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Use of Blockchain Technology to Manage the Supply Chains: Comparison of Perspectives between Technology Providers and Early Industry Adopters

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Abstract: Following the interest in blockchain technology (BCT) business solutions and the nascent stage of technology in supply chain (SC) practices, this research compares views from business practitioners who are experienced in real cases of BCT adoption with the views of technology consultants proficient in the complexities of BCT to analyze the benefits and challenges BCT holds for SCs. Based on the comparison of the two sides, the joint views that both adopters and technology consultants share is the ability that BCT holds to speed up processes across SCs through decentralized data access, thus decreasing human errors and reducing paperwork. However, technology consultants perceive the need to increase BCT awareness levels of businesses, to prevent BCT implementation just for reasons such as 'recordkeeping' and to reduce misconceptions in areas such as cryptocurrency applications. The findings also revealed that technology consultants insist on the careful evaluation and definition of records to be kept on BCT platforms prior to the adoption process, in order to avoid unnecessary data input. Currently, according to early industry adopters' cases, most business attempts of BCT adoption use private networks, so technology consultants promote business entities on developing plans towards open-access public networks.

Keywords: supply chain management; blockchain; early industry adopters; technology consultants; semi-structured interviews

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1. Introduction

In today's digital business environment, most processes are being transformed by emerging technologies. Organizations are aiming to reshape their supply chain management (SCM) processes to strengthen the value chain and achieve a seamless flow of information [1]. Digitalization is happening rapidly, but SCs still suffer from poor transparency and low trust levels [2]. One of the disruptive technologies that has seen increased academic and industrial interest in recent years—blockchain technology (BCT)—is being scrutinized as a promising solution to those challenges [3].

BCT is a distributed ledger within a decentralized infrastructure that records transactions between parties in an immutable way, providing public accessibility [4]. Records on a BCT ledger create a chain of entries that cannot be altered without changing the previous record, which adds a significant layer of safety to business operations [5]. BCT is claimed to solve traceability issues of SCs, as information shared across the network is equally visible to everyone [6]. Ref. [7] explained that BCT can enhance the performance of SCs if

supported by the integration of the Internet of Things (IoT) for tracking purposes and, in such case, the features that BCT would contribute to the SC performance maximization is the record and standardization of transaction data from various sources through predictive and prescriptive analytics.

Traditional SC issues arise from the multiplicity of intermediaries in the ecosystem. Stakeholders are concerned about risk of data modification and lack of product traceability, emphasizing the crucial need for new ways of building trust among players [2]. Even though business applications of BCT are a few years old, the investigation of BCT in an SCM context is a new concept [8]. Some studies focus on specific cases of BCT application to SCs in particular countries [9–11] and geographical regions [12,13], but no studies were found with a more global perspective.

An attempt at understanding managers' opinions on the value of a BCT system and resistance to implementation has already been performed [14]; however, the gap remains in technology specialists' views on BCT adoption [15]. The methods of enablers providing smooth BCT adoption were explored among industry experts [16], and barriers of adoption were investigated among early piloting companies [17]. In the extant literature [12], various types of BCT ecosystem stakeholders were brought together to build a framework of a BCT type adoption decision-making process, and it was pointed out that future research should focus on the measurement and comparison of concrete benefits and challenges from the views of different stakeholders. However, such deep understanding of the driving factors and challenges of technology adoption by comparison with opinions from technology consultants/providers and early industry adopters is still missing. The gap of the comparison needs to be addressed, as innovative technology adoption always involves a technology consulting aspect that creates flow in a correct path of industry adoption; thus, the two views in this case are essential. Moreover, the exploration of the views of adopters and technology consultants should not be limited to a specific geographical region of BCT adoption or a specific country use case. When it comes to a novel technological solution, the holistic understanding of the value that this solution is able to provide to an industry is more essential, rather than its consideration under specific geographical conditions.

The purpose of this research is to contrast the perspectives of technology providers and early industry adopters of the BCT adoption process to the SC. Moreover, this research aims to uncover the potential benefits BCT may bring to SCM, the current status of technology in the managerial context, adoption constraints, and future paths from the perspectives of both technology providers and industry adopters. Consequently, this research aims to answer three questions from the perspective of both BCT adopters and technology providers:

RQ1: What are the triggers and motivations for BCT adoption under the SCM scope?

RQ2: Are there any feasible improvements caused by BCT adoption that are able to address current SC issues according to the views of both technology consultants and early industry adopters?

RQ3: What are the main challenges that technology consultants and early industry adopters witnessed in the application of BCT to SCM?

To address these questions and explore real-world BCT potential for SCM, a comparison of the global perspectives of BCT adopters and technology consultants was performed to uncover potential deficiencies in their approaches and ways to overcome them. We investigated the BCT adoption process through semi-structured interviews with both sides—providing a more holistic and global view on the process, current status and the future of blockchain. To the best of the authors' knowledge, to this day, there is not yet a comparative analysis of views of early industry adopters of BCT for SCM practices with the views of technology consultants. This original comparison is essential for uncovering the whole variety of features that BCT can contribute to SCM improvement, taking into consideration potential constraints at the beginning of the adoption journey and the evaluation of the BCT necessity as a solution for current SC challenges.

The paper is structured as follows: Section 2 builds a literature review, providing a deeper understanding of BCT features and current SCM challenges. Section 3 explains the

methodology and data collection process. Section 4 provides the findings, divided into subsections for clarity. Section 5 brings up the discussion of the findings, and the main conclusions, contributions, and paths for future studies are outlined in Section 6.

2. Literature Review

As a distributed digital ledger, BCT can be executed in a public or private network, where each block would be connected to the one before and after it, creating a continuous and irreversible chain. This allows all players to directly verify the records—without an intermediary [18]. The best-known example of a public (or permissionless) network is cryptocurrency, such as Bitcoin. Private blockchains are designed to maintain and serve specific consortiums of organizations and are not accessible by all industry participants [19], whereas public blockchains are available to anyone who wants to verify transactions [20].

2.1. Features and Applications of Blockchain Technology

One of the greatest innovations of BCT-based networks is the automation of processes and intermediary removal, which is achieved through smart contracts, making BCT applications more powerful [21]. Smart contracts are programmable protocols that allow BCT network participants to define and agree on certain conditions [22]. The unique characteristics of smart contracts allow the automation of processes, as they are self-executable and do not require resources to revise and confirm process status, thus accelerating the execution to the next stage and speeding up SC processes [23].

The innovativeness of BCT can transform a variety of industries, including healthcare and life science services [21,24], various food SCs with agricultural [25], dairy [26], halal [27] and seafood products [28], and the beverage industry [29]. There are possible applications for a vast number of industries, such as automobile manufacturing [6,30], logistics [31–33], luxury goods [34], real estate [35], etc.

2.2. Current Challenges in Supply Chain Management

Designing an SC is a great challenge; thus, the utilization of available resources for an achievement of balance between responsiveness and efficiency is a primary objective to address [36]. Traceability was traditionally required mostly for upstream supply tiers to track the origins of products and components [31], but today, traceability is necessary across the whole gamut of SC processes and transactions. It is crucial for establishing product provenance in resolving fraud and counterfeit issues [37]. Current challenges of global SCs include issues of capital allocation and setting of payment terms [34], uncertainty in material and product demand [38], and information cyber security [39]. On a global scale, SCs need a drastic shift towards environmental sustainability and resilience for social benefits of consumers [40]. Compliance with administrative protocols and time-consuming procedures with paperwork also create challenges for SMEs, forcing them to involve more intermediaries [41].

Nowadays, to keep competitiveness levels high, SCs need to be flexible to respond rapidly to changes in the business and social environments, and collaboration requirements remain challenging to some networks [42]. One of the greatest difficulties for SCs is trust. With the currently insufficient traceability and poor quality of information about partners, it seems nearly impossible to achieve full trust between entities [43]. There is little assurance of information flow reliability among SC partners [6] and low consumer trust due to inadequate traceability [44]. The disruptive possibilities of BCT have had a significant impact in various areas and are considered as potential game changers by SC managers, allowing organizations to fortify relationships with current partners, as well as attract new ones [37].

2.3. Blockchain Possibilities for Transforming SCM

BCT enables permanent and shareable recordkeeping of a product's movement throughout an SC, resulting in improved visibility, product authenticity, and legitimacy [24]. BCT-

enabled traceability is claimed to be the most significant reason for its SC implementation, on a par with immutability and provenance auditability [45]. BCT's immutability and decentralized network architecture provide assurance of data security, as well as the capability of fast settlements and decreased transaction costs [46]. The inherited nature of BCT, backed up with smart contracts, reduces documentation flow and paperwork, especially for complex industries such as global logistics and container shipping [32]. BCT can link and maintain resource consumption information, which all stakeholders can have access to, and the final consumer would be able to verify the environmental impact before making the decision to purchase the product [20], which encourages environmentally and socially sustainable SC networks [47]. Moreover, guaranteed environmentally sustainable activities are important to final consumers not only in regard to tangible goods and products, but also from the perspective of service-providing activities [48]. Backward resource tracing enabled by BCT has the potential to combat the flow of counterfeit products in SCs by reducing the circulation of sold or fraudulent pieces [21].

One major difficulty in endorsing an SC is the selection of the right partners and building trusting relationships [5]. The trust between SC players in a BCT context is also achieved through its inherent visibility and transparency [45]. Technical expertise and willingness to try the platform is still lacking among SC players [49], which suggests that BCT's trust-enabling function may not be properly understood. In their study, [12] expressed the opinion of professionals from big tech companies that referred to BCT as "a reverse of complication"; however, the views of SC specialists were not directly compared to the IT professionals, which opens a door for the necessity of comparing and understanding the views of two groups. In this regard, the analysis of the attitudes of adopters and consultants in this paper can provide the necessary insights for smoother technology adoption.

3. Materials and Methods

This research followed a qualitative approach with semi-structured interviews, following the example in the extant literature [12,17,22]. Hence, the primary preparation task was to build an interview guide based on extant academic studies. Therefore, a list of topics for interviews (see Appendix A) was built upon a systematic literature review that identified dimensions of impact of BCT in SCM [50], where BCT features were classified upon vicious and virtuous cycles to the SCM practices. For academic integrity purposes, the interview plan and topics was screened by the Ethics Committee of Iscte-University Institute of Lisbon. After approval, potential participants were identified and contacted. The contacting and interviewing processes took place between May 2021 and January 2022. The search for participants was carried out using the LinkedIn platform, which included two main criteria for finding suitable respondents based on their experience descriptions in profiles. For early industry adopters, the criteria were the following: representatives of industry companies, directly involved in the BCT adoption process for SCM practices (e.g., team leaders, project directors, senior managers, etc.). The direct involvement to BCT adoption was identified through LinkedIn job position descriptions. For selecting technology consultants, the criteria focused on representatives of companies involved in providing outsourced IT services and the consulting of decentralized digital solutions. To achieve a global view of industry and technology experts on the adoption process, their cultural affiliation or country of operation was not restricted.

Individual interviews were conducted through online Zoom sessions fully in English and lasted on average up to 60 min. Participants were provided with the list of topics for the interview and were made aware of confidentiality issues prior to the interview session. All participants were also informed that there were no "desirable" answers and that they were free to express opinions to reduce bias. Upon the agreement of the participant, each session was fully recorded and transcribed verbatim afterwards. For convenience, the above-described research process for this study is summarized in Figure 1. The final data set came from sixteen interview sessions, eight with early industry adopters of technology

and eight with technology consultants. Table 1 provides information and profiles of the adopters' representatives, including their function in the SC, the industry type and location, and the duration of BCT adoption. Table 2 sheds light on technology consultants' personal profiles of expertise and focuses on business entities where they operate. For convenience, the participants are called "Adopter (consecutive number)" if they are industry adopters or "Consultant (consecutive number)" if they are technology consultants. Quotations of interviewees were professionally corrected grammatically by a native speaker, without changing the scope and meaning of the saying. The transcribed interviews were coded and analyzed through a qualitative content analysis approach [51], organized through a thematic analysis [52] using the MAXQDA Analytics Pro 2022 software. The analysis process and coding keywords can be found in Table 3 below.

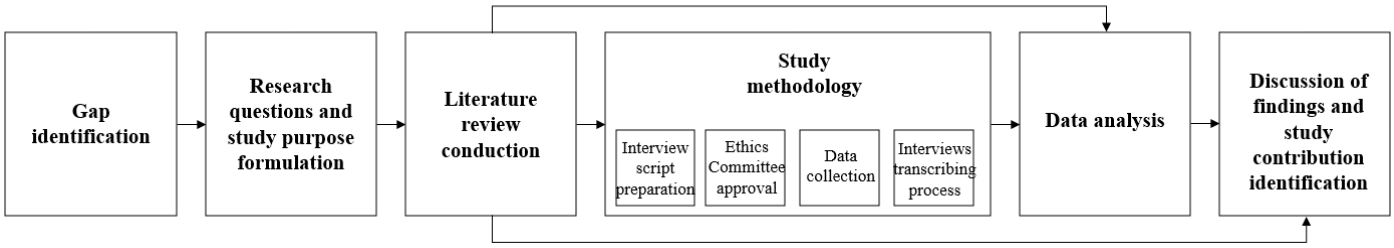

Figure 1. Research process flow of the study.

Table 1. Characterization of industry adopters' representatives.

Interviewee (Adopters)	Industry	Supply Chain Function	BCT Adoption Journey Duration	Headquarter Continent
Adopter 1	Beauty and wellness	Planning	Early pilot stage	Africa
Adopter 2	Logistics	Transportation	4 years	Europe
Adopter 3	Food and beverage	Distribution	3 years	North America
Adopter 4	Food and beverage	Supplier	1.5 years	Europe
Adopter 5	Food and beverage	Retailer	1.5 years	Europe
Adopter 6	Food and beverage	Planning	Early pilot stage	Europe
Adopter 7	Logistics	Transportation	Early pilot stage	South America
Adopter 8	Logistics	Transportation	1.5 years	Europe

Table 2. Characterization of technology providing consultants representatives.

Interviewee (Service Providing Consultants)	IT Consulting Focus of Company	Position in Company	BCT-Related Expertise Duration of a Consultant	Headquarter Continent
Consultant 1	Blockchain, Cloud, Cybersecurity, IoT, Digital Engineering	Strategist of Blockchain and supply chain	5+ years	Asia
Consultant 2	Machine Learning, Artificial Intelligence (AI), Distributed Ledger Technologies	Head of Distributed Ledger Technologies	1 year	Europe
Consultant 3	Hybrid cloud technologies, Cognitive Business Operations, IoT, Blockchain	Technical client leader	5+ years	South America
Consultant 4	Blockchain, Cloud, Automation and AI, Cognitive Business Operations, Digital and Quality Engineering	Sales in region	3 years	Asia
Consultant 5	Technical advisory of Blockchain and NFT	Self-employed Technology Advisor	2+ years	North America
Consultant 6	Blockchain-based payment solutions	Chief Executive Officer	4 years	North America
Consultant 7	Blockchain-related projects, workshops, trainings, webinars	Chief Executive Officer	4+ years	Europe
Consultant 8	Digital financing and AI	Head of Leading Office	4+ years	Europe

Table 3. Dimensions for data analysis and the coding keywords used.

Dimensions for Analysis	Coding Keywords
Advantages of Blockchain technology adoption for supply chain management *	'Speed' 'Product safety assurance' 'Paperwork reduction' 'Transparency and traceability' 'Immutability' 'Decentralization' 'Human error reduction' 'Trust'
Disadvantages of Blockchain technology adoption for supply chain management *	'Technology awareness' 'ROI concerns' 'Information privacy concerns' 'High costs of technology adoption'
Challenges of Blockchain technology adoption for supply chain management *	'Legal regulations' 'Complexity and access to technology' 'Early stages of adoption'
Feedbacks on Blockchain technology for supply chain management adoption based on experience **	'Reason of adoption' 'Private vs. public network architecture' 'Existing misconceptions'

* Dimension(s) that were previously identified in the literature. ** Dimension(s) that arose during the analysis of interviews.

4. Results

Despite the hype around the technology as an emerging solution, BCT has not been widely evaluated regarding its technical functionalities and potential to create actual value for business processes [26]. The sixteen research participants were based in a diverse variety of continents—Africa, Europe, South America, Asia, and North America—helping to capture a broader view of the opinions of adopters vs. consultants and allowing us to build a fairly comprehensive global comparison.

4.1. Supply Chain Management Challenges and Motivations for BCT Adoption

Unlike mature applications such as cryptocurrencies, BCT in the context of business is still at an early stage; however, interest in application to various industries is growing [53]. SC strategist, Consultant 1, also saw the current level of BCT adoption as exploratory: " . . . *right now I believe it is more experimental . . . trying to understand the technology . . . since BCT offers the ability to execute processes across businesses faster, cutting time from weeks to hours—that is what they* [adopters] *are really looking for.*" Consultant 2 also agreed that it was still too early to evaluate BC's impact on industry: " . . . *it needs multiple entities to actually really feel interested in the marketing around BCT-based use cases.*"

Initially, we explored the reasons behind industry practitioners' motivation towards BCT adoption. Companies with long SCs emphasized willingness to try BCT for traceability issues of sensitive goods, increasing efficiency and lessening friction in SCs. Having experienced disruptive solutions for businesses, Consultant 3 agreed that the above-mentioned reasons for BCT adoption in SCs were justifiable: " . . . *any market has a necessity to lower the friction, and they* [adopters] *also have a need to increase the traceability in their networks. The things I see coming in the next few years are efforts to interlink those networks to one another, doing cross-ledger record keeping to support the network.*" Adopter 1 stated that one of the main drivers that convinced them of BCT's suitability for SCM was "*how blockchain simplifies the recordkeeping*." However, technology experts do not entirely agree that this BCT feature is crucial for SCs. Consultant 4 said: " . . . *people feel that all records would go away, everything would get into the blockchain database*". A colleague in the field, Consultant 5 also said: " . . . *if you do not need that data in 3–4 months, then why put it on a chain?*" Thus, adopters need to define what kinds of information will be shared across the chain and what is valuable enough to keep.

Some companies are pursuing long-term goals for improving operational performance by joining with other organizations to transform the industry with wider BCT adoption. According to Adopter 2: "*Our company is changing the industry and it knows the return is not just for us –it is for everyone that signs up.*" As a platform solution provider, Consultant 6 was skeptical about the technological motivation of those who will "sign up": " . . . *unfortunately, in business space, consortium simply means that you have an environment where you have opportunities to understand where your competitors are and what they are doing. You are there not for common goals, but to observe what other are doing in the same space.*" This suggests that global SCs are not convinced about the benefits of decentralization to the industry as a whole and are still focused on furthering their own advantages. Consultant 5 supports this: "*The critical word is 'I'. 'I' as an organization that competes with others for my own advantage . . . As soon as there is an appreciable amount of people with a 'We' mindset, we will move forward.*" Again, due to early stage of BCT adoption, there is a need for greater awareness of what types of records to keep across the ledger.

4.2. Blockchain-Enabled Trust across Supply Chains

Blockchain networks can increase the trust of various SC players in business processes such as financial and digital transactions [54]. With regard to the holistic view of trust that BCT enables, both adopters and consultants shared the view that BCT improved trust among SC parties but questioned if adopting such complex technology for trust-improving purposes alone was worthwhile.

The desire to ensure trust comes from the general problem of mistrustfulness between business partners in SC networks [55]. Participants also recognized this challenge of trust in business practices, as Consultant 3 said that: "*We live in a world of mistrust, because you do not trust your suppliers and your customers, and pretty much no one trusts each other.*" Adopter 1 followed " . . . *trade happens, and trust was always a part of global trade.*" How BCT can address these challenges was explored by Consultant 7: "*Today there is no technology that allows trust between parties . . . so the main goal that companies are trying to achieve with blockchain is to give them trust to deal with each other in a trustless manner.*" From the adopters' viewpoint, Adopter 3 claimed that blockchain "*Increases trust between participants, where nothing is hidden—working on the shared ledger, where ledger is being automatically updated.*" Thus, trust improvement is an integral feature of the technology itself.

Trust in the context of business partnerships was defined by [56] (pp. 665–666) as "an expectation that a subject distinguished by specific characteristics will perform future actions aimed at producing positive results for the trustor in situations of consistent perceived risk and vulnerability." Adopters in the food and beverage distribution sector described how BCT addressed the risks and vulnerabilities involved. Adopter 4 saw blockchain as "*a tool to create more trust, as an anti-fraud system*", while Adopter 5 agreed that: " . . . *it solves the security part of the information.*" Adopter 1 provided an interesting interpretation of what happened with trust in their case: "*Blockchain almost democratizes trust or outsources trust to an independent function, that we can all trust.*" Technology project leader, Consultant 8, explained it as: "*If you have a centralized system, everyone needs to trust in someone. Here it is easier, because if you are decentralized you do not need to trust everyone, or in a single party to host all the data. So, definitely it brings value to the supply chain.*" Thus, based on our definition of trust, we see that BC ensures a positive result for the trustor in sensitive contexts by securing the information within the ledger, rather than involving a third party.

Since blockchain is so powerful in increasing trust, does it mean that trust between parties will be eliminated and building basic business relationships will no longer be required? Our participants were very conscious of BCT's opportunities, but even with its superior advantages in security and third-party elimination, it does not mean that trust is no longer an important business relationship component. Adopter 6: "*Blockchain can help by eliminating third-parties, but it does not eliminate the need of entities to trust each other in some degree.*" Adopter 2 further stated: " . . . *I think it solves a part of gaining confidence –you gain confidence into a technology, that was not just invented yesterday. But it still requires some kind*

of a psychological barrier to be broken." Technical experts also agree; Consultant 1 said: "*You are still going to need that human interaction—that will never go away.*" Consultant 3 further explained: "*I think what blockchain does is it thinks about trust in a different way. It leverages the fact that we mistrust to one another. It helps us deal with trust as a team effort, eliminating the need for excessive amounts of evidence that translates into excessive costs.*"

The trust-enabling function of BCT is explained by third-party elimination and the decentralization of information keeping logic, which brings a more secure feeling to organizations. However, at this stage, BCT does not eliminate the organizational need for trust and communication between partners. Companies still have to build relationships based on human communication. BCT is able to bring trust in terms of increased confidence in information sharing between partners, with less monitoring required across the SC.

4.3. Perceived Benefits and Challenges of Blockchain Adoption in SCM

Ref. [57] claimed that BCT implementation required considerable upfront costs, but the long-term benefits were likely to far outweigh the expense of adoption. Many benefits mentioned by both adopters and providers could also be found in the literature, such as trust [22,58], product safety and provenance assurance [31,47], third-party elimination [2], the immutability of information [5], data security [45], and collaboration improvement [55,58]. We highlighted those benefits that were mentioned by at least half of interviewees.

(1) Supply chain processes speed improvement (mentioned by four adopters five consultants): "*I think the biggest innovation of blockchain is the ability to do instant settlement*", said Consultant 6. Not only do smart contracts speed up processes through instant transactions [5], the speed-up also applies to information-sharing and transmission processes [59]. Adopters recognized the speed improvement value of BCT across the network, as Adopter 6 explained that entities were: " ... *trying to implement B2B system integrations, so that you could speed up processes.*" Adopter 5 also reported this benefit across their SC: " ... *time of response between the information being supplied by blockchain and our manual or semi-automated queries showed, that blockchain was faster.*" Consultant 3 explained the technological rationale behind the speed improvement: "*By building an integrative historic file of a transaction across the blockchain, participants only need to add their information, no not need to transcribe previous documents: with this you save a lot of time.*"

(2) Transparency and traceability (mentioned by five adopters and seven consultants): With BCT, every piece of information is captured and permanently distributed to every participant in the network, thus increasing traceability across SCs [53]. Traceability is a feature that is particularly important for food and beverage SCs to ensure the safety of products. Adopter 6: "*I think blockchain, if widely adopted by markets, can give a level of assurance of the traceability characteristics, in this case food, that we would not have with other technologies. We have seen participants eager to have technology that will give value to products with traceability assurance.*" A colleague from the same sector, Adopter 3, further highlighted this innovation as: " ... *getting to the next level of traceability.*" Consultant 7 explained that: "*Blockchain allows us to trace not only the bulk of products, but the product itself. You can put a decentralized ID in each product and trace all of the products and all of their transactions.*" It is important to distinguish between the two concepts of transparency and traceability. Consultant 3 warned industry adopters to pay attention to the given SC needs and to use blockchain accordingly: "*Keep in mind that transparency and traceability are not necessarily the same thing. Supply chain networks might need traceability to track the product shipped from one country to other, to see who signed documents etc. But should all the players be able to see 100% of the information? The answer is no.*"

(3) Human error reduction (mentioned by four adopters and eight consultants): Blockchain enables a reduction in uncertainties from human error [60]. Both sides saw human error reduction as a benefit, but from slightly different perspectives. Consultants view human error reduction as a result of high-quality smart contract coding. Consultant

8 said: " ... *if we have good smart contracts and good applications, and we integrate them well, decreasing the moments where humans need to execute something, it is very likely that we will decrease failures due to the human element.*" However, Consultant 3 maintained that the quality of the smart contract itself is crucial: " ... *once you ensure that your smart contract works in a proper way, you eliminate the possibility of human error ... but there can be human error from poor coding of the smart contract.*" For industry adopters, BCT looks attractive as a way to reduce errors through real-time visibility for the whole network. Adopter 7: "*Having more eyes on the same document information will help to reduce the errors of one person.*" Adopter 3 viewed error reduction as a long-term achievement of BCT adoption, rather than an inherited feature: "*I think in the long-run it does improve the quality, because you are exposing the errors immediately, and we can trust them in real time.*"

(4) Paperwork reduction (mentioned by four adopters and six consultants): Digitized documents on BCT ledgers may speed up processes such as certification and documentation through automation, eliminating manual entry [61]. However, industry adopters know that BCT is not just a tool for reducing paperwork—it provides a simplified process of recordkeeping and record sharing across the network. Adopter 3 described the adoption results of their SC network: " ... *what we saw was the reduction of manual electronic paperwork—the elimination of suppliers using different versions of Excel and sharing their information through email ... that aspect was completely removed from the picture.*" Adopter 8 explained how the decrease in paperwork also speeded up other SC processes: " ... *some clients need information about old articles and we have to provide it. In blockchain they do not need to ask us-they just access it themselves.*" From the technological perspective of Consultant 3, it is too early to talk about full paperwork reduction: "*You could use blockchain in order to get rid of the whole paper-based network, but for that to happen, people need to start requesting that.*"

Two crucial challenges that were reported by at least half of participants are technology misconceptions and inadequate legal regulations. The misunderstanding of technology, more precisely a misconception of blockchain with cryptocurrency applications, disrupts activities across SCs and can cause financial losses for investors. Another critical challenge is the lack of globally applicable regulations and laws relating to BCT-based networks. However, BCT is still in an early stage of evolution in the business context [62], which accounts for these problems, leaving space for improvements.

(1) Low awareness and misconception about BCT by SC players (mentioned by five adopters and six consultants): One of the most often referred-to areas of confusion reported by consultants are misunderstandings about BCT and cryptocurrencies. Consultant 6 stated that industry adopters often misunderstand how BCT works in a business context: "*Blockchain is all about hype, people get frustrated, because they don't know what they are dealing with, and it becomes one of the main problems ... There's a lot of education that needs to be done.*" From the point of view of an adopter, what is needed is better understanding of the technology, so that it can be clearly explained to SC partners. Adopter 7 said that players: "*need to understand how to send documentation, how to interact with the blockchain.*" In Adopter 3′s case " ... *we just explained to the participants what this is and how it works, but this is standard practice, not only for blockchain.*" From a technology expert's view, however, explaining the way the technology works to businesspeople is not so simple: "*If you are talking about blockchain to non-IT companies, it is not easy to explain the technology and how it works. It has pretty advanced concepts*", says Consultant 8. Thus, more education is necessary at this stage to make sure that SC sector specialists clearly understand that BCT in a business context is very different from the cryptocurrency situation. They need hands-on training to gain skills in working with digital ledgers.

Another misconception that was revealed is the fact that essentially, BCT implementation does not necessarily involve excessive investments. Technology consultants want to be

clear that businesses should not be misled by ideas of high BCT cost, as per Consultant 1: "*High-cost is a misunderstanding, BCT is a cloud-based system, you do not 'house' the hardware, you will have some technical architects etc.*" Consultant 3 further clarifies that the expertise of a service provider is something that might be even more costly than the BCT integration itself: "*Infrastructure part is rather cheap, the part that is more expensive has to do with professional services and with knowledge.*" Industry adopters are more focused on the returns that they are able to gain from BCT, rather than the cost of technology implementation, but surprisingly, the returns in this case are not represented in monetary terms; rather, it is the value that BCT adds to product/process. Like this, Adopter 2 explains: "*Tangibly speaking, you probably do not have an income cashflow that comes in the next years, but in the long-term it is going to make the industry just better for everyone.*" From a food and beverage industry perspective, Adopter 6 is seeing returns in terms of added value for consumers: "*BCT allows to pay back when you are proving the value of the product to the end-consumer with ways to access the information about traceability of food, thus increasing demand on this type of product.*" Service providing technology expert Consultant 8 explains this phenomenon as a marketing hint: "*It is not only about getting more money or cash, it is also about other gains, for example transparency: your company is seen as a transparent and that is providing better sales. It is marketing-related.*"

(2) Lack of legal ramifications (mentioned by five adopters and seven consultants): According to participants, the lack of legal regulations does not stop SC managers from using BCT to simplify processes and make them more secure, although clearly defined standards and regulations are preferable. Consultant 7 explained: "*This is crucial for companies to gain confidence, to be sure they are going to adopt blockchain without too many risks, but the problem is that innovation moves faster than regulation. But let's not overregulate. Regulators tend to try and regulate everything, and that is what stops innovation.*" Industry representatives believe that it is just a matter of time for legal regulations to be defined, as Adopter 6 averred: "*Legal frameworks are usually 5–10 years behind the current technology, but eventually they catch up. I do think we need some level of regulations not for BCT itself, but some use cases.*" Adopter 1 also agrees: "*. . . regulation has always caught up with innovation. People are constantly inventing and government needs to catch up.*" Thus, this challenge is not preventing progress as organizations across the globe are already showing success in applying BCT; these new digital solutions just need more time for the introduction of universal standards and regulations.

4.4. Status Quo and the Future of Blockchain in Supply Chain Management

Being at an early adoption stage, BCT uses closed permissioned platforms to make it safer for business [63]. Interviewees informed us that their use cases were based on permissioned networks. A permissioned blockchain is a good way to protect interplay between stakeholders with common objectives who have not developed total trust. In such a network, participants are known, and all transactions are recorded on the BCT in accordance with predefined conditions [58]. Consultant 5 considers BCT unnecessary for those who already have trustful relationships: "*If you have a group of entities that trust each other, you do not need a BCT or a shared database. That's why a private blockchain is an oxymoron. The key thing is the trustless nature of permissionless blockchain . . . the root of trust is the protocol.*" Consultant 7 supported this view: "*There is no reason to use blockchain by yourself–you only need it when connecting several different companies that do not trust each other. With trust, you do not need a blockchain–just some kind of database or other technology.*"

Some adopters do favor open, permissionless networks for the future. Adopter 3 takes a long-term perspective of BCT for SCM: "*Using Ethereum, or some other public permissionless blockchain is where I see the future of BCT going. Eventually, private blockchains will either build hybrid bridges for public use, or completely disappear as public BCT matures . . .* " Consultants have witnessed various technological leaps in business throughout the years, and they are able to develop some characteristic patterns for innovative movements. Consultant 7 described BCT development using the Internet roll-out as example: "*I experienced the Internet wave back in the 90s, where companies had two choices—the ones that used internet were*

more innovative and the ones using intranet had all the incremental innovation, but the changes were not disruptive. That is exactly the same thing that is going to happen to blockchain; so, as a company, you should use a permissionless public network." With sustainable growth in BCT adoption, the tendency is to move towards open permissionless networks.

5. Discussion

BCT is gaining recognition for disrupting the status quo and reshaping global SCs and business relationships [32]. This study compared the BCT adoption process from the perspectives of early industry adopters and service-providing technology consultants, and discussed the issues relevant to a harmonious and well-planned technological scenario.

One key finding at the early stage of the process is that entities need to carefully evaluate what information to put on an immutable BCT. It is crucial in a BCT-based environment to create effective links between physical goods and their digital records; thus, data that do not add value to the authentication process should be kept off-chain [3]. Our findings suggest that the primary major step towards adoption is for all records to be evaluated for inclusion on the BCT, as keeping all shared records for inter-company purposes might not be justifiable. In [64], the authors suggested 'blockchain pruning' on permissioned networks to delete unnecessary data or obsolete transactions; however, it would be time-consuming for participants and contrary to the immutability principle. For the BCT to bring its incremental value of immutability, we propose restricting ledger entries to vital information through negotiations between partners. Moreover, it would be effective to invite technology providing consultants to such negotiations, as their experience would help to define what type of information would be necessary to have on the ledger.

Another important aspect that emerged from this study was that individual organizations should move from an "egocentric" approach to BCT benefits, towards global goals aimed at improving the future of the whole industry. The extant literature suggests that pre-defining joint market goals is important for any industry, where BCT is being considered [65]; moreover, implementing collective goals will reduce the coordinated efforts of individual players [66]. BCT adoption is not just a technological decision, but a business decision that demands an innovative organizational mindset with leadership actions at the micro- and macro-levels [18]. However, our findings are bringing a novel argument, as it requires not only the innovativeness of mindset as found in the extant literature, but a collective view on the industry and supply networks, which will bring value for future. Consultants highlight that for the full potential of BCT to be revealed, adopters need to move from thinking only in their own benefits to a more global disruption of the industry. Achieving collective macro-level industry goals requires managers to adopt a more creative and collaborative mindset. This change will not occur overnight, but today's trends in business aim towards global sustainable goals, and BCT has potential to enhance operations of global partnerships.

Our interview results clearly support the idea that BCT increases trust and transparency across SCs by enhancing data security and decentralizing information. It is crucial for adopters to be able to access data independently at any given time and to be sure that the data displayed is the same that partners will see from their side. This level of transparency brings a sense of equality and promotes trust across the SC. BCT increases transparency; in particular, as our findings show, it brings novelties for visibility of those elements in SC that are located in the middle. For instance, with BCT, transporters and distributors are able to check not only the 'reverse' information of the product origin, but also have a 'forward' visibility of what stage the product is at once it is out of their own control and moves more downstream. This is a feature that was not possible before, and the visibility of the downstream players, mainly the end-customers, is also an innovation that adds extra value to products. The literature shows that decentralized architecture eliminates intermediaries such as banks and lawyers and reduces surcharges for verification [57]. However, our findings revealed that when a third party is eliminated, entities still need to cultivate relationships with each other 'off the ledger'. Even though BCT provides more

trust towards sharing access to equal information across players, it cannot fully substitute the communication and relationship-building aspects of organizations. We interpret it in a sense, that for a pilot to launch successfully, at least some level of communication needs to be present between entities, as they need to decide the design of the pilot and negotiate the need of sharing specific type of information.

Among the other benefits of BCT-based SCs, we highlighted the reduction in paperwork, minimizing human error, and improving operating efficiency and speed. The extant literature suggested that BCT helps eliminate the huge volume of traditional SC paperwork that constantly needed to be rechecked, verified, and updated [47]. Our study indeed proved, based on real pilots and use cases, that BCT-automated transactions and the self-executing capabilities of smart contracts create an environment of efficiency where SC players could focus on innovation and performance, instead of routine data flow maintenance. However, an important finding of our study is that even with the automation enabled, some challenges still exist—e.g., ensuring the quality of ledger records. Users of the network need to be certain that input information contains no errors. In a situation with information containing false or error information, the actual extraction of such data will be a problematic and time-consuming experience, which will probably need to be performed by technical specialists.

Misconceptions about the technology are common, and potential adopters need greater technological awareness to make good decisions. The authors of [51] claimed that business leaders and SMEs remained unsure of what BCT involved, and its value to businesses, but our findings showed the presence of basic understanding of the technology, only at different levels for different players. Previous studies focused on motivating the interest and expertise of players as a way to generate a favorable environment for successful technology transfer [21], but our study revealed that the differences in the level of BCT understanding need to be explored in the first place to create motivation for adoption. The misconceptions about BCT, such as a common association of it with cryptocurrency markets, creates a false expectation or misleads potential adopters. By enhancing awareness, we believe that this enthusiasm can be channeled into a desire of organizations to learn more about the technology and what it has to offer for SC operations. Here, technology consultants will play a crucial role, as their expertise will enable us to fill in the gap in potential adopters' knowledge of BCT. We suggest that finding a suitable and experienced technology consulting company should be the primary step towards the pilot.

Moreover, it was found that the high cost of BCT solutions is a misconception, rather than a reality. The potential high cost of BCT solution development and implementation was seen as a barrier by companies that did not pilot the technology yet [67]. In the research conducted among piloting and incumbent agri-food companies that deploy BCT, the extant literature finds financial resources as a key intraorganizational barrier for smaller organizations [23]. Our findings showed that technology providers feel organizations are sometimes being misled by the idea of vast investment required for adoption. Moreover, adopting companies with more mature levels of BCT deployment are seeing the ROI if not in monetary, than in value-adding factors to the end consumers. Thus, SCs that want to gain competitive advantages in terms of information availability need to consider BCT adoption without being stressed over monetary ROI, as the return comes from a value-adding factor to the products/services itself.

Another challenge identified was the lack of legal regulations for BCT use in the business sector. The literature assumes that risk-averse companies would be more receptive if governments and unions would standardize the procedures involved and define relevant policies [3]. For example, [68] suggested a collective agreement among members of the United Nations for the widespread universal acceptance of BCT adoption. The authors of [57] warned that careful attention needed to be paid to designing the standards regarding smart contracts, as they influence the adoption of BCT across different countries. However, our findings reveal that it might not be feasible to define universal rules, as each application will have its own specifications and needs. We do believe that legal and financial support

and recognition from governments will boost the confidence of companies and stimulate management to be less hesitant about moving towards digitalization. Moreover, important input that came from the side of consultants is that an 'overregulation' of BCT initiatives might result in a crash of the innovative component, such as decentralized logic.

Another key finding was the need for comprehensive BCT examination and mindful decision making prior to adoption. Results supported the idea that before finalizing the adoption decision, SC entities needed to think through the suitability of using BCT, as private blockchains are not justified in all use cases. In permissioned networks, players know who has access to the network and can update information in the chain, which makes the environment not fully decentralized. This obviates the main advantage of the technology and might not make the effort and investment of resources in the adoption worthwhile. On the contrary, when a BCT ledger is based on a fully public infrastructure, all participants are able to retrace a firm's actions, resulting in a completely new level of transparency. The extant literature highlighted that companies may not yet be ready to risk their competitive advantage by allowing information transparency [32]. Although we recognize that the transition of private BCT pilots to fully functioning public ledgers will take considerable time, our findings showed that SCs are striving towards the creation of permissionless networks to reach the inherent innovativeness of BCT. For this shift to take place sooner, we highlight the importance of businesses working in close collaboration with experienced technology-providing agents, as this will ensure a smoother transition to permissionless environments.

An interesting angle for the discussion was created by findings based on the geographical and cultural background of industry adopters and consultants. For example, the tendency of European-based technology consultants and adopters shows that competitive organizations are interested in adopting BCT for long-term outputs that would be visible for players of a specific industry. However, in North America, technology providers noticed organizations aiming for BCT adoption participation to gain a better understanding of competitive companies' activities. This might be a difference that is built upon a generally higher competition environment in North America and slightly different cultural foundations in Europe, where long-lasting relationships and family businesses are a more common phenomenon. When it comes to the argument of BCT bringing more trust and security into SCs, the views of both adopters and service providers are similar regardless of the cultural background, so we can say that this incremental feature of the digital ledger showed itself to be generally value-adding to any SC. The same happens with traceability assurance; the global view of participants is that traceable technology adds value and competitive advantage when it comes to the final consumers. As a result, the ROI that BCT implies is seen by participants as rather intangible, providing a unique opportunity for customers' visibility, therefore creating a higher level of satisfaction.

6. Conclusions

The chief advantage of our study was the comparison of the views of adopters and consultants, which revealed key differences in their attitudes towards BCT adoption in SCM and allowed us to draw essential considerations for future pilots. In the extant literature, BCT adoption intentions among SC experts have been revealed through scenario-based experiments [51], and a mixed-method approach was used to explore incumbents' and pilots' barriers [23] and managers' resistance [20]. Critical success factors of BCT adoption [69] as well as barriers [70] were examined among academic and industry specialists. To the best of our knowledge, this study is the first to compare views on the BCT adoption process, with its subsequent benefits, challenges, and future paths of development through interviews with industry adopters and technology consultants. It was mentioned in the extant literature [71] that both technical and business aspects of BCT implementation should be addressed prior to its adoption; thus, this paper contributes by revealing international views of both adopters and consultants, highlighting the differences in BCT perception of the two groups and discussing ways of optimizing their approaches.

This study not only contributes to academic research and theory, but also brings value to industry. SC managers who are considering adopting BCT can get acquainted with the experiences of colleagues from the industry and gain knowledge from consultants' advice and methods for estimating a given network's BCT needs. In this study, adopters discussed the main issues to be considered before and throughout the process, again stressing the importance of a solid definition of problems that a piloting SC needs to address. When participating parties choose to implement BCT as an essential technology, they need to agree on the types of information that will be kept on a shared network, as not every piece of data should be added to an immutable ledger. Risk-averse companies need to understand the value of BCT, but as regulations related to BCT-based SCs are still inadequate, this implies an element of risk in implementing novel technology.

This study was limited to the perspectives and opinions of 16 participants. Thus, we used a qualitative approach, which allowed participants to "speak" and share their perspectives, creating a substantial amount of deeper material for further analysis and discussion. We recommend using mixed-method models for future studies to obtain quantifiable results [20] and to see if findings can be generalized; quantitative data collection and hypotheses testing could also provide a more extensive basis for further analysis [72]. As a path for future, we also suggest longitudinal research that allows for the comparison of the evolving views of technology consultants and industry adopters throughout different stages of adoption and maturity. SCs in specific industries could be explored to show narrowly focused tendencies. An in-depth case study with a piloting SC could be performed to evaluate the difficulties encountered by different tiers, to find the consensus between different tier perspectives. We hope that our study will drive future research in the area and will serve as a solid base for filling the gaps.

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Appendix A

Semi-structured interview guideline topics:

1. BCT journey/consultancy experience duration.
2. Intentions behind adoption.
3. Data security and privacy concerns with BCT.
4. Product safety assurance and documentation flow with BCT.
5. Transparency and traceability of BCT networks.
6. Human error in BCT networks.
7. BCT knowledge and awareness raising.
8. ROI concerns and cost of adoption.
9. Participants' involvement in the adoption process.

10. Legal ramifications for BCT networks.

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