applied to all or parts of the Supply chain management. It will be guided by the urgent questions identified:

1. What are the necessary conditions for the application of Blockchain in the industry?
2. How should blockchain be implemented for best results in the supply chain operations?

A thorough description of the properties of blockchain technology in supply chain and limitations that need to be overcome, will provide the background of the analysis and conclusions.

1. Theoretical Background

1.1. The significance of blockchain for the supply chain

The growing agreement among corporate leaders and entrepreneurs is that blockchain technology's future will involve much more than Bitcoin. Blockchain technology will impact every significant aspect of a company, from accounting to operations, and the transformation has already begun. What is it, and why is it so crucial to the future of business? (Parth Misra, 2018) Blockchain is essentially a distributed database system that maintains transactional data or other information and is regulated by a consensus method secured by encryption (Swan, 2015). It is a data format that joins data records, or blocks, in a chain, developed in 2008 by Satoshi Nakamoto, the unknown person or individuals behind the Bitcoin white paper. (Cole et al, 2019) Blockchain is made up of a series of interconnected data blocks. The data in the blocks include a hash (cryptographic "fingerprint") of all previous blocks. This feature makes it impossible to tamper with the earlier blocks, as communication within the network occurs between geographically dispersed nodes in a peer-to-peer network through transactions and cryptographic elements. A focus on the definition of a transaction is needed. Transactions on a blockchain do not necessarily have to be financial; in fact, these represent a state change for any data point that blockchain stakeholders want to monitor, a perpetual and traceable record between multiple parties (Swan, 2015).

When a user triggers a transaction, his details are transmitted to the entire network, checked by other users and accepted in case of consent, a feature that underpins this technology. The actions carried out do not need third-party interventions as they are automated. Moreover, the essential data for all parties can be updated in real-time, eliminating the need for time-consuming and error-prone reconciliation processes with each party's internal records (Casey and Wong, 2017). Blockchain is not a single technology. Instead, it is a family of technologies used to develop and maintain distributed ledgers (i.e., databases massively replicated across all "nodes" or machines in the system). It is also important to remember that blockchain technology is about data storage, not acquisition, for example, through sensors, such as radio frequency identification [RFID]. (Cole et al, 2019)

A vital advantage of this immense archive in a commercial context, where no single entity is in control, is that it solves disclosure and accountability problems between individuals and institutions where interests are not necessarily aligned. Blockchain can automatically perform some parts of the process with smart contracts, computer protocols designed to facilitate, verify, or enforce a contract's negotiation or execution. These specific protocols can decide whether and how a particular transaction or payment is made and whether the latter should be allowed or not (Pilkington, 2016).

When a transaction has been validated, it is grouped with other transactions in a data block. A cryptographic algorithm protects each block. The ledger is secured by reliable means of cryptography, including private keys to sign transactions, hash functions to link blocks, and consensus mechanisms to ensure irreversibility (Bahga & Madisetti, 2016; Wang, Shen et al., 2019; Zheng et al., 2018). For the first time, organizations of all kinds can communicate and exchange data securely with other organizations they do not need to trust without using an intermediary. The Blockchain is built using P2P networks. There must be an agreement among all relevant parties in order for the transaction to be valid, thereby ensuring that inaccurate or potentially fraudulent transactions are not included in the database. The data's immutability guarantees that agreed-upon transactions are recorded and not changed. Given the asset provenance, it is feasible to determine where an asset is, where it has been, and what has happened to it during its lifespan.

There are two types of blockchains, both public (e.g. Bitcoin) and private. However, it is worth noting that there are very few properties common to all blockchains. For example, data immutability, i.e. the fact that transaction cannot change retroactively, is a feature which, despite present in many versions of the Blockchain, does not bring them all together, contrary to common belief. The main difference between the two different types of Blockchain lies in the membership or authorization to enter the network. A public blockchain is completely open, and the network is studied through a mechanism that pushes as many participants as possible to join. All this complexity creates problems. One of the disadvantages of a public blockchain is, in fact, the considerable amount of computing power required to maintain a large-scale distributed ledger. More specifically, to gain consensus among all users, each node on the public network must solve a complex and resource-intensive cryptographic problem called "Proof of Work" (PoW) to ensure that all nodes are synchronized and immutably chained. (Cole et al, 2019). Proof-of-work (PoW) as a consensus technique for Bitcoin provides for a reliable approach to ensuring data immutability. Nonetheless, such a process is inefficient in terms of energy, bandwidth, and CPU time. (Babich and Hilary, 2019). Another relevant issue confronting the public Blockchain is privacy poisoning, especially likely to arise in case of personal data violating privacy laws. Balancing an individual's privacy rights in an open network is indeed a hard process, especially across international blockchain platforms (Chang et al., 2019). Private blockchains, on the other hand, require an invitation, as well as a verification operated by the participants. Businesses and supply chains would generally create an authorized private network rather than an open public network (Pilkington, 2016), thus reducing the problem of managing an unlimited number of users. As a result, many of the networks' technologies (such as Hyperledger Fabric) use protocols that preserve computing resources. (Babich and Hilary, 2019). For example, to approve a new consensus, the mechanism can rely on votes. In this scenario, the problem is to design a technical solution that strikes a compromise between data verifiability, resource efficiency, and the highest level of privacy (Babich and Hilary, 2019). The organization may have struggled in the past with dozens of ERP systems and inconsistent data and processes. A single distributed ledger, rather than one central ledger for each subsidiary, can reduce the requirement for reconciliation (Davis et al., 2018). Companies are looking into how internal digital tokens could represent cash or other assets to facilitate transfer between company units. Instead of time-consuming and expensive bank transfers, currency conversions, and many emails regarding each transaction, users can now do it all online (Davis et al., 2018). Smart contracts can conduct tokenized transfers in near real-time, allowing users to watch the progress of each transaction (Bahga and Madisetti, 2016). Internal buy-in, data harmonization, and size are all issues that a corporation building a blockchain for itself will face (Davis et al., 2018). Nevertheless, just like it does with its ERP today, this corporation may define and enforce blockchain standards. The benefits of Blockchain are best realized when several industry participants collaborate to develop a shared platform (Chang, et al., 2019). Indeed, it encourages organizations to share data because it is designed to be dispersed and synchronized across networks, making it perfect for multi-organizational business networks like supply chains or financial consortia (Cole et al, 2019). However, another problem confronting

Blockchain is the establishment of network trust. It is somewhat ironic that a technology created to bring people together encounters a snag when developing rules and standards (Davis et al., 2018). While objectively easier to acquire, social consensus based on values and expectations is more complicated, as demonstrated by the examination of current banking payment systems and methods. Even though everyone currently follows the norms of existing systems, they do not always agree on how a blockchain-based model should be structured and operated (Cole et al, 2019). There are alternative ways to collect and share data (private networked systems, intelligent sensors, mobile apps), and blockchain technology will not replace but rather enhance these methods (Babich and Hilary, 2019). The cheaper costs of adding new players, data encryption, and record validation are the primary distinctions between Blockchain and various existing systems. (Parth Misra, 2018) As previously said, the latter fosters trust in information shared. Blockchains can be used to produce verifiable digital claims (tokens) for production, inventory, and financial assets and share, trade, and exchange these assets among various participants (Babich and Hilary, 2020). The exact attribution of rights to diverse characteristics of assets simplifies asset administration, sale, and trade. Contracting, B2B, and B2C interactions can be made more formal, lowering legal and transaction expenses. As evidenced throughout the paragraph, the typical features of blockchain, such as transparency, consensus, immutability, and others, represent the premise for boosting numerous domains.The field in which such a technology could potentially have relevant benefits, leading to its evolution, is that of the supply chain.

1.2. Strengths and Weaknesses of blockchain with respect to SCM

The supply chain has changed dramatically in the previous decade due to the development of the Internet and the availability of new technology via the Internet (Helo and Hao, 2019)). Supply chains, in general, are made up of self-contained, interested enterprises, organizations, and individuals linked by physical, informational, and financial flows. Consumers both generate and consume items and services due to their activities (Babich and Hilary, 2019).

The ongoing digital transformations seek to optimise flexible mass production, real-time coordination and optimization of value potentials and opportunities. The term "internet of things" (IoT) that became trendy in the first years of the XXI century, is viewed as a catalyst for Industry 4.0. supply chain management. Although there is a wide range of definitions for the Internet of Things in the literature, the present project will, for practical reasons, stick to a broad definition. The latter will refer to the IoT as a world in which virtually all (physical) objects can be transformed into so-called "smart things" by incorporating small computers that are connected to the internet (Hofmann and Rüsch, 2017)

The Internet of Things (IoT), big data analytics and cloud manufacturing affect the economic, social and political factors that drive business operations globally (Ferdows, 2018; Rossit, Tohmé and Frutos, 2018). In recent years, industries of all kinds and sizes have experienced a steady increase in complexity due to ever more and broader international competition, increasing market volatility, the demand for highly customized products and the shortening of product life cycles (Spath et al.,2013). Previous industry 3.0 approaches are no longer suitable for managing the growing demands for cost efficiency, flexibility, adaptability, stability and sustainability. Supply chains are growing increasingly complicated in structure, tough in the task, and diverse in players, and many organizations do not have a comprehensive perspective of the full supply chain (Helo and Hao, 2019)

Several multinational corporations have developed their own identities and systems to maintain global operations and have the authority to direct their suppliers (Helo and Hao, 2019). They can also readily check the quality of items during transit and measure the performance of each operation in the supply chain (Chen et al., 2017). There are strong indications that, similar to the IoT, an internet of services (IoS) is emerging, based on the idea that services are made easily available through web technologies, allowing companies and private users to combine, create and offer new kind of value-added services. Barros and Oberle (2012, p.68) propose a broader definition of the term service, namely “a commercial transaction where one party grants temporary access to the resources of another party in order to perform a prescribed function and a related benefit”. As the Internet of Services (IoS) and cyber-physical systems (CPS) become more vital, the applications and usability of “blockchain in supply chains” will continue to expand.

Blockchain technology has the potential to change the economic and even legal structure of supply networks, which were typically split into two configurations. The first model is based on an entity's strategic plan being optimized through documents by a single corporation (such as the headquarters) (Chod and Lyandres, 2018). The second is a distributed structure, in which numerous participants construct a chain of trades and transactions. Blockchain networks offer a middle ground for supply chain improvement that does not necessitate total integration by establishing a self-contained institution (Chod and Lyandres, 2018). Some of the touted benefits of adopting blockchain technology in businesses and supply networks include increased speed of data and financial transactions, higher security of shared data, and digitized assets. As mentioned in the preceding section, Blockchain is thought to have enormous promise to improve supply chain management operations and enhance business models (Helo and Hao, 2019). The decentralized ledger, similar to a stock ledger, provides a single unified data source for all suppliers involved in operations like manufacture, assembly, distribution, and maintenance, offering a clear audit trail and consistency (Cole et al., 2019). As blockchain technologies enable exceptionally secure and irreversible access to supply chain data (Kim and Laskowski, 2016), authenticity may be assessed even when no single individual claims ownership of the data. Blockchains provide real-time data to the network on the origins of resources, sales order, stock levels, commodities received, shipping manifests, and transactions. According to Hofmann & Rüsch (2017), there is still a lot to learn about Blockchain, but it will help to improve supply chain integration. However, sectors and enterprises that are already well-integrated may be unwilling to engage extensively in Blockchain if it does not provide considerable benefits over current solutions, although the decentralized technology improves product safety and authenticity and service levels and maintenance costs (Cole et al, 2019). According to a poll conducted by Petersen, Hackius, and von See (2018), regulatory ambiguity and collaboration issues are the most common hurdles to supply chain adoption among managers. The number of potential applications is massive, even though the lack of awareness may be an issue, as most specialists are still unaware of the technology's enormous potential. Large global firms like Unilever, Walmart, and Sainsbury's are experimenting with blockchain technology to improve the transparency and sustainability of their supply chains, yet remain at the stage of development (Edie, 2017). More generally, the initial focus of empirical research on the implementation of the Blockchain is the prerogative only of large organizations. Larger enterprises have more resources, higher transaction volumes, activities with a wider geographical dispersion, more supply chain partners, and more information to manage than smaller businesses. As a result, these businesses will likely be the first to implement technological solutions that enhance operational efficiency and save expenses (Patterson et al., 2003). Nethertheless, we should not underestimate the influence that blockchain technology could have on small businesses . Because end-to-end transparency is a key feature of this technology, even small and medium-sized businesses must participate in it. Smaller businesses are likely to receive preferential financing, subsidies, and tax incentives due to the adoption of the supply chain using blockchain technology (Antle and Diagana, 2003; Sarkar and Singh, 2010). As a result, blockchain implementation may become a means of realizing benefits while also securing capital. Indeed, the combination of asset digitization, smart contracts, and cryptocurrencies creates a trade environment devoid of intermediaries, with perfect transparency and trust among all parties involved (Pournader et al., 2019), and may provide a distinct advantage over its larger, direct competitors. Blockchain technology describes five capabilities when utilized for OM applications: visibility, aggregation, validation, automation, and robustness (Babich and Hilary, 2019). To reduce the risk of capacity shortages, it is critical to eliminate information asymmetry and promote information sharing across the whole supply chain (Nakasumi, 2017). As a result, blockchain open visibility allows supply chain participants to track products throughout the whole supply chain (Chang et al., 2019). Bills of freight, insurance policies and invoices are important documents used in international trade to assure that sellers get paid, and buyers get authentic, unaltered merchandise (World Trade Organization 2018a). These records, however, are not without flaws (Chang et al., 2019). In order to reach high levels of visibility different systems are used such as an EDI network to merge several types of code schemes or by creating an integrated Enterprise Resource Planning (ERP). These are the most commonly used systems to date. Because Blockchain has yet to be proven at scale, it cannot be asserted with certainty that it can process the same number of transactions as current ERP systems. However, when implemented in an application, blockchain technology facilitates the integration of parties and eliminates risks thanks to its high level of security. (Li et al., 2018)

For example, in most supply chains, the payer may monitor some aspects of their operations at their tier-one suppliers but rarely manages to monitor tier two or beyond.

(Babich and Hilary, 2019) Blockchain technology has the potential to provide visibility at these higher levels. The Blockchain provides real-time visibility into the SC to ensure all contract conditions are satisfied and forces organizations to coordinate and work within compliance requirements, while stored data is readily available to auditors for verification (Microsoft 2018). It is designed on a peer-to-peer network and represents a unique opportunity to strengthen the interrelation between cybersecurity and physical transport security while ensuring the integrity of the chain of custody process (Babich and Hilary, 2019).

In contrast, suppliers may oppose OEMs' efforts to map out wider supply chains and discourage their suppliers from participating in the blockchain system. (i.e. Toyota's automobile manufacturing Greimel, 2012). Another disadvantage of blockchains is that, as not everyone advocates for a high level of transparency and visibility, unethical suppliers may be incentivized to engage in riskier behavior. (i.e. China's use of melamine for the adulteration of food products (WHO, 2018).

Blockchain data are gathered from various sources, including businesses, clients, legislators, and intelligent systems. Previous transaction records are permanently stored in subsequent ledgers, giving the data a temporal dimension (Davis et al., 2018). In this way, consumers could benefit from more detailed data than is now available thanks to blockchain technology. Consumer choice models generally use only a few factors to describe items such as "quality", which is appropriate for analytical results, yet each product has a multi-dimensional and multifaceted story. In the era of big data, information aggregation is incredibly significant, and this technology is excellent at gathering data from various sources. The combined data can be used synergistically to improve system performance and redistribute advantages among participants.

Relying solely on big data is not necessarily better because it can obscure essential facts. Consumers can become swamped by too much information and make poor decisions or none at all. More in-depth training may split the supplier market, lowering provider rivalry (McKenzie, 2019). Decision-makers must have faith that every data recorded on a distributed ledger by numerous organizations corresponds to objective reality. The value of data aggregation is contingent on the willingness of many stakeholders to either share data or supply accurate data.

Validation refers to the notion that once data is captured in a distributed ledger, it is validated and tricky to tamper with (Babich and Hilary, 2019). The information kept on the chain may be reviewed by an authorized party, and it cannot be removed or manipulated, but it can only be modified after stringent verification by network consensus methods (Gupta, 2018). Following validation, all nodes send a confirmation message, and the validated transaction is appended to each node's chain (DU). Furthermore, decentralized identity management with powerful security features is possible with Blockchain. (Babich and Hilary, 2019) However, because validation is challenging to obtain in conventional bilateral interactions, validation is likely to be especially critical for applications in the SCM. Yet, there are other advantages that can be achieved through the use of alternative technologies. In reality, because nodes in the public Blockchain are expected to authenticate every transaction of each block, transaction testing is an essential part of the distributed consensus mechanism (Reyna et al, 2018). As previously said, the fundamental distinctions between Blockchain and some existing technologies are the lower costs for adding new players, data encryption, and record validation.

The main strength of the latter is that it develops trust among supply chain partners and in the quality of the information transmitted, providing the key to new business models (Babich and Hilary, 2019). In any case, structured validation of contractual logic and its validity are fields of study expected to receive contributions in the following decade (Luu et al., 2016). The capacity of the Blockchain to conduct transactions automatically in response to specified conditions is known as automation (Babich and Hilary, 2019). Workflow automation is rapidly cementing itself as the backbone of SCM digitization, alongside artificial intelligence (AI) and the Internet of Things (IoT) (Gartner 2018; The Economist 2018b). Intelligent contracts are vital components for automating this process, encouraging an increasing number of businesses to use them (Lohmer and Lasch, 2020). Although ERP systems can compare records and process payments for their organization, the Blockchain takes it a step further by offering insight and automation across the supply chain (Li et al., 2018). The Blockchain offers faster times to receive approvals from participants involved by supporting the automation of some transaction axioms through intelligent contracts and giving trustworthy and confirmed information. However, not all that glitters is gold. If smart contract rules are set in place before being implemented on a system that cannot handle changes since the beginning, the system may become too stiff to handle the needs of dynamic environments. Furthermore, if the logic of a smart contract is dynamically updated, the algorithms that underpin this transaction may or may not be performing correctly (Li et al., 2018). Algorithms, by conducting transactions, make choices that may be incorrect in the future, and they notice when it is too late for humans to intervene. Resilience refers to the idea that the entire blockchain database is fault resistant since it is duplicated on every point in the chain (Babich and Hilary, 2019). This fault tolerance is the feature that ensures that the system continues functioning normally even when one or more of its components fail.

The concept of resilience refers to how soon a supply chain can resume normal operations after being disrupted by a dangerous occurrence (Waters, 2015). Even if a node is disabled, the system can still work, thereby enabling a faster recovery in the event of a natural disaster or a cyberattack. (Mougayar, 2016). While the vast replication of the database provides security in physical stress, the possible impacts of computer infection are yet little known. The concept of resilience is not the same as that of vulnerability. The latter denotes the likelihood that dangerous occurrences will have an impact on the supply chain. As a result, SCRM might take one of two courses depending on the conditions. The first is to manage stress events from occurring, thus lowering vulnerability; the second is to recognize that they do occur and rapidly allow the chain to function in the proper manner, boosting resilience. (Waters, 2015).

Some collaborative business models will be presented in order for the reader to appreciate how elastic blockchain may be when addressing various business scenarios, in order to fully understand how this technology might affect business partnerships. Blockchain can, due to its versatility, assist practically every company relationship, either vertical, horizontal, or diagonal. These relationships, as well as the implementation process of blockchain along with its issues will be thus the central focus of the following paragraph.

1.3. The implementation process of SC: issues and opportunities

Several companies and researchers are attempting to interact with the blockchain movement based on their business goals, although the implications of Blockchain on the supply chain have yet to be thoroughly investigated. (Cole et al., 2019) Indeed, the multiple unanswered questions which arise within blockchain research often result in a diffused skepticism in the business world. An organization's information is in fact still seen today as a vital competitive advantage for the company and a low propensity to share it freely (Agrawal and Pak, 2001). Access to data is, in fact, a fundamental prerogative for a partnership between companies based on this technology. Understanding who will be the actors gaining the maximum profit as soon as possible and when the blockchain will pay off the investment, particularly in supply chain management, will be crucial for the faster adoption of this technology in the business process. At the same time, it is fascinating for scholars to look at the future of blockchain in terms of business and technological innovation (Helo and Hao, 2019). The level of user understanding is a major impediment to blockchain's widespread adoption. A strong blockchain investment necessitates a certain level of blockchain comprehension, which is often lacking as the majority of existing blockchain interfaces is overly complex. As a result, efforts to improve user experience and formalize blockchain protocols are critical (Mulligan et al., 2018).

The potential of blockchain technology to perform within a supply network has been compared to working in a vertically integrated chain (Catalini and Gans, 2016). Nonetheless, the use of blockchain technology does not imply that a supply chain is vertically integrated in the classic sense. (Cole et al, 2019). Companies frequently have a supplier-customer relationship in the context of vertical partnerships, with an organizational structure that integrates and sequentially orders processes and relies on contracts. (Babich and Hilary, 2019)

To deliver a final product to their consumers, the various suppliers are grouped in levels (London Hydro et al., 2020). Vertically integrated companies must be willing to let their partners observe inner systems and processes in order to develop an end-to-end process, and they must comprehend the ramifications of integration across the whole supply chain

(Venkatraman and Henderson, 1999). However, in the past, companies who wanted to expand their processes had to build more trusted and collaborative connections with their business associate, but this is not the situation with the blockchain. The blockchain works as the most substantial legal contract, obviating the need for agency processes (Cuevas et al., 2015).

But what if businesses today used Blockchain-based methods to expand their commercial relationships? What if this technology was widely used by businesses and was required to process hundreds of millions of orders each second to spur the economy without significant delays?

When attempting to improve a platform's operational capability, the term scalability is frequently used. From a standard client-server design, vertical scaling entails upgrading current system hardware to add more memory space. (Jagati, 2019)

When discussing scalability in the context of blockchain technology, it is essential to note that, because public blockchains are already dispersed networks, increasing the overall throughput of a network by merely adding additional hardware entities - such as miners, nodes, or validators - is challenging. (Jagati, 2019) From the perspective of a system built on a distributed ledger, using nodes built by quantum computers makes every internal component of a structure faster and more robust, albeit the drawback being that only few selected people are capable of tying these knots.

As a result, having fewer nodes producing blocks speeds up the process. However, centralization undermines the appealing qualities of blockchains, such as their censorship resistance, visibility, and overall integrity. This directly opposes blockchain's core concept and vision as a technology that aspires to allow horizontal integration (Lohmer and Lash, 2019). Similarly, horizontal scaling entails altering the platform's underlying infrastructure to create a server cluster capable of handling many new transaction requests (Jagati, 2019). Horizontal partnerships between enterprises are frequently associated with strategic firms that cater to an exact targeted population (Meador, 1996). Commercial alliances can then be created in this way, functioning in concert to benefit customers and their interests (Meador,1996). To be more explicit, horizontal scaling improves a network's trust or security while degrading the overall system performance (transaction processing capacity). Organizations can collaborate to provide new or improved services to their clients by modifying their corporate models to suit new strategies and opportunities, as previously indicated. (Cole et al, 2019) In parallel to the vertical and horizontal models, the use of cases and illustrations on how differently connected organizations might join forces with new enterprises emphasize a third model, the diagonal prototype. Diagonalities, a complex hybrid system where horizontalities (e.g., spot markets) and verticalities (e.g., supply chains) collide, are also likely to be affected by blockchain technology (Babich and Hilary, 2019). Companies that are not in the same industry as one another may occasionally request services from one another (Leible et al., 2019). Diagonal relationships are those in which two companies are not directly interconnected but impact each other (Bernardes, 2010). The overall purpose is the same, whether firms have horizontal, vertical, or both sorts of relationships: to provide value for the target audience (Babich and Hilary, 2019).When it comes to creating value, pooled connections can have a variety of effects on businesses: They can profit from using blockchain to strengthen alliances with other businesses regardless of how their commercial relationships are structured. Blockchain interoperability is seen as the next great thing, with the potential to add a lot of value to the decentralized internet (Accenture, 2018d). Enabling several related blockchains to link can greatly enhance the blockchain's scalability, speed, and extensibility. This allows businesses to reach out to new audiences and potential customers previously unavailable when operating in a siloed environment (Mckinsey, 2018). Furthermore, scalability is required for blockchain to obtain widespread approval across industry sectors and users. As a result, the blockchain is adaptable enough to accommodate businesses with varying relationships, and it can reduce the technical aspects of consolidating a network with various participants, resulting in significant time savings.

However, the blockchain network's autonomous architecture is bound by the time required to handle each request (Giungato et al., 2017). The blockchain network's ability to scale will be constrained due to its limited transaction capacity. A user through one blockchain should be capable of reading, grasp, and interact with another blockchain with little effort in a completely interoperable environment (Association for Financial Professionals, 2017). Techniques must be developed to reduce the number of participating nodes required to validate each transaction while preserving trust in its validity (Mulligan et al., 2018)). By guaranteeing that trust barriers between organizations may be bridged via the consensus mechanism in blockchain networks, the benefits discussed here aim to encourage enterprises to cooperate and grow together.

2. Bottom Line

As shown by a Deloitte survey conducted in 2016, blockchain adoption - and its transition to production - might have occurred at a quicker rate than demonstrated in the second study conducted in 2018 (Deloitte, 2018). Its adoption remains optimistic and inevitable, on a level with today's extensively utilized digital platforms. In reality, our daily lives are now characterized by the frequent use of these platforms: if we want to book the perfect vacation rental, we utilize Airbnb or Booking.com and search for the most acceptable option. If we are in a big city and need to get about quickly, we will probably use an Uber. Finally, if we cannot decide between two restaurants, we can use the TripAdvisor app on our smartphone to get recommendations from people who have already eaten there. Despite their differences, they all begin with the same fundamental concept: data exploitation, which involves data storage, analysis, and sale to other parties, not to mention how having information about platform users becomes an irrefutable competitive advantage. As a result, we see how much of this is a genuine platform economy: platforms are our economy's guiding model, with data at the heart of trade, social, political, and cultural activity.

Blockchain holds the same promise for business across various industries (Deloitte,2018). Shortly before the pandemic expressed its full disruptive effect, the centrality of ecosystems in corporate development and competitiveness strategies played a crucial role. In particular, in ecosystems, the size of the single node is not necessarily decisive as much as its strategic positioning is. The technological convergence of recent years - for example, of IoT and blockchain - significantly contributes to the integration and efficiency of complex ecosystems, also by technologically solving more relational issues, such as trust between ecosystem members, transparency of transactions, visibility, and sharing of events. The past 12 months have severely tested, on a global scale, the classical systems of relationships on which social exchange and economic practice were based for a long time. Whole sets of values, such as sharing, closeness, and, in some ways, the same trust in others, have taken on different connotations and have been largely weakened. At the same time, the digital dimension has proved to be the most effective glue of social relations and the main tool to support business resilience. Naturally, these phenomena have accelerated awareness and made clearer the potential benefits of the blockchain, which form the first applications in the financial field, and has greatly expanded its range. Today, blockchain takes an increasingly significant role in the production world. The technological dimension, combined with the substantial changes taking place at a global level, places companies in front of a paradigm shift, which allows both to achieve greater interconnection and cooperation in the context of supply chains and ecosystems and to enable new organizational models and favour the birth of new professional figures. All this requires important changes within a company and in the complex of external relations. According to the Milanese Observatory on Blockchain Technology's report, there has been a 59% increase in international projects compared to 2019, while announcements declined by nearly 80% indicating the exit condition of "hype" and the move towards more tangible projects. While early adopters, digital entrepreneurs, and new revolutionaries who have structured their firms on blockchain from the beginning are making rapid progress, efforts to put blockchain into production are not keeping up. We expect blockchain to gain substantial traction as more businesses invest their human and financial resources and better understand how it can improve their business processes and profits. We expect cost reductions, gain competitive advantage, and ROI benefits to become more pronounced as more businesses engage their people and financial resources in blockchain (Deloitte, 2018). Blockchain is a technology that has the potential to revolutionize how we think about security and trust in social and economic contexts. The efforts that place Blockchain technology at the core of their innovation strategy are numerous and scattered at various levels, with applications that have found fertile ground in both the public and private sectors, not only financial services. To now, however, predicting which applications will be the most revolutionary has proved to be challenging.

It is crucial not to assume that a blockchain solution will "change the world" for a company or sector from the start, as the process could be complex and very slow. As Hartmut Rauen, Deputy Executive Director of the Mechanical Engineering Industry Association, said : "The implementation starts with small steps here and there, and there will not be a big bang to Industry 4.0. Maybe when we look back in ten years, we will realize that the world has changed significantly", (VDMA), (2012, p. 56).

It is also essential to make sure that if we decide to invest in blockchain, the latter is the tool that best solves the company's problems to avoid unsuitable investments. As stated by PwC, among companies with a blockchain project in the pilot phase, 54% did not believe that the effort ultimately justified the result (Brown, 2017). presents a sobering statistic where among the 26,000 new blockchain projects conceived and activated in 2016, only 8% of these were still active in 2017. A gradual approach could bypass this problem. Indeed, it is possible to deduce three phases to adopt the technology. Starting from the assessment stage, moving on to the implementation of the technology and finally to the integration (Grover and Goslar, 1993; Damanpour and Schneider, 2006). To help companies determine how to achieve their business goals, the discussion of the possible uses and applications of blockchain in the supply chain is heated.

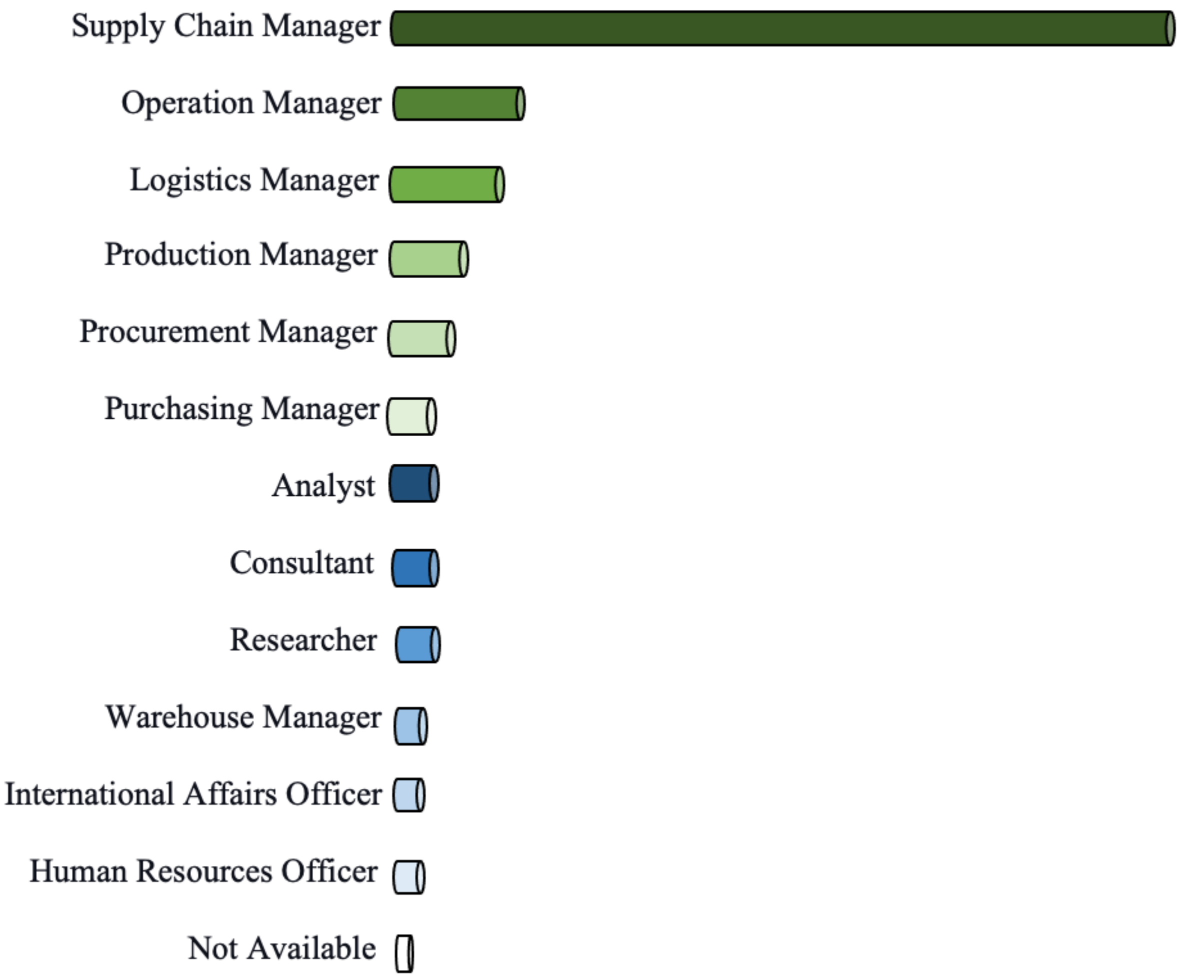
3. Overview and Methodology

The ESSEC Business School of Paris commissioned this survey. The primary purpose is to investigate the trend of overall investments regarding blockchain technology within the international companies' supply chain. The survey was sent to more than a thousand senior executives from manufacturing companies, wholesalers, distributors, suppliers and retailers, between September 2019 and January 2020. The online responses come from more than 150 companies located in nineteen different countries around the world. 51% of the companies surveyed have an annual average turnover of $100 million. The information shared in this research project provides summary prospects of a subset of the data collected through the administration of a questionnaire on Omnichannel, Blockchain, and Last mile. All respondents had extensive knowledge of the blockchain, and investment plans of their organizations related to this technology.

The questionnaire sent to companies consists of three blocks. The introductory phase with default questions (type of company, average turnover, company headquarters) is followed by the first block dedicated to the Omnichannel section (how the company has achieved its consumer in the last two years, the objectives that aim to reach into the consumer-based dimension and so on). The second block is the section that most interests this research project as it is dedicated to the questions that aim to identify the degree of implementation of blockchain technology within the business process in the last two years. In this regard, the four selected variables appear to be, among the seven available, those able to best answer the research questions addressed in this project. The available responses to the four variables, namely "Integrating Blockchain Technologies with other Digital Technologies", "Aligning the technology requirement with the regulations", "Modifying the Management of Contracts and Transactions" and "The Company developed New Platforms" were developed through the " use of a seven-point Likert scale. Specifically, the extreme positions of the scale (Agree-Disagree) and the median value (Neither agree nor disagree) were considered in the data analysis. These variables were put into the system through a multivariate analysis with seven other variables, namely "Blockchain variables by type of company", "Blockchain variables by management of logistics and safety", "Blockchain variables by management of forwarding and reverse logistics", " Blockchain variables by management of lack of transparency "," Blockchain variables by management of info sharing with consumers "," Blockchain variables by management of product traceability "," Blockchain variables by investment in Information System and High-tech". The intention was to cover the main parts of the supply chain and, in particular, where blockchain's technology interrelated. The starting point was to identify the companies that had or were implementing blockchain the most, then consider essential aspects of the supply chain like the last mile, the relationship with consumers, information transparency, regulation compliance and new contracts systems. It was considered appropriate to choose these variables because, as widely discussed in the first part of this project, blockchain technology can better express its full potential in logistics processes, in processes inherent to the management of transparency, traceability and customer service.

4. Survey Overview

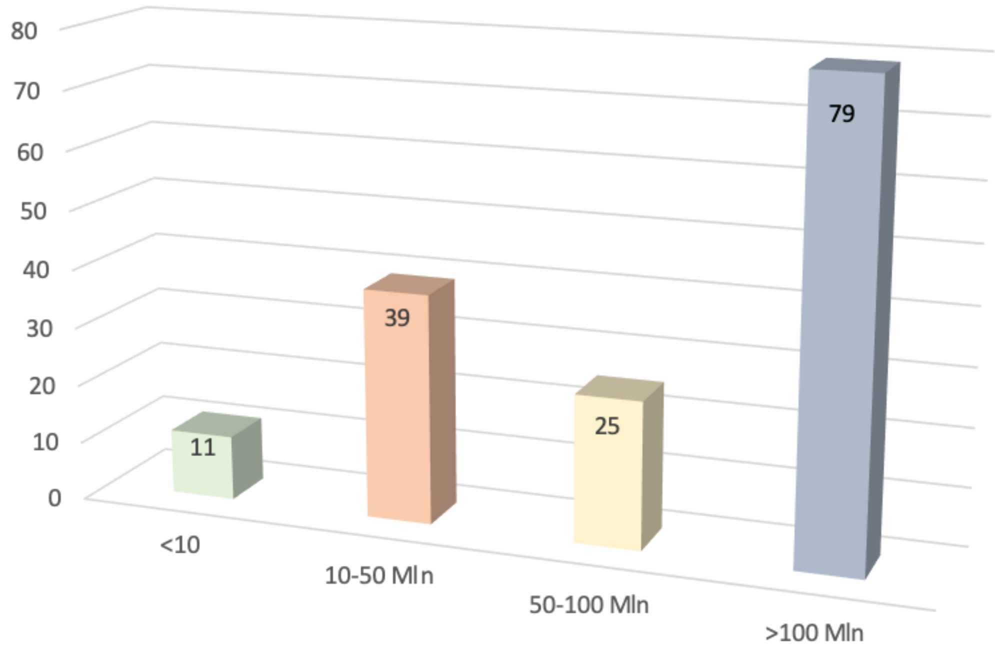
4.1. Representation of the statistical collective, by role's respondents



Note: Base:154 companies

Source: ESSEC BS's Global Blockchain Survey 2020

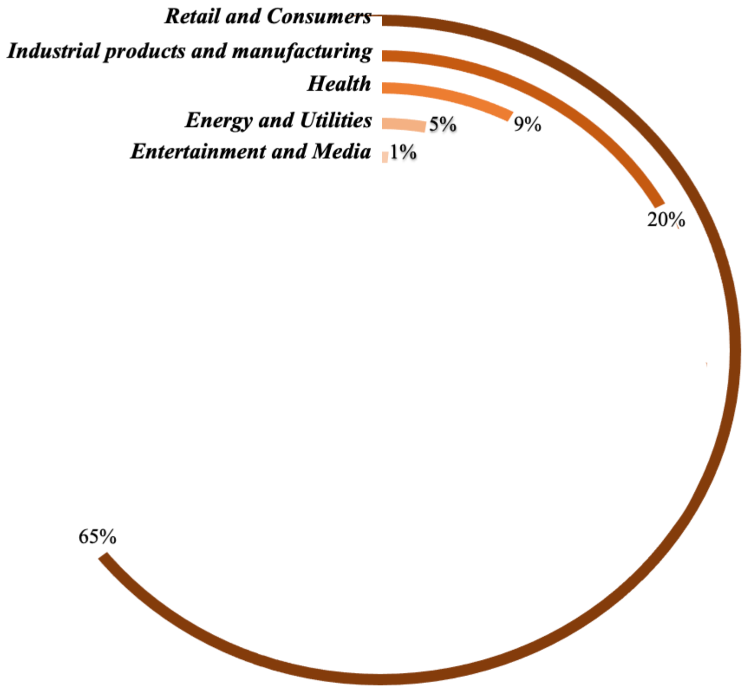
4.2. Representation of the statistical collective, by average turnover



Note: Base:154 companies

Source: ESSEC BS's Global Blockchain Survey 2020

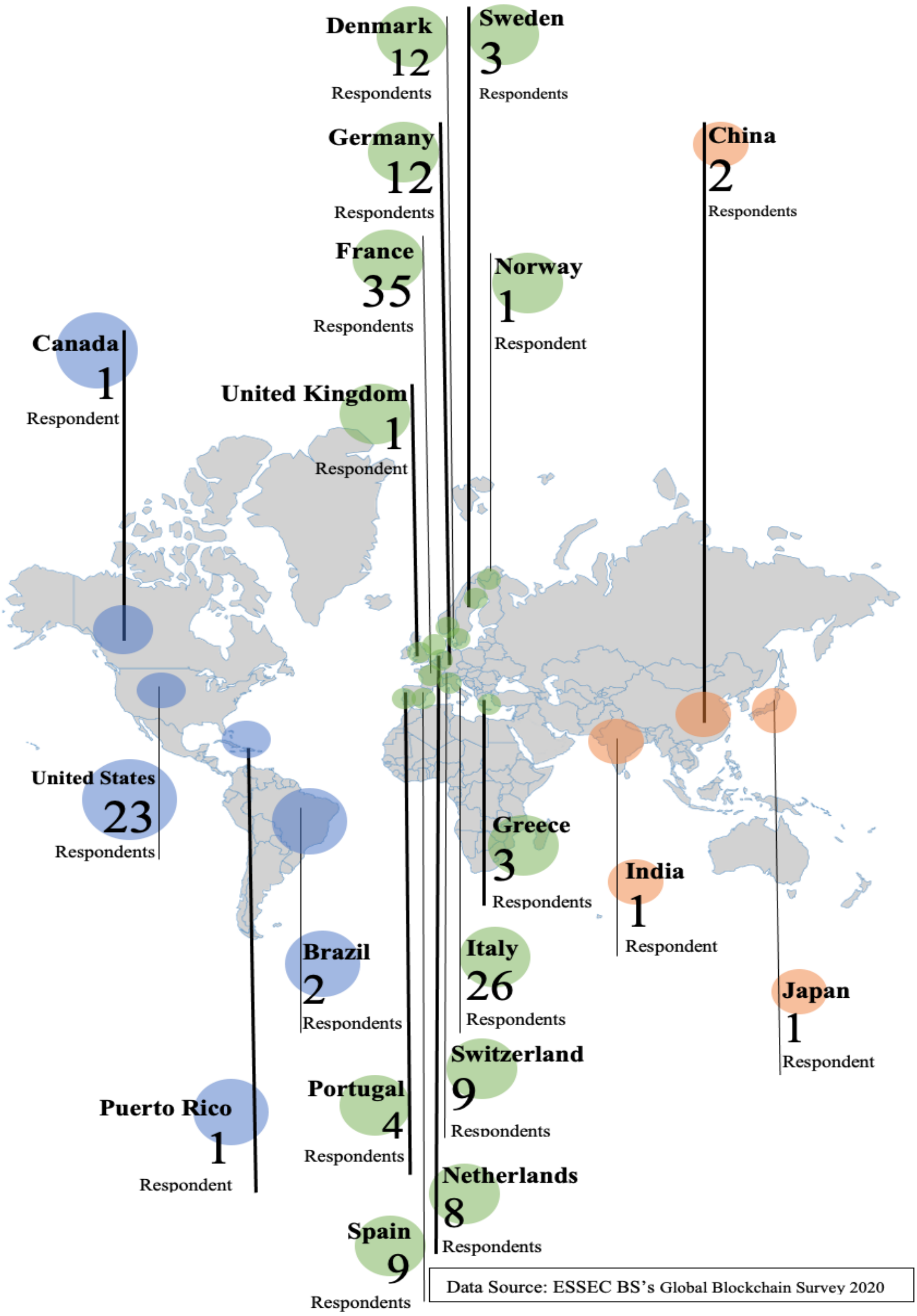
4.3. sentation of the statistical collective, based on companies 'type.



Note: Base:154 companies

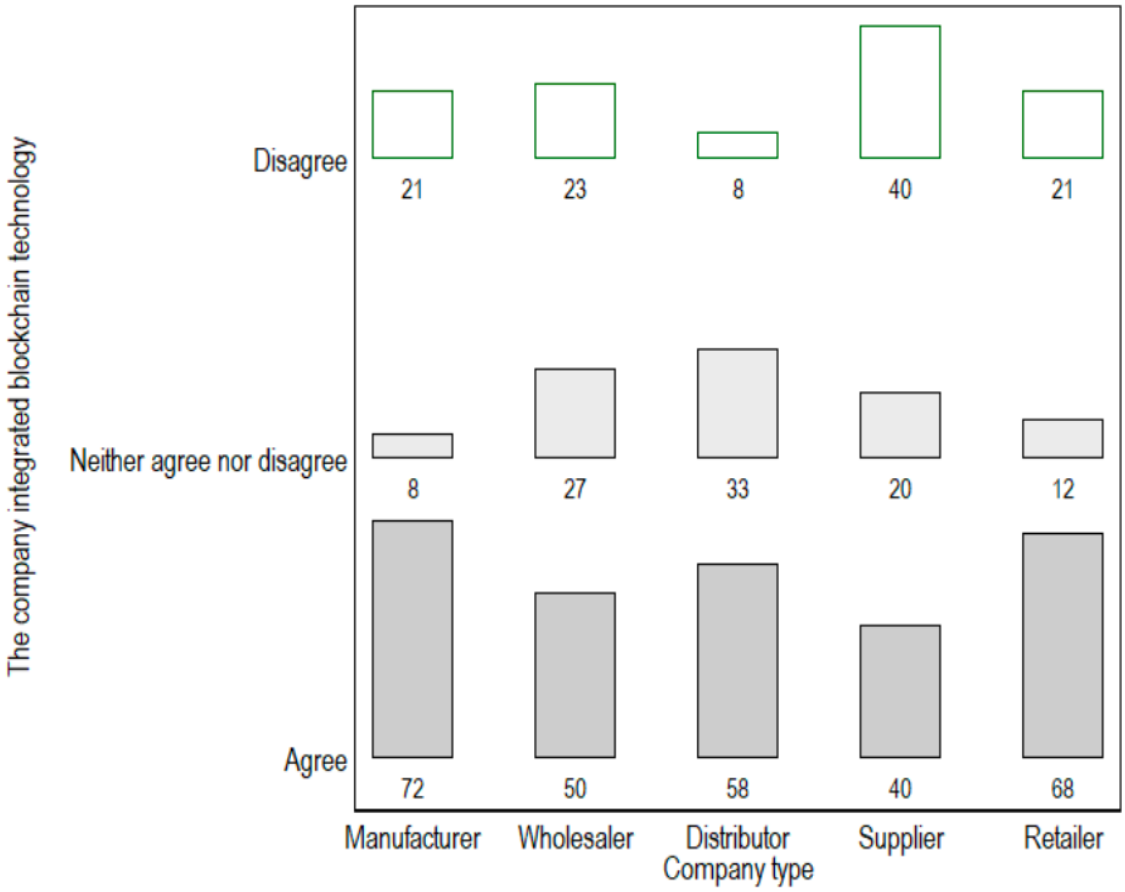
Source: ESSEC BS's Global Blockchain Survey 2020

4.4. Representation of the statistical collective, based on headquarter location

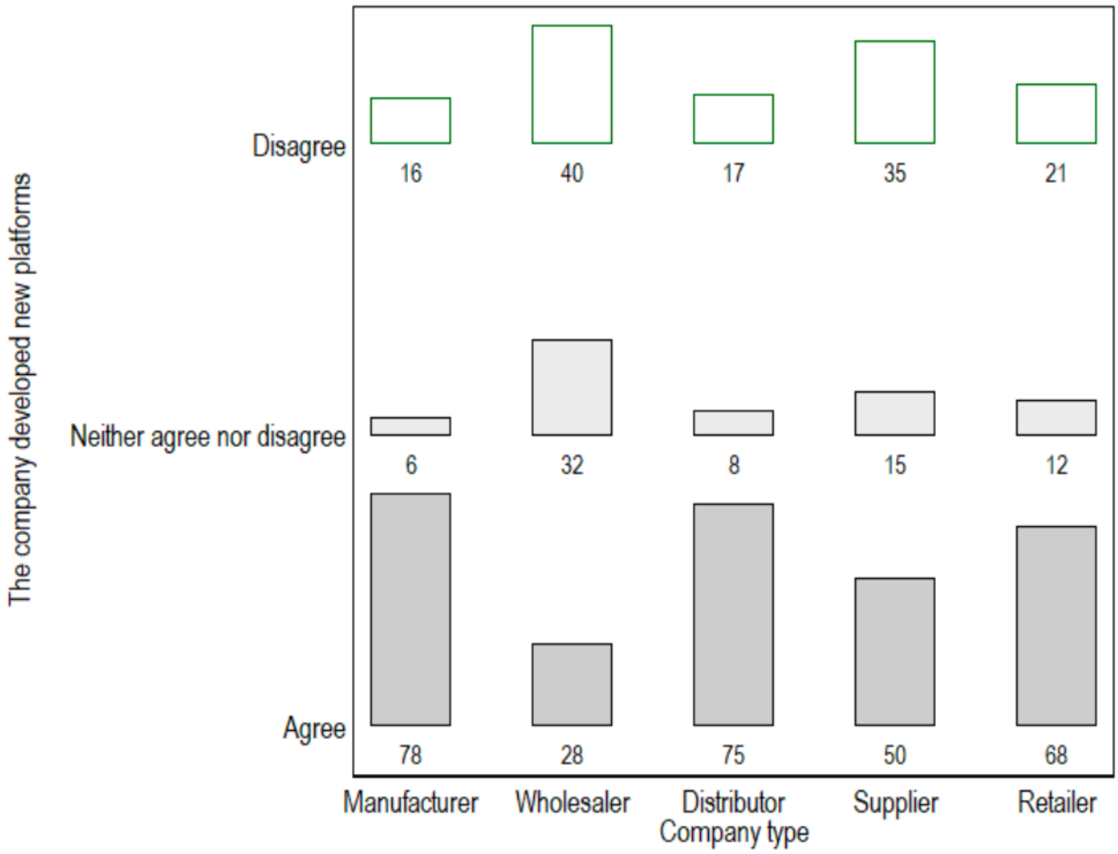


Data Source: ESSEC BS's Global Blockchain Survey 2020

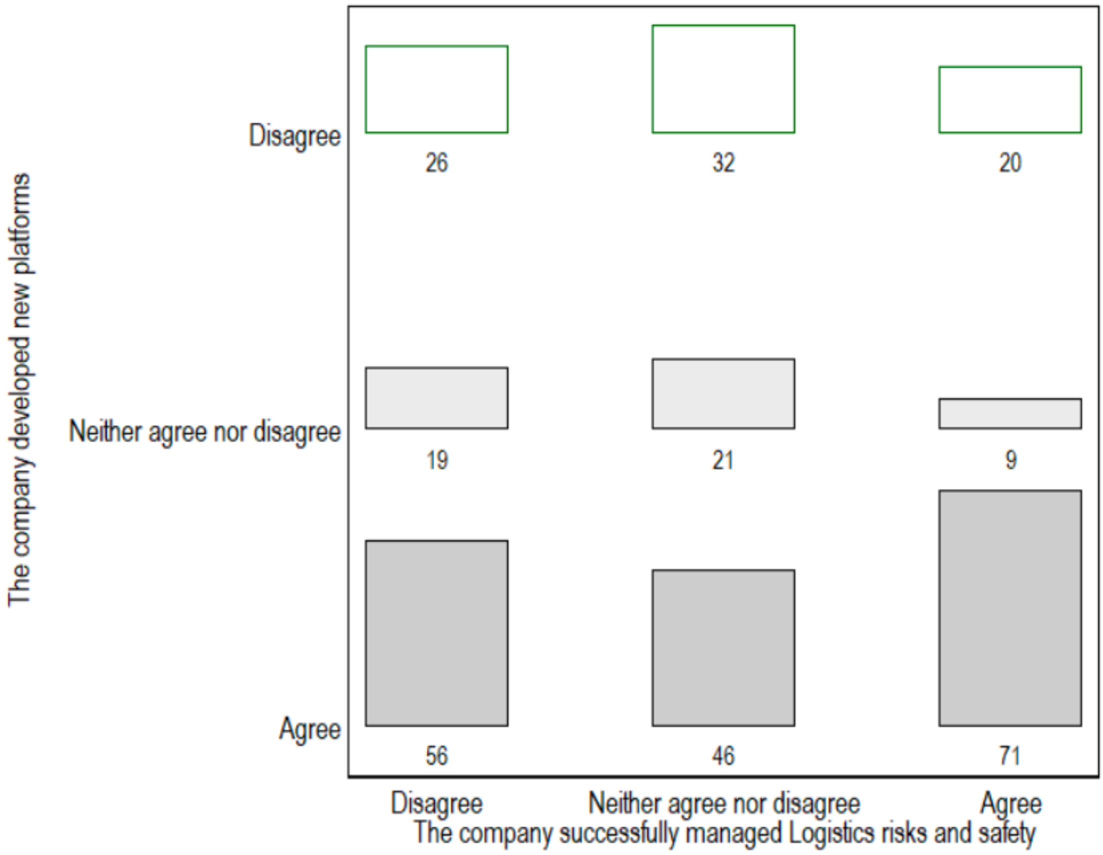
5. Data Analysis



The data analysis will begin by examining which level of the supply chain corresponds to a greater integration of blockchain technology. The hypothesis of an evolution of the industry 4.0 program towards a hypothetical "Die 4.0", starts from the main value junctions of the supply chain and gradually involves all interested parties, both public and private. As can be seen from the graph, in the sample examined the companies that have mostly implemented blockchain are production companies, closely followed by retailers. The interest of applying blockchain technology in the manufacturing industry has primarily risen because of its ability to provide financial transparency to manufacturing supply chains. Because of a lack of confidence between merchants, verification expenses are incurred (Catalini and Gans, 2016). Indeed, when a manufacturing firm does business with an intermediate products supplier, the supplier must evaluate the risk of default and fraud by the manufacturing firm and require the manufacturing firm to demonstrate that it has adequate money to complete the transaction. Because of the lack of confidence and the danger of default, a third-party audit or middleman is required, and the manufacturing company must pay for verification. These expenses may be approximated using the accounting industry's revenue, which is expected to exceed 156 billion US dollars in 2018 in the United States alone ("Accounting industry in the United States — Statistics & Facts," 2019). The efficient application of blockchain technology allows a manufacturing company to disclose its genuine financial position to a supplier, eliminating the need for accounting firm verification. As a result, the manufacturing company may save a substantial amount of money on verification. Furthermore, the real-time transparency of blockchain technology helps company owners to save money on manager supervision. Because the business's shares are split among numerous owners, many of whom have incompatible interests, a single owner may find it challenging to run the company. According to Berle and Means, the problem of conflicting interests among shareholders is handled by managers' choices. However, these expenses can be minimized since a blockchain system can provide both financial transparency and corporate governance (Pilkington, 2016; Underwood, 2016) (Yermack, 2017). As a result, managers' activities may be monitored in real time, obviating the need for extensive monitoring. Also, the owner of a business may then use blockchain to monitor the supply chain to see if a manager is optimizing profit while also keeping track of the quantity of intermediate products acquired to estimate the amount of product the company expects to create. To gradually develop this system based entirely on blockchain technology, it could be useful to start from a hard core of players, in this case producers and retailers, and then broaden adoption to all contiguous players. As our study shows, in fact, suppliers and wholesalers are still far behind with respect to the integration of this technology. The blockchain's capacity to monitor ownership when products change hands makes it obvious that it can help improve the supply chain. As items flow from manufacturer to supplier, wholesaler to distributor, current supply chains are rife with potential for mistakes and delays. The graph shows that the levels of integration of blockchain technology are not uniform. Because each of these participants maintains their own transaction database, even exchanging information online causes delays and errors. For all parties concerned, reconciling information is a significant waste of time. The gaps in the supply chain, as well as the risk of mistakes, would be eliminated if blockchain were widely used, particularly by suppliers and distributors. Blockchain has the ability to reduce the extra hours of effort that suppliers, wholesalers, and distributors put into processing purchase orders, invoices, and payments because everyone participating in the transaction sees the same data, and individual actors update the important information in real time. It is now feasible to keep track of what has happened thus far in a transaction and immediately produce payment once an ordered product is received, thanks to the introduction of smart contracts. Strengthening contracts and fully eliminating the need for invoicing will also aid these businesses in more effective corporate accounting administration and faster governmental oversight. To aid this transaction, process or technology skills are a key factor. The preparation of training courses for the necessary professionals, such as blockchain experts, integration specialists, specialists in IoT technologies, security experts in distributed environments remains the main way for a supply chain homogeneously integrated with Blockchain. It is urgent to accelerate the digitization process, also in order to enable other options - in particular, a management and coordination of supply chain data that allows to build the story of the product, and to make explicit the values it bears. One of the fundamental steps of this digitization process through the blockchain is the development of new platforms. The following graph aims to analyze this aspect.



With 78%, manufacturers are among the leading developers of new platforms in the supply chain, closely followed by distributors and resellers. Blockchain has proven to be the perfect and most efficient technology in the pursuit of more secure and private data management, and this perfectly fits the needs of the supply chain. The main benefits deriving from the adoption of the blockchain are the immutability of transactions, consent (using the network to verify and validate transactions), decentralization and disintermediation. Currently companies mainly use ES (Enterprise Systems), application software packages that support business processes, information flow and data analysis; such packages in modern ES rely on a central database, which collects information from a variety of applications and at the same time provides data to support various business functions. The goal of implementing the blockchain in any business should be to be as less "disruptive" as possible with respect to the existing system. A possible solution is to integrate blockchain technology with the ES, to benefit from the first feature of keeping track of transactions in an immutable way, together with the documentation of the ES as a channel for other applications such as business intelligence, reporting and analyzing data; in this way each application, previously independent, could communicate directly with the others or with external applications, favoring an increase in the speed of the system and business decisions. However, these benefits are only possible after a thorough analysis of the impact of the blockchain on one's business and the actual need for its implementation; in fact, its use should take place in conjunction with a whole series of factors, such as the need to record transactions between two or more parties, that of greater security, reduction of manual errors, disintermediation. Using the Lansiti and Lakhani framework, the implications deriving from the adoption of a technology are categorized on the basis of two dimensions: level of novelty and level of coordination required. The first represents the degree of novelty of an application in the world, and the higher it is, the greater the effort required to make people understand which problem it solves. The second dimension represents the level of coordination required, i.e. the number and diversity of parties involved that must work together to generate value with this technology. The development of new Blockchain-based platforms suitable for the supply chain can fall into the transformation quadrant, i.e. applications that could change the social, political and economic nature of the systems involved. In particular, the greatest difficulty in implementing blockchain platforms in the supply chain lies in the need for all players to be included in the platform. This is demonstrated by our graph in which the percentage of development of new platforms shows very low percentages in wholesalers and low in suppliers. More generally, with an uneven distribution of technology within the supply chain, it will initially be difficult to obtain full collaboration between the actors given the different levels of technological predisposition. Furthermore, further challenges are represented by the development of costs to migrate from pre-existing systems to the blockchain platform; the industrial sector, given its competitive nature, will be characterized by multiple private blockchains, thus making it essential to develop standards that allow interoperability between different systems (Jagati, 2019).Considering the objective and services offered by an enterprise system and the qualities of a public or private blockchain, the type that best suits a pre-existing business system is certainly the private one. Public blockchains guarantee reliability and trust, however, in the business world such ownership is not strictly necessary as the nodes of the network are part of the company itself and therefore are already trusted (Lohmer and Lash, 2019). Public blockchains are also inefficient in terms of the number of transactions per second. By combining private blockchains with enterprise systems, it is possible to obtain advantages in terms of reducing errors in data entry, data storage and security and consumer privacy (Babich and Hilary, 2019). These advantages are particularly appreciable in the logistical phases. The following graph that focuses on the development of platforms within the management of logistics risks and safety, demonstrates these advantages.



Blockchain and Distributed Ledger technologies are expected to accelerate significantly in the coming years, particularly in the transport and logistics sectors, characterized by increasingly widespread ICT (information and communication technologies) and IoT solutions. And AI. In particular, as can be seen from the graph, 71 per cent of companies that have integrated Blockchain have improved their logistical and security risk management processes. It is reasonable to think that this improvement comes from the necessary development of blockchain technology platforms. When it comes to safety within the world of logistics, it cannot be forgotten that road accidents often account for about half of the total deaths at work.

Moreover, among the many factors that increase the vulnerability of transport activities, the state of the equipment used is undoubtedly one of the most important. In fact, among the many fields in which this innovative method of sharing information can find a particularly fertile ground is Facility Management, where the sharing and transmission of information and data are fundamental not only in the daily work of operators in the field but also in the relationship between the facility service provider and the customer. In reality, there is a slew of platforms that currently offer cutting-edge tools for managing the risks associated with round-trip logistics. The study of platforms created as a distributed network of nodes, which offer an alternative strategy capable of managing the complexity of modern supply chains by dividing them into smaller and functionally independent portions, is one of the solutions investigated (Parth Misra, 2018). The modular structure of the platform allows users to create new nodes or extend the functionality of existing ones. Furthermore, the nodes interact using IoT technology, which acts as a link between the virtual and physical world, transforming this platform into a trustworthy digital platform.

The Blockchain infrastructure can revolutionize company logistics, especially in the field of transport document management (e.g. invoices, transport documents, etc.) and the traceability of goods (from the origin of products to the fight against counterfeiting, to monitoring the fleet vehicles, etc.). Documents and physical assets, with the Blockchain, are converted into digital objects that find a unique representation in the distributed ledger (IBM Institute for Business Value, 2018). A shared ledger that allows each logistics actor to add the data generated by their systems to an infrastructure capable of storing all information - in terms of transactions - as well as providing tracking of supply chain movements without the need for any brokerage and, above all, in a secure and automated way.

The import/export procedures will benefit from the advantages generated by implementing Blockchain platforms in terms of acceleration of the steps and exchanges, which today take place in less efficient and fragmented ways (e.g. email, software applications and communication tools). Advantages could derive from the diffusion of solutions based on the management of vehicle fleets based on Blockchain platforms which, integrated with IoT peripherals installed onboard the trucks, can automatically send confirmations of taking charge, transport temperature, unloading goods and more data such as discharge times and additional information on returns and collections. The data and information are made accessible through software that integrates operational aspects and economic variables, interacting directly with the reference Blockchain, ensuring a high level of decentralization and data integrity. All this is not science fiction; Blockchain technology is already present in the world of shipping. Starting from 2017,

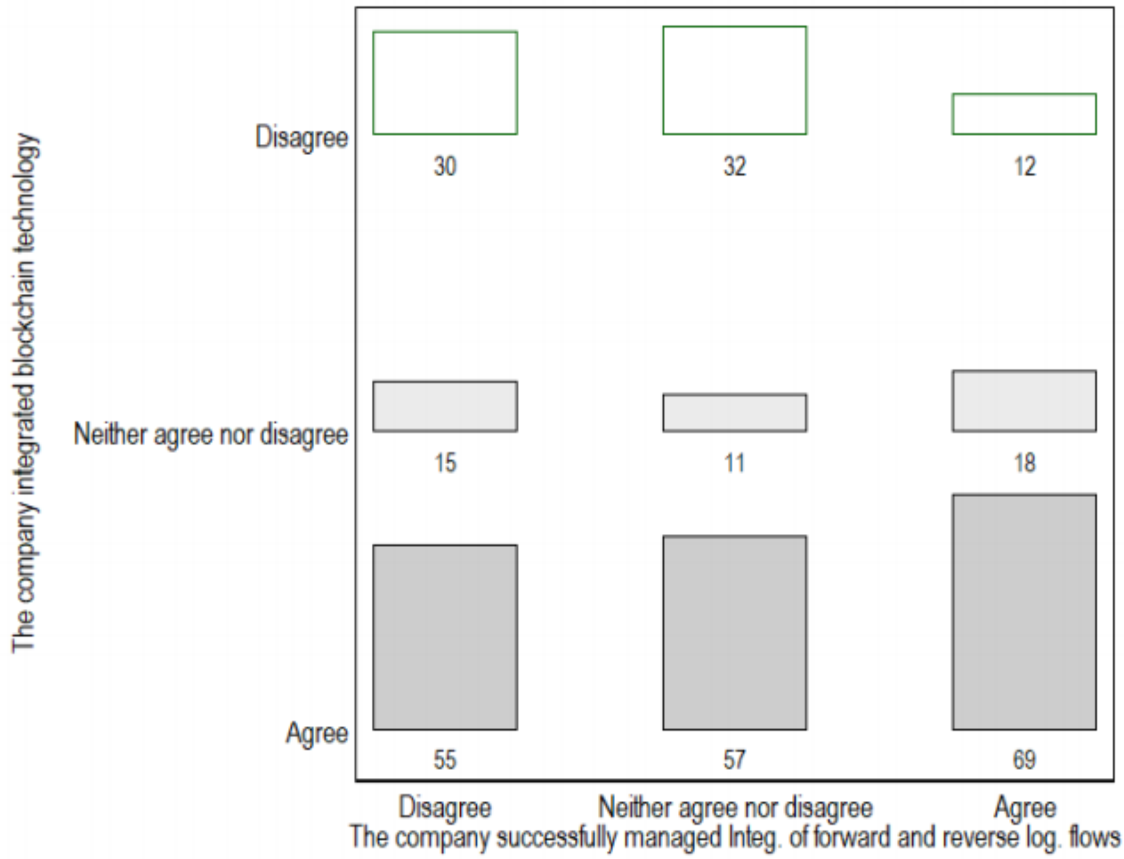
Maersk and IBM and MSC (through its subsidiary Interlink Transport Technologies) have begun to carry out tests to apply this technology to port logistics to ensure safer transactions non-manipulable sharing of information. In addition, the use of a private Blockchain to keep track of periodic maintenance and service visits, for example, would provide traceability and, consequently, greater responsibility for insiders (IBM Institute for Business Value, 2018). Facility managers will know in real-time what happened, when and why, and how to act to solve problems and prevent them. Today, information is undoubtedly a value, and so the Blockchain can be added to the IoT to significantly reduce the exchange of information by increasing efficiency and operations.
To date, although it is clear what this new technology has to offer, large-scale adoption is still far away. The questionnaire survey shows that 56% of those who develop new blockchain platforms do not agree on successfully managing the risks effectively related to logistics. As regards the Management phase, a breakthrough with a strong innovative character is therefore necessary. First of all, the complexity and rigidity of the software solutions on the market, which are difficult to customize. Therefore, the challenge is to ensure access to information both for professionals in the sector and those who have to make economic decisions on the managed asset.

The logistics sector (forward and reverse) is one of the sectors that could benefit most from implementing blockchain technology. Consequently, it is essential to discuss what function blockchain technology will perform in the logistics industry.
The SCM is evolving rapidly as a result of digital transformation, and the use of blockchain technology is being hailed as a revolutionary breakthrough that the SCM must seize. Blockchain is not simply another new technology that improves logistics within the supply chain. Blockchain will play a crucial role in ensuring that logistics activities continue to increase steadily.

Lack of collaboration with supply chain partners, lack of top management awareness, high costs associated with reverse logistics, uncertainties related to product returns are all challenges that logistics faces. Furthermore, the logistics information system as it stands ignores part of the product life cycle as there are no technologies that can reliably trace a product from production to sale (Issaoui et al., 2020). These problems are then exacerbated when it comes to reverse logistics specifically. Most supply chain and business resource management strategies are focused solely on outbound logistics. As a result, customer satisfaction with the reverse channel is low due to insufficient data visibility and support for return and disposal policies. Throughout the entire Reverse Logistics process, lack of information is a constant problem, which is more complex than shipping logistics as it must keep track of returned products and their reuse or disposal (Issaoui et al., 2020). The much longer lead times compared to outbound logistics pose many challenges in supporting continuous data logging.

Furthermore, the reuse and recycling of the product are strictly time-dependent. Having immediate information on the quality of the product is essential for its possible reuse in a second sales cycle. Managers, therefore, need adequate decision assistance implemented by a system capable of handling these huge volumes of data (Cerulli-Harms 2018). When companies started seeing Blockchain as an intriguing technology, they experimented with it by rewriting how people interact.

As shown in the graph above, 69% of respondents from companies that have implemented Blockchain believe that investing in blockchain technology has improved forward and reverse logistics processes. Along the supply chain, Blockchain potentially offers greater transparency as well as lower costs and risks. Specifically, the main potential benefits of using this technology in the logistics field are that the transaction data on the blocks cannot be modified or manipulated (Cerulli-Harms 2018). In this way, the risks associated with the loss of products or the risk of counterfeiting goods are eliminated, making the information on transactions extremely reliable. Additionally, the pace of the entire business process can be significantly increased by using smart contracts, which can automate transactions under certain conditions. Secondly, providing regulators and end consumers with a clear image of all phases of the product along the supply chain is an element that, to date, only Blockchain can provide and that brings numerous advantages to the company. Proactive supply chain management and traceability curve prediction can help a company establish a reputation as a leader in responsible manufacturing by increasing public confidence in supply chain data (Cerulli-Harms, 2018). By digitizing physical resources in logistics and creating a decentralized and immutable register of all transactions within the process, it allows customers to monitor the quality and provenance of the products purchased. Blockchain technology, therefore, allows all parties involved in the logistics process to access the same data, potentially minimizing communication and data transfer problems.

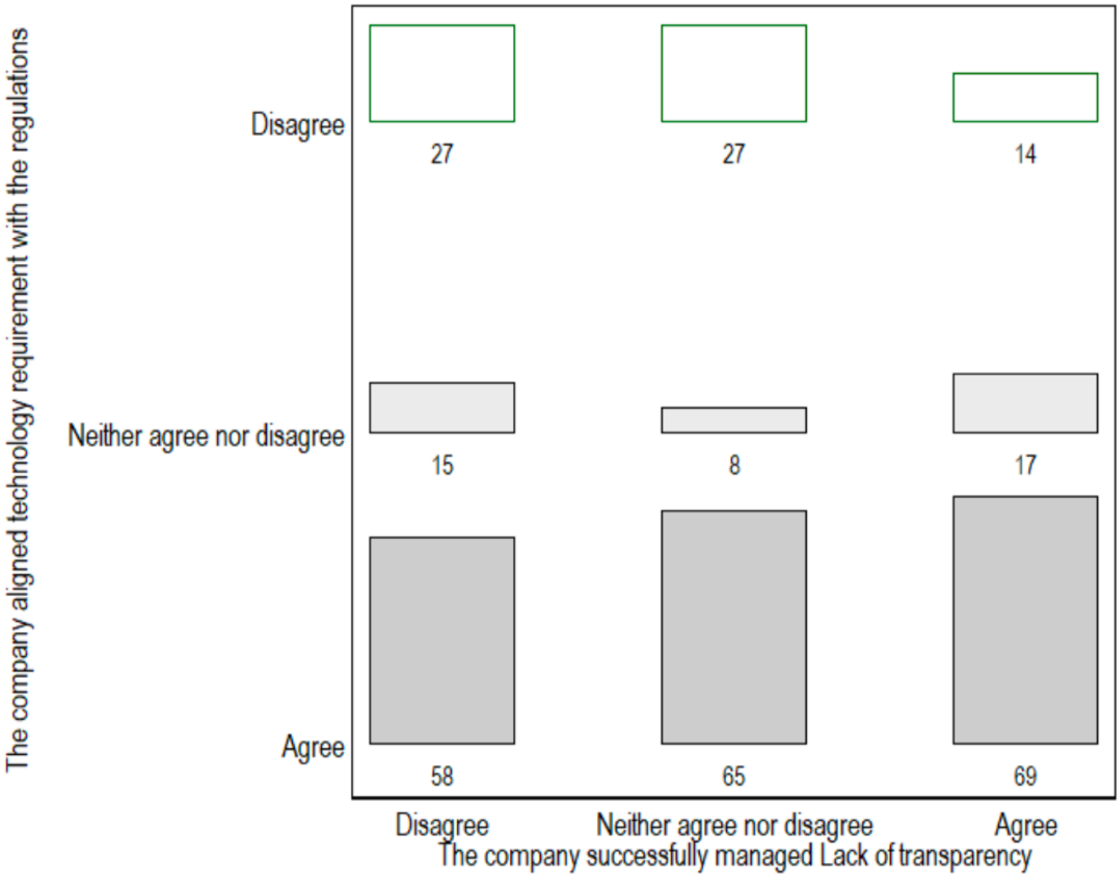


As shown in the graph, 12% of respondents whose company has not invested in blockchain technology still agree with the claim that their company has successfully managed round-trip logistics processes. This figure represents only four per cent of the collective examined, contrasting with the twenty-three per cent of those who, after the integration of blockchain technology, see an improvement in round-trip logistics processes. Although the latter's percentage is considerably higher than that of the former, there is still strong skepticism about the real advantages of this technology. This column agrees with what is explained in the rest of the graph, according to which 55 per cent of those who have integrated blockchain technology have not seen improvements in their companies to manage round-trip processes. To understand why, it is necessary to understand the policies, procedures, and regulations to which these businesses must adhere when selecting to incorporate blockchain technology in their supply chains.

Although this technology can be particularly effective in logistics processes, the implementation within the company is not limited only to this sector. For example, 30% say they have had a development using blockchain technology but have not had a particular improvement in the management of back-and-forth logistics processes. This data can be interpreted following two different lines of thought. The first assumes that the company has invested in blockchain technology but not in the logistics branch or lacks effective use of the technology in the logistics sector to make a net improvement appreciation.

Other possible explanations for our results include uncertainty following such an investment, concerns about the sensitivity of competitive information, or a failure to recognize the technology as a business priority (Helo and Hao, 2019). For starters, obstacles to the acceptance and scalability of blockchain technology could be detected early in this innovative process, raising concerns about the feasibility of replacing or modifying existing legacy systems. Our chart shows how 30% of respondents say their company has not invested in blockchain technology and at the same time, has not been able to manage back and forth logistics processes effectively. This, therefore, leaves the door open to possible future adoptions of this technology, allowing the improvement that current technologies do not allow. Furthermore, the data on which it is worth dwelling is the percentage of those who remain impartial concerning the integration of Blockchain within their company. As already mentioned in the previous section, our collective was mainly made up of managers who had some knowledge of Blockchain and their organizations' investment plans related to this technology. Therefore, it suggests that 16 per cent of the total, therefore 24 out of 154 companies, cannot express an opinion that is in total agreement or in total disagreement with the phrase "your company has integrated blockchain technology". Even if we talk about a small percentage, this highlights how a lack of internal competencies, such as a lack of the degree of skills or grasp of technology, are significant impediments that stymie the innovation process.

Of course, Blockchain cannot solve all the issues that come with logistics. Blockchain, for example, cannot forecast how customers will react to a bad product experience or the condition of returned equipment (Mckinsey, 2018). However, data held in the Blockchain can be used to verify the authenticity of returned products, identify the retailer who sold them, and trace them while they are prepped for resale, cleared, or disposed of. To conclude, Blockchain in logistics can assist forward and reverse logistics, track and verify returns against original transactions, and minimize costs.



The use of blockchain in supply chain management raises several regulatory issues. In Europe, EU legislation requires large corporations to publish information about how they operate and deal with social and environmental issues, which benefits investors, civil society organizations, customers, legislators, and other stakeholders. The EU Directive 2014/95 - also known as the Non-Financial Information Disclosure Directive (NFRD) - establishes the rules on disclosing non-financial information and diversity by certain large corporations to assess their non-financial performance and encourage their companies to develop a responsible approach to business.

These EU non-financial reporting rules, which currently apply to sizeable public interest corporations with more than 500 employees, cover approximately 11,700 large companies and groups across Europe, including listed companies, banks, insurance companies, and other companies designated as public interest entities by national governments (Jeffery, 2017).

According to our survey, 69 per cent of organizations that have aligned technical requirements with existing legislation value better transparency management practices. Acts like the European Non-Financial Information Disclosure Directive may have an impact on supply chain blockchain applications. Companies are expected to give trustworthy information on environmental issues, social and labour issues, human rights issues, and issues related to the fight against corruption to promote more openness in their operations (Jeffery, 2017). However, the lack of an intermediate at most, if not all, phases of the supply chain could create ambiguity among the parties involved in the future, particularly concerning automated forms of transaction execution and control. Most of the time, accountability concepts and processes must be implemented and altered to solve unforeseen issues. The Transparency Directive requires each EU country to establish an officially named mechanism (OAM) to ensure that the public has access to the information revealed by businesses (Jeffery, 2017).

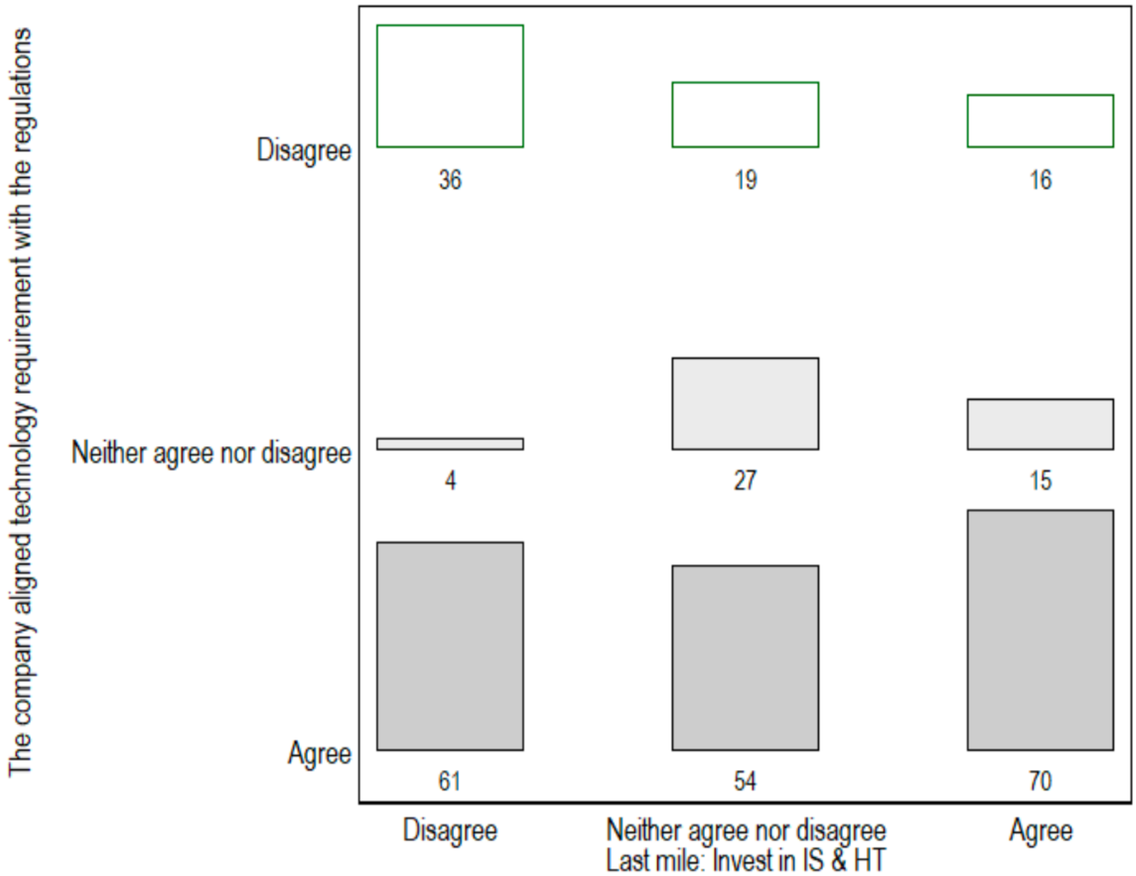
However, accessing this data on a pan-European scale is currently difficult due to a lack of interconnection between different state databases. This could account for the 58 per cent of people who say they have not noticed a difference in terms of openness despite having aligned their technological requirements to the regulations.

Furthermore, even though this digitizing process has been of European interest for some time, it takes time. As a result, the European Commission issued a suggestion in 2007 for EU members to connect their non-financial information storage methods.

Coming to more recent times within the European Union, following a series of initiatives promoted by the European Commission including "Blockchain4EU: Blockchain for industrial transformations", "EU blockchain observatory and forum", "Blockchain for the social good ", with its Resolution on distributed ledger and blockchain technologies on October 3rd 2018 (2017/2772(RSP)), the European Parliament "recognized the relevance of Blockchain technology as a tool" "that may democratize data and promote trust and transparency." ("Texts Adopted - Distributed Ledger Technologies and Blockchains: Building Trust with Disintermediation - Wednesday, 3 October 2018,") It "strengthens citizens' autonomy" and "improves transaction cost efficiency by removing intermediaries and brokerage charges, as well as enhancing transaction transparency."

("Texts Adopted - Distributed Ledger Technologies and Blockchains: Building Trust with Disintermediation - Wednesday, 3 October 2018," n.d.)

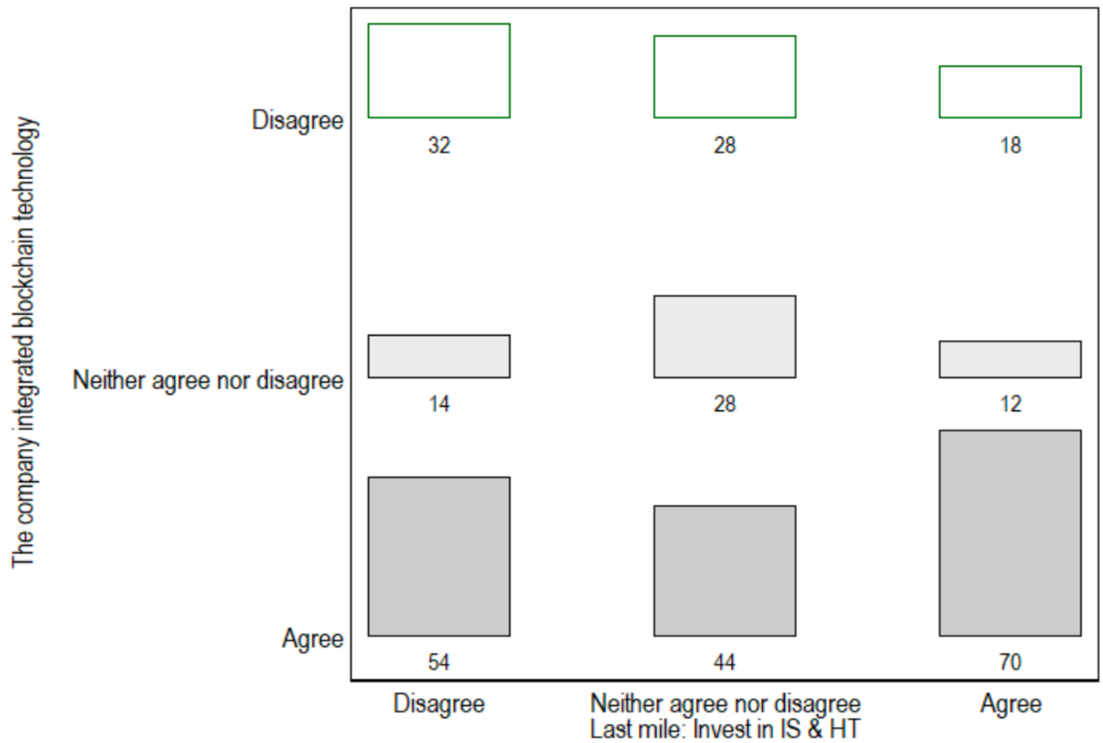
Following receipt of this instruction, the number of those who cannot determine whether there has been an improvement in transparency procedures to date should drop in the coming years, thanks to future investments resulting from the resolution of October 3rd. To that end, it is hoped that the current legal-regulatory framework will be adapted to these innovations to ensure "legal certainty" and "compliance with the principle of technological neutrality" by defining strategies to raise skill levels and promote widespread adoption of this technology.



The idea of last mile or last-mile delivery in logistics and transportation refers to the actual delivery of the object to the consumer, which can occur at the customer's home, shop, or via the click & collect method.

The last mile has long been one of the essential stages in the supply chain, and the development of e-commerce has added to the complexity of this phase by allowing goods to arrive in as little as 24 hours.
It's enough to say that after a delivery issue, 80% of customers switch to a different merchant (Gopi, 2018). This figure proves beyond a shadow of a doubt that investing in last-mile management is critical for achieving optimum logistical efficiency and increasing customers. Of course, the control of the last mile varies depending on the business model, but regardless of the model, the blockchain can have a favorable impact on this part of the supply chain.
The manner of distribution and any actions that occur before or after delivery must be tailored to the logic of B2B and B2C (Michener, 2020). The last mile is critical in the B2B manufacturing and distribution chain since raw materials are delivered to advance factory production operations or items needed to stock store shelves. When we talk about the last mile, it is frequently imagined as a shipment that travels short distances, but this is not always the case (Michener, 2020).
The last step of the supply chain can also take the form of sending products abroad. Because of a trade that today knows no physical boundaries, it is complicated to adapt the technological requirements to all the countries concerned. As shown by the graph, however, 70% of the companies that have invested in the last mile have at aligned themselves with the regulation; with the remaining 30% perfectly divided between those who have not yet aligned and those who remain impartial. However, it can also be noted that the adaptation of technical requirements to regulations is an issue that, both due to regulatory constraints and the companies' will, leads to high values (Michener, 2020). As proof of this, the percentage of those who do not implement the last mile but still align themselves with the regulation for technological requirements is 61%. This data could explain how investments to adapt technical requirements to rules have been made in the previous stages of the supply chain, such as the development of platforms, the management of contracts or the integration of blockchains.

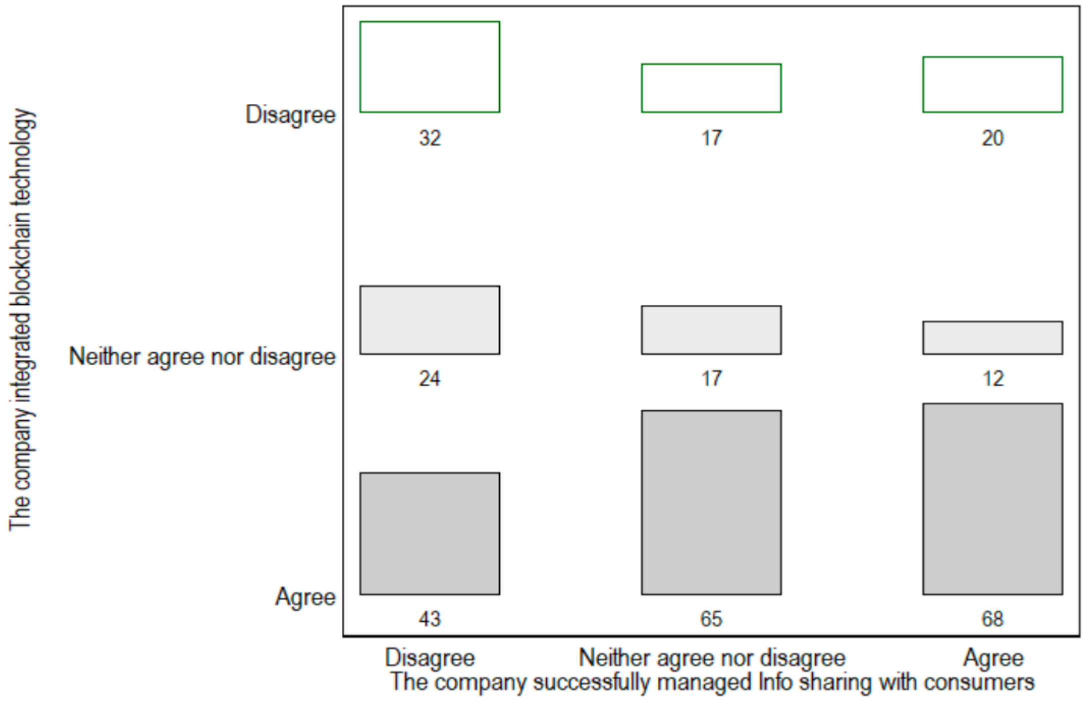
The graph that analyzes the development of this technology in the last mile deserves a specific discussion. As mentioned above, this technology could solve most of the problems of the last mile as we can see 70% of companies that have invested in blockchain have done so by investing in the last mile and 54% in the previous stages of the supply chain.



Setting up efficient and effective last-mile logistics is essential to keep a company competitive. However, this is not a simple undertaking for managers, who must satisfy increasingly attentive and demanding consumers without increasing company costs.

Therefore, optimizing last mile logistics does not mean working only on transport activities (Globaltranz, 2017). Several aspects contribute to improving this point, most of which concern the warehouse and find the turning point in the blockchain. Operational planning must first reduce lead time (Globaltranz, 2017). From the moment a product leaves the warehouse, a whole series of unforeseen events can occur that result in delays or non-deliveries. For this reason, companies should reduce the lead times of all processes that anticipate the last mile delivery to accumulate precious time to be allocated to the delivery phases. But how do you get this extra window of time? By implementing a warehouse management software, the Warehouse Management System (WMS) based on blockchain technology can help plan picking operations, establish a hierarchy of priorities, and speed up both the selection and picking activities and the shipment of goods (Michener, 2020). When working with multiple logistic operators and agencies, it is desirable to use software that allows, on the one hand, to standardize communication and processes, on the other hand, to effectively track the movements of goods, thus adapting warehouse processes to transport needs. Thanks to the multi-party system nature of the blockchain, all this will be easily accessible allowing to recover precious time to be allocated to the delivery phases. In this phase, an analysis of the Key Performance Indicators is a must (KPI).

The delivery related KPIs to monitor are the percentage of deliveries on schedule, planned kilometers VS travelled kilometers, delivery costs per package, per kilometer, per vehicle, several stops, customer complaints, rate of damaged goods and packages during transport. These factors concerning the last mile can be easily monitored thanks to IoT and blockchain technology (Afanasenko, Barkova, and Tkhai, 2018). The current situation in last mile management has gained significant importance due to the increasing complexity of supply chains and the incredible dynamism of today's logistics ecosystem. The rise of e-commerce has brought out the historical weaknesses of last mile delivery, highlighting new ones. Ignoring or underestimating these aspects can compromise a company's competitiveness and survival.



We are in the midst of a consumer confidence crisis, with 75% of consumers losing faith in the items they buy and over 60% finding it difficult to avoid the proliferation of numerous labels. Therefore, it becomes critical for the company to provide regulators and end consumers with a clear picture of all product stages along the supply chain path. However, this need for transparency contrasts with the fact that, due to the fragmentation of their supply chains, most brands and manufacturers lack the necessary information. There is a direct correlation between a lack of trust, a lack of openness, and a lack of exact product life cycle traceability. As customers want more transparency, an efficient, low-cost means of identifying every component utilized in the final product is essential to gaining the trust of increasingly environmentally and socially conscientious customers. And it is precisely this real-time traceability that blockchain technology provides, allowing consumers to have more confidence in the product. A single assignment connected to labour concerns in the production process or unapproved subcontracting (for example, the subcontracting manufacturer outsources work to another facility without alerting the brand) might spell disaster in today's social media world in the field of public relations. The graph examines these aspects by highlighting that a high percentage equal to 68% of those who have implemented blockchain has improved information sharing with consumers. However, the process takes a long time, and many coordination levels could explain the high percentage of those who are currently unable to express themselves on a practical improvement in info sharing but remain impartial. To confirm this, the rate of those who do not appreciate tangible progress is also relatively high, reaching 43% in contrast to the disruptive potential of this technology in the practice of info sharing.

6. Conclusion

The present research stemmed from the interest to investigate the implications of blockchain technology applied to supply chain management, through an empirical analysis focused on 154 companies aiming at implementing the present technology. The latter, indeed, has the strong potential to cause a rethink both in the production and in sales of companies of disparate nature. The supply chain management, which has already been subjected to substantial alterations since the start of digitalization, may be further revolutionized by blockchain. Through blockchain, both the economic and legal structure of supply networks, that are the premise for supply chain improvement, could be considerably enhanced. The theoretical part of this project has evaluated the numerous benefits that blockchain may have, especially in relation with SCM. Nonetheless, it has been remarked that the barriers to its implementation are several, ranging from intra-organizational and inter-organizational to technological and external. Furthermore, the novelty of such a technology, along with the scarce awareness and the diffused skepticism in terms of transparency, governance, uncertain regulations, trust, and disclosure of data strongly contribute to hindering the successful implementation of blockchain in a wide range of companies. Finally, technical silos, missing infrastructure, legal ambiguities of smart contracts, complex protocol selection and setup, as well as the adoption and use of cryptocurrencies are all issues that need to be addressed.

Blockchain has been primarily used in the financial domain, but the analysis presented is this project has looked at its potential applications in fields different from the fin-tech area. The study has addressed the supply chain management as the latter has the most suitable features for the effective implementation of blockchain. Of course, a single qualitative analysis conducted through surveys involving 154 companies is not explicative of what could be the general future trend, especially as the analysis has focused on responses which have evaluated companies' performance over the last two years. The latter has in fact been characterized by a multifaceted crisis that has disrupted the entire world, invading all sectors, and generating a complete shift of the salience of the issues, all strictly related to the pandemic.

Nonetheless, the post COVID-19 world industry is seeing a move to overcome the barriers to blockchain acceptance. The virus has exposed flaws in our supply chains, our incapacity to deploy resources where they are most needed to combat the pandemic, along with challenges in gathering and disseminating the data needed to make quick management choices. This research will hopefully contribute to shedding light on such challenges, aside from analyzing the ways through which various types of companies have invested in blockchain over the last two years.

To answer the first research question, namely, what are the conditions necessary for the application of Blockchain in the various sectors the type of company has proved to be a determining factor. In fact, the analysis shows that the companies that best align technological requirements with the regulations are the producers, while those that have proved less compliant are the suppliers. Furthermore, the general trend shows that the companies that have mostly implemented new platforms based on blockchain technology are once again the producers and distributors, with a low percentage of development in wholesalers and suppliers. On the other hand, companies that invest in blockchains and develop new platforms have highlighted better management of logistical and product security risks. Regarding the second research question, that is, whether blockchain can be implemented to achieve the best results in supply chain operations, we could see that the field of forward and reverse logistics is the field that can take most advantage of this technology. Furthermore, the higher percentage of such integration was evident with investment in blockchain for managing lack of transparency. Conversely, blockchain investment for managing the lack of transparency is generally not coordinated with investments in information systems and high technology. Moreover, the development of new platforms was evident in the coordination with the management of the round-trip logistics, while it was not in place for the management of info-sharing with consumers and the management of product traceability.

As for transactions and contracts, while manufacturers are the ones who invest the most in managing contracts and transactions, wholesalers are more reluctant to do so. Also, while the management of contracts and transactions was generally accompanied by a good management of the lack of transparency, the former was poorly coordinated with the management of logistics and security. From a regulatory point of view, we note that companies that have had to adapt to existing regulations have done so by focusing mainly on the last mile, by adapting to the rules governing the movement of goods between the various countries.

What the analysis shows is that steps forwards have been made by companies in the implementation of blockchain for the improvement of SC. However, the two categories of wholesalers and retailers are lagging behind. The demand for supply chain openness continues to grow; increasingly consumers' want to know about a product’s origin, supply sources and detailed manufacturing history. Although blockchain holds the promise of solving this problem compared to other technologies, traceability should be significantly fostered in order to maximize the potential of this technology. Another issue that many consumers are increasingly becoming more concerned about is production practices relating to environmental sustainability, food integrity and human rights. In this regard, by providing a reliable way to track and trace product origins and processes, blockchain can assist businesses in evaluating and mitigating supply chain risks. Therefore, a crucial recommendation is that such features underpinning this unique technology are emphasized to a greater extent, in order to incentivize companies to implement the latter.

Of course, new technologies need time to be effectively implemented in companies of various types and sizes, and the use of new tools do not ensure its success. More research and practical applications are needed. The potential benefits of blockchain for the smooth running of financial transactions, logistics and connecting in real-time the different players in SC need to be discussed alongside urgent issues of production practices and origins in the supply chain management. Better understanding of Blockchain technology applicability can raise awareness in issues that this industry must address.

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