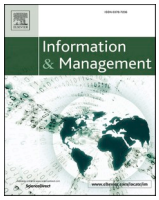
Information & Management 58 (2021) 103444

Contents lists available at ScienceDirect

Information & Management

journal homepage: www.elsevier.com/locate/im



A framework of blockchain technology adoption: An investigation of challenges and expected value☆

Elissar Toufaily [a,*], Tatiana Zalan [a], Soumaya Ben Dhaou [b]

[a] American University in Dubai, United Arab Emirates
[b] United Nations University, Portugal

ARTICLE INFO

Keywords:
Blockchain technology
Distributed ledger technology
Adoption
Diffusion
Innovation
Private sector
Public sector
Entrepreneurs
Socio-economic implications
Value creation
Ecosystem

ABSTRACT

The purpose of the paper is to investigate the challenges and implications related to blockchain adoption in the private and public sectors, and from the entrepreneurs' perspective. Based on 46 semi-structured interviews, a data-driven conceptual framework is proposed focussing on the environmental, organizational and technological challenges of blockchain adoption. The framework includes expected socio-economic value of blockchain adoption at the ecosystem level from a multi-stakeholder perspective: organizations and industries, end-users and society, public sector, and start-ups and entrepreneurs. The paper highlights the differences between permissioned and permissionless blockchains and identifies new constructs in blockchain technology adoption.

1. Introduction

Blockchain, a complex technology at the intersection of computer science, cryptography and economics, is a foundational technology of the fourth industrial revolution [1]. It can be described as a distributed ledger technology (DLT) underpinned by five fundamental principles: decentralization; peer-to-peer (P2P) transmission; transparency with pseudonymity; irreversibility of records and computational logic [2–5].

While blockchain is the technology that underpins the digital currency Bitcoin, its broader applications are being explored in a growing number of industry sectors. These include smart contracts for tamper-proof ballots and election results (e.g., Bitcongress, followmyvote.com); smart properties (e.g. securities, patents, title registries, real estate) which can be tracked or exchanged on the blockchain itself; and decentralized autonomous organizations (DAOs) where agents derived from artificial intelligence execute tasks without human involvement [6,7].

For any transformative technological innovation to realize its socio-economic benefits, it needs to be widely adopted and diffused [4,8]. While the issue of blockchain adoption has generated considerable interest among academics, policymakers and practitioners, it remains relatively unclear how its transformative potential is realized in practice. Risius and Spohrer [9] state that future studies need to "provide insights on why people use the technology and what features enhance or constrain its dissemination among the society". Janssen et al. [10] advocate for a broader view of organizational adoption, addressing multiple challenges and complexities across technical, social and regulatory areas. Accordingly, the purpose of the paper is to investigate the challenges and implications of blockchain adoption by organizations across sectors from an ecosystem perspective. In this study, we seek to answer two related questions: 1) What are the barriers to and challenges of blockchain technology adoption by various industry sectors and organizations? and 2) How will blockchain technology adoption create value for the actors in the ecosystem?

When a wave of "buzz" builds, and the expectation of an innovation rises above the current reality of its capabilities, the technology is believed to be at the peak of inflated expectations phase of the Gartner's hype curve [11]. At that point, researchers are well-advised to focus on investigating the potential applications and challenges of the adoption of the technology, its influences on companies and traditional business processes as well as how the technology might generate value [12]. Our research is a step forward in this direction through the development of a

☆ The authors sincerely acknowledge the anonymous reviewers for their constructive recommendations that enhanced the first versions of the paper.
* Corresponding author.
E-mail addresses: etoufaily@aud.edu (E. Toufaily), tzalan@aud.edu (T. Zalan), bendhaou@unu.edu (S.B. Dhaou).

https://doi.org/10.1016/j.im.2021.103444
Received 3 November 2019; Received in revised form 21 January 2021; Accepted 5 February 2021
Available online 9 February 2021

conceptual framework, grounded in primary data, showing interrelationships between challenges of adoption and the expected value or implications. Our study expands existing frameworks based on practical evidence, as strongly advocated by Risius and Spohrer [9] and O'Leary [12]. Our empirical research will help researchers and practitioners gain a better understanding of the transformative potential of the technology and guide future research and practice. The study offers companies a frame of reference when considering blockchain applications.

It is essential to mention that there are primarily two types of blockchains: permissionless (i.e., public blockchains) and permissioned (i.e., private and consortium blockchains). The two types of blockchains share some similarities (e.g., a cluster of nodes functioning on a P2P network system, timestamping of transactions, immutability). However, the consensus process of validation and recording of transactions and the number of nodes on the network differ (see Appendix 1 for more detail). In this paper, both types of blockchains are considered for investigation, and the proposed comprehensive framework will distinguish the challenges and expected value for each type.

The paper proceeds as follows. In Section 2, we briefly review the literature on blockchain technology adoption and the theoretical foundation of the paper. In Section 3, we describe the research design, data collection and analysis. In Section 4, we present, compare and discuss the findings. Section 5 presents the conceptual framework which emerged from the data. In Section 6, we discuss our findings and their implications. Finally, in Section 7, we provide some concluding remarks and openings for future research.

2. Literature review and theoretical foundation

2.1. Blockchain technology adoption: state of the art

In the past few years, a growing number of academic papers have examined the technical aspects of blockchain technology [e.g., [13]], validation strategies (e.g., Proof-of-Work and Proof-of-Stake), consensus mechanisms [e.g., [14]], various applications of the technology as well as its impact on corporate governance and financial reporting [e.g., [15]]. The adoption of blockchain and DLT by firms, consumers and governments has also been the subject of research.

To synthesize the current state of knowledge on blockchain technology adoption, we conducted a review of empirical and conceptual studies. We identified nine streams of research related to blockchain adoption: (1) challenges, barriers and benefits by industry sectors; (2) data protection, sharing, security and privacy; (3) socio-economic implications and macro-consequences of blockchain adoption; (4) impact of blockchain on business models and governance; (5) environmental factors, government and ecosystem role in blockchain adoption; (6) applications and use cases of blockchain adoption; (7) factors affecting adoption; (8) state of blockchain adoption; (9) blockchain adoption and cryptocurrencies. The research method for the literature review, the key insights from these research streams and representative studies can be found in Appendix 2.

Our review shows that the literature on blockchain adoption is highly diverse. Most of the papers are conceptual [e.g., [16,17,8]], or descriptive in nature [e.g., [5,18,19]], and very few studies are based on empirical research, particularly on primary data [e.g., [18]]. Economic models have also been used in the literature and have considerably enhanced our knowledge of the phenomenon. For example, from an economic modelling perspective, Benjaafar, Chen, Taneri and Wan [20] present a strong case for a permissioned blockchain and discuss the benefits of its adoption (e.g., cost reduction). In another study, Notheisen and Weinhardt [21] pose the question of how the core features of blockchain transactions affect behaviours of market participants and market outcomes. They argue that public disclosure of quality information can give rise to opportunistic behaviour. Blockchain adoption may lead to the market collapse in markets with a high level of transparency and intense competition. Besides, using blockchain-based systems in environments prone to irrational behaviour (such as retail markets) can harm welfare and impede a market's functioning.

Our analysis of the literature is consistent with the conclusions by Risius and Spohrer [9]. Research on blockchain is mainly conceptual, argumentative and design-oriented, based on prototypes and case studies; the number of business-related qualitative or quantitative research is limited; theory-driven empirical research on blockchain-related phenomena is generally scarce (Francisco and Swanson [22] is an exception). This is common for research done at the first stages of the technology in the hype cycle [13]. Risius and Spohrer [9] encourage researchers to collect primary data for a better understanding of blockchain technology. They suggest that complementary organizational, psychological and behavioural lenses to explore blockchain adoption are needed.

The phenomenon of blockchain technology adoption requires a comprehensive, multi-level, empirically grounded investigation which incorporates multiple interdependent actors. Our paper addresses this concern.

2.2. Innovation adoption, externalities, uncertainty and isomorphism

Innovation adoption and diffusion research are subsets of the more general technological evolution theories [23–26]. While it is impractical to review these theories for this study, the key insight from this field is that technological innovations are socially constructed. Given our primary empirical focus on organizations within the blockchain ecosystem, we examined a variety of adoption theories that could be useful to better understand the adoption of blockchain technology.

Conceptually, we position our study within the literature on technology adoption and diffusion of digital networks under uncertainty, coupled with an institutional perspective (see Table 1). Because blockchain is a network technology, its adoption might be subject to both direct and indirect network effects; mimetic pressures from the actors in the environment and to the uncertainty of expectations, outcomes and technological development. We examine the organizational adoption of blockchain technology from the perspective of the ecosystem actors by combining different theoretical models, mainly Roger's diffusion of innovation (DOI) theory (e.g., perceived attributes of innovation; norms and degree of network interconnectedness; type of innovation decisions) and the TOE (technology–organization–environment) model which emphasizes the role of the context and external environment. DOI and TOE have been used extensively in IT adoption studies, and have enjoyed consistent empirical support [27].

In summary, our theoretical positioning integrates key concepts from mainstream innovation adoption theories with adoption in the presence of networks effects and under conditions of uncertainty and isomorphic pressures. As each theory has its limitations concerning the adoption of blockchain, we have combined different theories to better guide our theoretical stance as well as the analysis, the coding and the development of the conceptual framework.

3. Research design

3.1. Method and sampling

To accomplish our research objectives, we selected an exploratory research design, based on qualitative data given that the study explores the challenges, risks and implications related to blockchain adoption from a multi-stakeholder perspective in different industries. Further, the qualitative approach helps to understand the interrelationships among the various components of the challenges and implications of blockchain adoption by organizations. Finally, an exploratory research is justified to identify new theoretical constructs, develop a new conceptual framework, and contribute to advancing research on blockchain adoption [44,45].

Table 1
Theoretical foundations of blockchain technology adoption

Theories	Relevance for blockchain adoption	Limitation for blockchain adoption
DOI [28,29]	• Decision of an individual or organization to make use of an innovation • Diffusion as the accumulated level of users of innovation in a market • Relevant tool to understand the benefits of blockchain technology • Relevant for the assessment of blockchain adoption and diffusion complexity • Role of early adopters in defining the success of adoption	• Has limited applicability for technologies with network externalities/ network effects • Assumption that rational adopters are free and independent to chose to adopt or not to adopt an innovation • Neglects environmental context
TOE [30,31]	• Organizational level • Role of the external environment • Impact on the adoption decision • Classifies the challenges and benefits of adoption	• Missing critically important variables such as uncertainty • Neglects mimetic, coercive and normative institutional pressures towards IT systems • Neglects the role of individual characteristics (e.g., top management support)
Network externalities [32, 13]	• Network externalities: adopters care about how many users adopt blockchain • Market power externalities: adopters with market power will care about the adoption by others if early adoption of blockchain implies some market power • Learning externalities: early adopters of blockchain may teach late adopters something useful	• Neglects the characteristics of the market, organization and the technical changes
Adoption under uncertainty [33.34] [35,36, 37]	• Market uncertainty: affects the investment and the delay of the adoption • Technological uncertainty: expectations about the timing of future and continuous improvements may lead to postponing the adoption and diffusion of blockchain	• Adoption is driven mainly by euphoria in anticipation of short-term gains and a pervasive fear of missing out, neglecting other factors.
Institutional isomorphism [38,39] [40,41] [42,43]	• Adoption of blockchain-based on mimetic / peer pressure: institutional pressures from the environment will magnify the homogeneity of practices across organizations and increasing the adoption • Isomorphic/mimetic pressures are particularly acute under conditions of high ambiguity and technological uncertainty	• Adoption based mainly on myths in the institutional environment rather than a calculus of costs and benefits

Semi-structured interviews were conducted in English with different stakeholders from the blockchain ecosystem in the Middle East and North African (MENA) region, starting in November 2017 and ending in December 2018. According to O'Leary [12], when the technology is still at experimental and exploration stages, interviews with experts are highly recommended to solicit their opinion on the challenges and value of technology development and adoption. Following the advice of Miles and Huberman [44], a purposeful sampling technique to identify the interviewees in the blockchain innovation ecosystem was used. Forty-two participants were interviewed, tape-recorded and transcribed. Four additional semi-structured interviews were conducted later in March 2020, with a purpose to distinguish between the challenges and the expected value of blockchain adoption and categorize them by type of blockchains (i.e., permissioned and permissionless), as well as to consolidate the findings between the different panels in the sample. In total, 46 participants formed the final sample for this study. The respondents in our sample belonged to three main groups (see Table 2). The first panel is composed mainly of industry professionals in the supply chain, real estate, payment/finance and big tech companies. The second panel is composed of participants from public institutions. The third panel is composed of blockchain experts, such as lawyers, consultants and entrepreneurs.

The purpose of the diversity of respondents' background is to consider the entire ecosystem perspective for a comprehensive understanding of blockchain adoption. According to Mollenkopf, Frankel and Russo [46], interviewing respondents with diverse profiles supports the validity of the findings and offers a varied perspective on the research topic. It is important to mention that most of the participants in this research are located in the United Arab Emirates (the UAE). The UAE is considered a highly visible "case" and an innovation hub for blockchain technology. Different blockchain applications have already been adopted by public and private institutions in the UAE [47].

Most of the respondents in the entire sample are male (89%), 45 years old on average and have an average of 5 years of experience in their current positions.

The unit of analysis in our study is the ecosystem. Drawing on

Table 2
Profile of the sample

Sample ($N = 46$)	Profile of the respondents
Private sector panel: $n = 28$ -Payment and finance ($n = 11$) -Supply chain ($n = 4$) -Big tech companies ($n = 7$) -Energy ($n = 2$) -Real estate ($n = 2$) -Legal and venture capital ($n = 2$)	*Finance sector*: most of the respondents hold a position of manager (e.g., head of payment, head of trade finance, financial manager, portfolio manager, electronic channel manager, internal audit manager) in a local or an international bank. Among the interviewees, there is a CEO and general manager of a financial and investment company; another is chief information and security officer in an international bank and 2 financial advisors, as well as one finance university professor. *Supply chain sector*: the 4 respondents are directors or owners of cargo, shipping and procurement private companies. *Tech sector:* 7 respondents are senior consultants and advisors in IT and software development, where 4 of them are consultants in blockchain business development in their respective companies. *Real estate:* 2 respondents, one is a sales manager, and the other is a leasing consultant. *Energy sector:* 2 respondents, both are financial directors in 2 different oil and gas companies. *Other:* 2 respondents, one is a partner and a portfolio manager at a venture capital platform and the other is a legal advisor in an established consulting law firm.
Public sector panel $n = 7$	Respondents are advisors, analysts, directors and experts in different public institutions mainly in Dubai, such as Dubai Future Foundation, Mohamed Bin Rashid Fund for SMEs, Prime Minister Office, Federal Competitiveness and Statistics Authority, Dubai Customs and Dubai Technology Entrepreneur Campus.
Experts and entrepreneurs panel $n = 11$	Seven of the respondents in this panel are founders and CEOs of blockchain-based start-ups, operating in the MENA and Europe. The other 4 respondents are advisors and consultants in technologies and digital currencies, legal services for ICOs and STOs, as well as cybersecurity.

research into business ecosystems and digital platform management in the presence of network externalities (for a comprehensive review, see [48,49]), we define an "ecosystem" as a complex dynamic network of actors/stakeholders interacting with each other. The adoption and diffusion of foundational innovations such as blockchain can only happen when ecosystem actors rely on each other for knowledge and resources [48,49–53]. Accordingly, we interviewed multiple stakeholders in the ecosystem (see Table 2).

3.2. Data analysis

This study adopted Eisenhardt's [54] theory-driven approach of qualitative data analysis, starting with the research question definition followed by the determination of a priori constructs, transformed into questions for the interview protocol based on the theoretical foundations. We have derived the constructs from the theories described in Table 1, which contributed to developing the preliminary coding scheme. However, during the data analysis, we maintained an "intimate connection with the empirical reality" [54] to allow new relevant concepts to emerge from the data collected.

In the first phase of the study, the researchers have independently and collectively contributed to the initial coding scheme based on the objectives of the research [55]. This phase resulted in an open coding, an analytical process using the sentences and/or a paragraph as a unit of analysis to identify the concepts, their characteristics and scope [56]. Then, the coding results were compared, and, if disagreements occurred, discussions followed to improve consistency. In the second phase, and following a replication logic [44], the researchers compared the three panels' results and extracted the similarities and differences in the responses. If different opinions occurred, extant literature was re-visited, and transcripts and findings were reviewed accordingly [57]. In a third phase, we grouped the codes to create axial codes by linking the categories and sub-categories identified in the first phase. This step is the starting point for building the explanation, clarifying the research questions and identifying the main categories of blockchain technology adoption. Finally, we arrived at plausible explanations of the findings supported with examples of the most relevant quotes extracted for each code [55]. The outcomes of the coding, categorizing and selecting activities to facilitate the identification of the core constructs, the explanatory concepts and other linked variables, which were interpreted with reference to the literature.

4. Research findings

In this section, we present the findings of the interviews which are grounded in the received literature. First, we briefly present the state of blockchain technology adoption, and then we discuss the challenges associated with each type of blockchain (i.e., permissioned versus permissionnless), according to the interviewees. Last, we examine the expected value created from blockchain adoption for the ecosystem stakeholders.

4.1. State of blockchain technology adoption

Most of the organizations in the study in the public and private sectors (excluding entrepreneurs) are using or aiming to use permissioned blockchains (Ripple[1], Hyperledger Fabric, Corda and private forks of Ethereum). Permissioned blockchains allow organizations to change the rules of the ledger at their discretion, allow for cheaper transactions, provide greater privacy, and mitigate the risk of traditional consensus-based attacks (Li, n.d.). Permissioned blockchains do not have the property of being publicly open and trustless. However, according to experts in the space, the trend for the future is a move from permissioned blockchains to permisionless: "*We are moving from private to public and maybe what will happen next is a huge integration, where private blockchain will be the second layer solution on public blockchain […]*" (Ex11/Ent)[2] .

Some of our interviewees noted a dearth of successful blockchain implementations. One expert from the public sector (with a technical background) pointed to a lack of solid use cases for start-ups: *"So far, I have not come across any compelling use-case in the start-up space other than [ICOs, cryptocurrencies, rating systems and funds transfer]. Mostly start-ups seem to be in a rush to implement blockchain and have been extravagant in deploying blockchain in areas where it's either a misfit or not adding any value"* (E7/PUS).

Does this mean that blockchain is a "blue-sky" technology in search of a use case, as some have previously suggested? [58]. While there is some truth in this statement, borne out by the empirical evidence, we should note that technological trajectories of breakthrough innovations are never driven by "market pull" factors alone and, therefore, clear use cases. Such innovations are the outcome of scientific advances, economic factors, institutional variables and "Schumpeterian" companies [24], so it may take a while until blockchain use cases for the public and private sectors are clearly defined.

Overall, based on our interviews, and by the time of writing this paper, the state of technology adoption in the MENA ranges from non-adoption to planning and exploration of options, and early-stage adoption. More advanced use cases include the public sector, entrepreneurs (who work on applications on public blockchains, particularly Ethereum) and some early-stage adoption in cross-border transactions, cheque registration and trade finance.

4.2. Challenges of blockchain adoption: Technology characteristics

In this section, we address the first research question: What are the barriers and challenges to blockchain adoption? Three categories of challenges have been identified by our interviewees, particularly technological and technical, environmental (external) and organisational challenges. If the respondents highlight a clear distinction in challenges between the two types of blockchains permissioned and permissionless, it is presented and discussed.

4.2.1. Technological immaturity

Classic lifecycle theory (e.g., DOI by Rogers [28]) suggests that the evolution of any industry or product can be divided into four stages: pioneering/introduction, growth, maturity and decline. Our interviewees consider blockchain as an infant technology, at the introduction stage of its lifecycle, and adopters are concerned with its technical immaturity, regulatory risks and a lack of well-defined business models, which is hindering mass adoption. A leasing consultant in a real-estate company states "*The tech is still very new, so it may not be able to meet all the requirements that real estate players have, but it is something that has been addressed across industries*" (R4/PS). A consultant in the public sector argues: "*It is a nascent technology which is still under aggressive development, has a long way to become mature*" (E7/PUS).

These findings are consistent with academic and practitioner literature. Higginson et al.'s [59] report discusses that across its many applications, blockchain remains stuck at stage 1 in the lifecycle (with a few exceptions). The vast majority of proofs of concept (POCs) are in the pioneering stage, and few pilot projects and prototypes have demonstrated blockchain feasibility or practical applications. Likewise, in the academic literature, Wang et al. [60], based on the capability maturity

[1] From a technical standpoint, Ripple is a distributed ledger, but not a blockchain, although many assumptions underlying blockchains apply.

[2] The following acronyms denominate our respondents and their industry: PUS: public sector; PS: private sector; Ent: entrepreneur; Ex: expert; G: a respondent from the public sector, E: an entrepreneur and R: a respondent from a private industry.

model (CMM), find that blockchain technology is at stage 1 (initial stage) of adoption, described as chaotic and ad hoc. Stratopoulos and Wang [61] find that blockchain is still at the experimental stage, and its diffusion is primarily limited to the early market (innovators and early adopters).

4.2.2. Security

Even though blockchain has the potential to positively impact many industries, some applications have called into question the legitimacy of the technology, given security and privacy concerns. Interestingly, our results show that while security is a main concern related to the acceptance and adoption of public blockchains, for some interviewees, security, as a trust component, is a driver of adoption. For example, a respondent from the public sector argues that "*Because of the security part of its hashing system, blockchain technology cannot be hacked similarly as centralized systems, and therefore is a trusted source*" *(G6, PUS)*. The CEO of a venture capital platform believes that the risks of security for not using blockchain are higher than using it: "*I think you run more risks not using the blockchain than you do using it. It depends ultimately what you are using it for. The only reason to adopt the blockchain is to build a more secure way of conducting business*" (*R9, PS*).

However, some respondents (mainly from the financial industry) consider security as a barrier to permisionless blockchain adoption. A chief information security officer in a bank says: "*We are not planning for the moment to adopt blockchain for multiple reasons, to start with my own specialization, at this stage, I am talking about the technology that is evolving, like at this stage we have a couple of security concerns or cybersecurity concerns, and some business behavioural concerns as well. Security risks and the lack of guidelines by industry regulators are the current barriers to the adoption*" (R4/FI).

The literature has shown that the banking sector, in particular, is concerned with a possibility of 51% attack, where a single entity can have full control of the majority of the network's mining hash-rate and, therefore, will be able to manipulate the blockchain [13]. Smaller blockchains are especially vulnerable as a result of versioning and hard forks [13]. Moyanno and Ross [62], in their study of KYC process design, use a private distributed ledger and not a public one. The decision was based on the feedback received from finance executives who stated that banks would not be comfortable having customers' private information available on a public distributed ledger. In addition, potential bugs or reverse engineering of the smart contract code could result in exposing information unintentionally [62].

To address the security and privacy concerns, most of our respondents from the public and private sectors consider adopting a permissioned blockchain (e.g., Hyperledger Fabric and private forks of Ethereum), where only authorized people can access the ledger and therefore the data. This, however, goes against the findings of Moody's [63] financial industry report: "Private/centralized blockchains are more exposed to fraud risk because system design and administration remain concentrated with one or few parties. In addition, consensus mechanisms may not be in place or may be relatively weaker than in a public/decentralised network".

Security, as a possibility of 51% attack, hard forks and system bugs for permissionless blockchains, and a risk of fraud, centralized control, risk of data tampering and lack of consensus mechanisms for permissioned blockchains is a challenge to the adoption of the technology.

4.2.3. Data privacy

As a distributed ledger, blockchain is designed to disclose more data to other participants than traditional centralized databases, given data need to be shared among multiple peers [64]. Ecosystem actors (e.g., developers, operators, infrastructure providers) agree that overcoming privacy and confidentiality issues constitutes one of the key challenges to widespread DLT and blockchain adoption [65]. However, data privacy concerns vary depending on the type of blockchain and the nature of the privacy issue.

Data privacy, in terms of personal and sensitive data and information sharing of the network participants, is a concern to most organizations across sectors. Excessive openness of public blockchain was mentioned as a disadvantage by most of the private and public entities. A common argument against public blockchains is that participants (particularly those in highly regulated industries) will face difficulty complying with regulations. A chief information security officer in an international retail bank states: "*there is no customer privacy. For example, if … you do a transaction, everybody on blockchain will know that you did a transaction, and they will know the value of the currency you used in the transaction […] a copy of both transactions will be copied to each member device on blockchain, that's a privacy issue for the customers, which is conflicting with the current banking tradition*" (R4/FI). According to Amico [66], new technologies (e.g., advanced cryptography using zero-knowledge proofs) are being developed to allow institutions to transact on public blockchains while still protecting sensitive customer data. Public blockchains are gradually solving the issue of confidentiality, and, probably, in time, the need for private blockchains will disappear [67]. A blockchain expert and consultant states that "*The second layer solutions of public blockchains, specifically Ethereum, are focusing on solving scalability and privacy and we will be moving the most sensitive data in the coming years on the public blockchain. The new protocol called Baseline is based on Ethereum, and all the' enterprise's applications, CRM, ERP, all things related to enterprise businesses will be on … the public blockchain*" (R11/expert).

Data privacy, in terms of anonymity, confidentiality versus transparency is perceived as an enabler for the adoption of permissioned blockchain by most of our respondents. For example, a banking innovation manager points out: "*In private blockchain, there is control who sees what type of information under what circumstances, and there is control who can write that information onto the blockchain*". For corporations, anonymity is undesirable. Permissioned blockchain can provide organizations with the necessary level of data confidentiality and other essential parameters for setting up various business projects, as it requires the permission from the organization that controls access to the network and its resources. However, as transactions and access to the ledger are limited to selected nodes in the permissioned blockchain, a security risk could occur: "*Encryption is not an issue for both blockchains, but with permissioned blockchain, it is easy to roll back the ledger as it is centralized*" (R28/PS). A private distributed ledger is, in principle, set up by one party and the others are authorized. This makes the network centralized as one party ultimately controls the access and data.

Finally, data privacy in terms of consumer protection is an additional concern. With such a transformative technology, it is still unclear how to ensure whether users understand the purpose of data collection and processing, what they agree to, to whom they disclose their data, who is responsible and accountable for their data; the level of information they want to disclose and their legal rights in case of data misuse and data breaches. Data privacy and data sharing are still a challenge for all types of blockchain.

4.2.4. Cost of the technology

Using a new technology requires initial investments for both businesses and consumers, including learning costs linked to getting acquainted with the system in general and the adoption of the technology in particular.

Regardless of the type of blockchain, public sector interviewees perceive blockchain adoption costs as an investment for long-run benefits of efficiency when it comes to transactions and payments: "*If we all work together blockchain implementation would be cheap, if we don't it would be very expensive …*" (G11/PUS); and *"It's an investment, we don't call it as a cost, it's a capital investment into developing the blockchain."* (G4/PUS).

Respondents from the private sector identify the costs of blockchain adoption and implementation as a barrier. In the words of a financial director from an energy company, "*Since it is a new system for us, there are implementation costs. Starting with the new interface we are getting to use*

blockchain, the new hardware, and most importantly the new employees that we will be hiring for our IT department, who have the required knowledge, of the system" (R12/PS).

These findings are supported in the literature. For example, Ammous [68] notes that the use of Bitcoin-based blockchain in the banking sector is very costly in terms of resources. Data storage costs and computational burden on network members will grow exponentially as transaction numbers grow, so unless it is a closed network, members may not be prepared to commit the necessary resources if the financial rewards are insignificant [68]. Abadi and Brunnermeier [69] argue that it is impossible for any documentation system to be reliable, decentralized and cost-efficient at the same time. Radanovic and Likic [70] note that the adoption of blockchain in the healthcare sector will raise costs, at least in the very beginning given the implementation and electricity costs could offset any savings made by reducing the bureaucracy and boosting efficiency.

4.2.5. Scalability and performance

Performance and scalability are two key technical challenges in blockchain adoption identified by our respondents. Hileman and Rauchs [65] define performance as the output of the system, measured usually in terms of transactions per second. Scalability refers to the ability of the system to sustain performance while growing and expanding, such as increasing the number of nodes, storage requirements and the response time per transaction as the network grows.

Scalability of public blockchains, such as Bitcoin and Ethereum, is a legitimate concern across the three panels of respondents: "*[…] I don't think anyone has found a winning solution yet. There will be a few more years of research and development required for blockchain technology to come to full fruition. Many issues still exist in scalability, speed and centralization of the solutions*" (E2/Ent).

Permissioned blockchains are technically more scalable. For example, an expert in the banking sector argues that "*Ant Financial Blockchain can perform* 10,000 *transactions per second, while People Bank of China* 300,000 *transactions per second*". He also states that "*[b]eing able to add nodes on demand can provide a great advantage to the enterprise. When you distribute the nodes locally, but also have much less nodes to participate in the ledger, the performance is faster*" (E6/PS). In private, permissioned blockchain, the number of distributed nodes that add blocks to the chain is smaller, which increases performance and improve scalability.

It is worth mentioning that while scalability and performance are main barriers to mass adoption for permissionless blockchain, it is also the issue that is attracting most resources and mindshare from the developer community. The constraints of limited scalability, latency issues and query delays are likely to be of a temporary nature. Further improvements of current public blockchains may resolve them as new protocols evolve (because various solutions, such as sidechains and state channels can support off-chain transactions at a much higher frequency and only settle on-chain as necessary) [66]. As developers continue to build new solutions, scalability of public blockchains will certainly improve: "*Scalability and performance are still an issue for public blockchain, it is not a problem for private ones. That said, public blockchain has come up with second-layer solutions. The second layer solutions are focusing on scalability. These problems will be solved in the near future […] this is happening*" (Ex10/PS).

4.2.6. Interoperability

Interoperability refers to the ability of different applications and programs to exchange and make use of information [70]. Interoperability deals with connecting separate ledgers and facilitating cross-chain communication, interaction and value transfer.

Our respondents have divergent views on interoperability. Experts and respondents from the private sector are not particularly concerned, believing that this issue will be resolved in the near future. For example, a software product manager in an IT company does not see a future with one blockchain: "*I do not think we are going to be in a world where there is just one blockchain, I think we are going to have networks of networks that can communicate with one another and you have a lot of smart people working on various protocols and various implementations … all these networks all these technologies will converge, and they will all work with each other. Everyone wants to see operability between technologies*" *(R6/PS)*.

For the public sector respondents, however, interoperability between systems and among public entities is anticipated to be a challenge that will take time, skills and facilities to be resolved: "*… the main challenge is the time and let's say the facilities that we need, because not every system could be integrated with the other system. The most challenging thing will be to bring all these government entities into one chain, and this will be changing very slowly. Without a universal reach, it will be increasingly difficult to integrate into older systems*" (G12/PUS).

A lack of interoperability between different blockchain frameworks, networks and platforms, as well as between blockchain networks and legacy systems, is a significant concern acknowledged in the literature. According to Hileman and Rauchs [65], nearly, 70% of DLTs claim to be interoperable with others; however, this is mostly limited to the public Ethereum network, and Bitcoin to a lesser extent. In order to maximize the power of DLTs, agreements will need to be reached about data interoperability, policy interoperability and the effective implementation of international standards. Cosmos is a high-profile example that has launched recently on the premise that it can link together independent parallel blockchains (thus increasing interoperability), while also boosting transaction throughput using a new consensus mechanism, known as Tendermint [66]. Furthermore, an alternative new protocol, known as Baseline [67], allows the integration between existing legacy systems and existing databases on a decentralized blockchain: "*There are a number of entities out there, where the only purpose of their existence is to create interconnectivity between different type of networks. Even between legacy existing networks and blockchain networks […]. Just like the Internet today, people are using different platforms and protocols, and it makes no difference what are you using to send emails, collaborate. Nobody finds out what the other person has used. This is going to be the norm with blockchain. There are entities that are trying to make it more and more simpler. It is going to be just the norm*" (R26/PS).

4.2.7. Complexity

Our interviewees appeared to be confused about the level of complexity of the technology, most likely because it is still nascent. Some of our interviewees underestimate its complexity, regardless whether the blockchain is public or private. Respondents from the financial industry, as well as some entrepreneurs and professionals from big tech companies, believe that the technology is relatively simple: "*Blockchain is the reverse of complication. It will be easier, faster and more transparent than current systems. Actually, blockchain makes complicated procedures uncomplicated*" (*R12/, PS*). "*Blockchain is not complex at all, but it will require a lot of changes in the current policy and processes*" (*R7/FI*).

In contrast, other interviewees, mainly CEOs and government stakeholders consider the technology complex, requiring time and skills to be clearly understood: "*Blockchain initially appears complex as we have to work within the framework we implement and could be less flexible, though over time with training, we can manage the best of the system*" (*R5/FI*).

We attribute these misconceptions and confusion about the level of complexity of the technology to a lack of awareness and education, combined with an insufficient understanding of the technology and its implications at technical and business levels. Therefore, companies need to understand how to configure, design, and use blockchain technologies. Some may be tempted to adopt a wait-and-see attitude and become late adopters of blockchain.

According to Swan [71], because blockchain technology is at the intersection of several disciplines, from cryptography, computer science, to economics and game theory, even the basics are difficult to understand, both conceptually and technically. Such complexity is a barrier to effective decision-making, adoption and use of the technology, which is

consistent with received theory [e.g., 29].

4.2.8. Blockchain and tokens

Even though not always required for permissioned blockchain, public and permissionless blockchain applications entail the use of cryptocurrencies/tokens. Among our respondents, entrepreneurs, in particular, are aware of the importance of tokens in accelerating the adoption of public blockchain networks: "*They're the same thing, cryptocurrency and blockchain are completely the same things they cannot be separated, but the adoption of cryptocurrencies is in the speculation of buying other cryptocurrencies, it creates the ecosystem which creates more value to those networks to do what they do, that is the point of it. You can't have a blockchain without a cryptocurrency; you need it because it is the reward system which is in place to incentivize people buying that blockchain to do their work*" (E9/Ent).

Extant research (e.g., Cong, Li and Wang [72]; Wang [73]) corroborates this result in that accelerating the pace of public blockchain adoption by institutions is positively linked to the widespread adoption of cryptocurrencies, advocating public blockchains over private or permissioned ones.

Tokens adoption and their relation to blockchain is not a challenge for the adoption of permissioned blockchain in organizations.

4.3. Environmental and external characteristics

Our respondents identified three main challenges under environmental and external characteristics: government policy and regulations (regulatory uncertainty), network externalities/network effects and ecosystem readiness (lack of understanding by consumers, lack of awareness and education). These challenges apply to both permissioned and permissionless blockchains.

4.3.1. Regulatory uncertainty

Our interviewees across the three panels agree that regulatory uncertainty is a key challenge hindering blockchain applications and a wider adoption for both types of blockchains. Absence of legal frameworks is stifling innovation, although some countries are implementing sandboxes to bring more regulatory clarity. For example, a manager of the electronic channel department in a bank states: "*Until today, the absence of regulations and frameworks is the biggest challenge of blockchain implementation*" (R7/FI); while another respondent suggests: "*the legal concerns, for example, KYC, is not something you can do with blockchain. So this is a banking requirement that you need to know who you are dealing with. There is no framework in blockchain as of today that really regulates the right usage of blockchain.*" (R4/FI). All the panels share this point of view. The CEO of a blockchain-based start-up argues that "… *the legislative landscape is extremely outdated to deal with anything blockchain-related. This is a big hindrance as you cannot be compliant with laws that do not yet exist or are far outdated. Regulators need to clarify compliance and acceptability requirements*" (E2/Ent). "*Regulations are necessary for any misuse of data, a hack of data and access to data*" (R26/PS).

In the context of blockchain regulations, many challenges remain unexplained. Jamison and Tariq [74] argue that regulators need to consider: (i) blockchain's strategic potential, rather than technical issues, (ii) the use of the technology by regulators and industry, (iii) the automation of transactions with the use of smart contracts, (iv) the opportunities offered by blockchain for artificial intelligence and (v) the change offered by blockchain in shaping businesses. Janssen et al. [10] submit that the technology, by definition, is not the subject of regulation. Instead, it is the different uses of the technology itself which may call for regulatory oversight. Laws and regulations can influence how fast the technology could develop. Regulator attitudes to blockchain technology are generally positive. However, given the cross-border nature of the technology, an agreement on international regulatory principles and cooperation among regulators is needed. Generally, the TOE framework [30] emphasizes the role of the external environment, such as government regulations and infrastructure, in influencing technology adoption decisions.

4.3.2. Network effects and inter-organizational connectedness

User-base externalities (a.k.a. demand-side economies of scale, or network effects) have been recognized as one of the defining features of P2P platforms, sharing economy and various decentralized systems. As more individuals join the platform, they enjoy more surplus by interacting with other users because it is easier to find a trade partner [72]. Our interviewees understand the importance of universal acceptability, and a large user-base of stakeholders involved in the adoption of blockchain, both to support the definition of standard and protocols and to leverage network effects. An administrator in a public institution explains: "*All the entities have to come on the blockchain, which means today some of the government entities are doing their own pilots and the banks are doing their own pilots … till you have all of them together the scale cannot be achieved*" (G1/PUS).

The interviewees discussed the importance of multiple stakeholders being involved in the adoption of blockchain, both to support the definition of standards and protocols, and to leverage network effects and technology benefits. According to one entrepreneur, "*Various public-private stakeholders [should work together through consortiums] to determine the appropriate standards, protocols, protecting privacy using blockchain*" (E1/Ent). While discussing permissioned blockchains, an expert in a big technology company argues for the importance of network effect to benefit from the technology: "*The network that you participate in needs to be outside your geography, your own control, and needs to have multiple entities and industries that participate to it. Only then it will be worthwhile, and you will start getting the benefit of the technology*" (R25/PS).

Frambach and Schillewaert [75] and Greenhalgh et al. [76] have found that during the adoption phase, informal inter-organizational networks and general interconnectedness among organizations are positively associated with the adoption of innovations. Universal acceptability and collaboration for a technology subject to strong network effects [72] is seen as a considerable challenge by our interviewees.

Two approaches to tackle the challenges of collaboration were identified by our interviewees: (i) public–private partnerships (PPP) and (ii) identification of new opportunities for start-ups. As blockchain projects are multidisciplinary and involve government, developers, financial actors, start-ups, regulators, accountants, audit companies and consultants [77], our interviewees perceive such collaboration as the main ingredient of successful adoption: "*[Blockchain initiatives] will only be successful if everyone comes into this. Government* […], *banks* […], *people* […], *[and] authorities* […] *should come*" (R1/PUS).

4.3.3. Ecosystem readiness

Our interviewees suggest that there is a lack of awareness, education and understanding about the benefits and applicability of blockchain among the ecosystem stakeholders. As stated by a portfolio manager: "*Until blockchain is broadly understood and recognized it would be hard to adopt it. People need to understand and accept it on a broader scale before it can be compared to our existing systems*" (R6, FI).

Our respondents point to educating ecosystem stakeholders about the implications of blockchain for business and society as being critical for the implementation of new solutions and for acquiring new customers: "*My first action was to try and educate the maximum of people. As long as the people that understand the potentials of blockchain are a minority, entrepreneurs will be facing struggles in implementing their solutions and acquiring new customers. By understanding the technology, I refer here to the implications blockchain might have on society and business and not its technical specifications*" (E8/Ent).

Indeed, misconceptions regarding the technology need to be addressed to reveal its value-creation potential [78,79]. There is a gap regarding how and where blockchain is effectively applicable, and its practical effects and value [9], which requires a broad-based education

of the ecosystem stakeholders. Knowledge related to business models, technical aspects and governance of blockchain technology is essential not only to better understand the technology per se, but also for its implementation. Most of the interviewees highlighted the need to better comprehend the technology in order to support regulation, define standards, protect citizens' rights and accelerate the adoption. To support capabilities development, it is necessary to create training programs, consortia and pilot projects involving different players. According to Angelis and de Silva [78], this could optimize the use of resources and ensure that the technology provides tangible benefits.

4.4. Organizational challenges

Our research has singled out three main organizational barriers to blockchain adoption: governance and leadership readiness, business model alignment with blockchain and organization readiness (i.e., absorptive capacity, skills and funding).

4.4.1. Governance and leadership readiness

Organizational leadership, particularly in championing innovations, is crucial for technology adoption. Different theoretical frameworks [e.g., [80,81]] identify leadership (CEO's influence, opinion leadership and top management support) as a key factor critical to the adoption of innovations. Although some studies [e.g., [82]] have found that positional power and job tenure of the IS department leader are negatively related to the organizational adoption of innovations, our interviewees point to the importance of leadership for the adoption of blockchain.

Holotiuk and Moorman [83] show that a lack of top management knowledge of blockchain is hindering its adoption. Similarly, our respondents, particularly from the public sector, appear to misunderstand the technical and strategic value of blockchain technology. At the same time, experts have stressed the importance of well-informed top management and innovative leadership mindset for increasing the pace of the adoption. For example, a CEO of a technology solutions company argues that "*Corporate governance, DLT knowledge and a mindset that focuses on process workflow improvement are needed to accelerate the adoption*" (E4/Ent). Another expert states that "*It took us 5 months to put the technology together and it took 6 months to actually convince people who participate in it at what the governance structure should be, so the biggest challenge is the human change management, and this has nothing to do with the type of technology, permissioned or permissionless, although with permissionless blockchain, you actually will run into bigger challenges because the network will be open*" (R26/PS).

According to Olnes et al. [84], blockchain needs to be governed, but it is also a governance instrument in itself. Appropriate governance frameworks related to the liabilities of respective parties, the applicability of law in case of disputes, decisions of authorized participants on the network, mitigation of market manipulation and unfair practices should all be clarified to ensure blockchain adoption [10]. As the technology involves new regulations, acquisition and integration of new resources, re-engineering of transactions and systems, development of new skills and competencies, governance, top-management support and vision all play a crucial role in blockchain adoption [85,10].

4.4.2. Business model alignment

Our interviewees from the private and public sectors lack clarity on how blockchain technology can be integrated within their existing business models and legacy systems. Blockchain may not be a good fit with traditional business models and processes, as mentioned by one respondent: "*Current bureaucratic processes and mindset are major hurdles in rethinking these processes in a decentralized manner*" (E7/PUS). According to Janssen et al. [10], there is a dearth of understanding among business, consumers and authorities regarding the potential use-cases for blockchain, the ways it operates and what the technology can do, confirmed by our respondents, as this quote illustrates: "*The major challenge while adopting not only blockchain but any technology is to identify your purpose and your reasons for adopting such technology*" (R6/PS). One respondent mentions the need to adopt a new business model when integrating blockchain: "*You have to think about adopting a new business model, you have to think about adopting a totally new ways of doing business. Your processes will change, your activities will change, and you will need to retrain your people if you want to avoid the noises, you have to work with entities that are ready to be experimental. You need to ask yourself is blockchain useful for you, if not, maybe you don't need a blockchain*" (R26/PS)

The experts and entrepreneurs have a better understanding of the nature of the innovation enabled by blockchain and are seeking opportunities associated with building start-ups that consider the design properties of the technology, particularly disintermediation, decentralization and openness. In contrast, the incumbents in the private and public sectors are sacrificing some of the characteristics of the technology and trying to integrate it with their existing legacy IT systems and processes, for reputational reasons and ROI before investing: "*Governments and enterprises need to find ROI before they invest into new technology. I think governments/established companies are investing in blockchain for two main reasons: The first is future returns (investing in amazon early on proved to be lucrative), and the second is to learn. They will only learn once they test out blockchain-based systems, but these are obviously done in phases, as an established business/government cannot risk moving fully on-chain and becoming totally decentralized, especially when the tech is not mature yet*" (E3/Ent).

Baden-Fuller and Haefliger [77] show that business models can be regarded as crucial moderators of the link between new technology development and business success, which explains why an innovative technology may lead to either success or failure. Differences in perceived benefits and use-cases expected from blockchain adoption across the panels reflect the different economics of the underlying business models (e.g., permissioned versus permissionless). Nowinski and Kozma [16] argue that blockchain technology may be one of the drivers of business model innovation, as it may disrupt business models via authenticating traded goods, disintermediation and lowering transaction costs.

4.4.3. Organizational readiness

Organizational readiness is conceptualized as the availability of specific organizational resources to adopt new IT innovations [81,86,87], including human resources, and financial and infrastructure aspects. It is also described as an organization's absorptive capacity, or the capacity to utilize innovative and existing knowledge, which has been found to be associated with the adoption of innovations [81].

Our interviewees from all sectors and panels were markedly in agreement regarding the skills, competencies and talents in the organization as a crucial challenge for adoption: "*The biggest challenge for any organization is going to be the people having to accept and adopt this new technology that is still unfamiliar to them, so they will be very hesitant to do so. We will need to re-introduce or hire new employees that are more familiar with the system, or to teach the already existing ones how to use it, as it is very complicated and complex*" (R2/FI).

Seed funding and financing have been stated as a challenge mainly for entrepreneurs, as this quote by the founder and CEO of a digital cooperative illustrates: "*The main challenges remain pretty much the same that any company faces when we talk about the entrepreneurial ecosystem and environment in the region. Funding and the inflexibility of regulations towards new technologies remain the biggest challenge*" (E9/Ent).

Existing theoretical research suggests that organizational readiness has a significant influence on the adoption of blockchain technology [81,71,60]. Our empirical results confirm that insufficient organizational readiness in terms of the availability of financial and human capital resources and knowledge is a challenge to blockchain adoption.

The challenges across the different panels are summarized in Appendix 3.

4.5. Ecosystem value creation from blockchain adoption

In this section, we address the second research question by examining the expected value created by blockchain for the stakeholders in the blockchain ecosystem, according to our interviewees.

4.5.1. Organizations and industries

Our results on the expected value of blockchain adoption in the public and private sectors and start-ups are presented in Table 3, highlighting a wide range of benefits. Our respondents appeared to take a pragmatic stance when discussing the value of blockchain adoption: business process improvements (including cost reduction, standardization, increased efficiency and transparency, eliminating errors, fraud, duplication and waste) were the most frequently cited benefits across the sectors and by all respondents, as illustrated by these quotes: "*Even though many companies are following the hype, the main reasons for an established organization to invest in blockchain are related to the fact that it can improve its processes on one side and their customer's experience on the other. Indeed, being distributed and automated, blockchains are able to automate a lot of processes, therefore making it sometimes faster and with lower costs. These same consequences could result in a better service offered to their customers in terms of quality, speed, reliability but also in financial gains*" (E8/Ent). The "hype" rationale for blockchain adoption is entirely consistent with the basic premise of institutional isomorphism [46,47].

Other reasons included a change in organizational processes, such as decentralization of decision-making, a shift in mindset (i.e., blockchain will allow established companies and governments to re-think their internal and external process flows) and developing new technological capabilities. In the words of one respondent: "*At the moment, no government or established company will fully migrate to a blockchain based system. The current benefit of adopting a blockchain-based system is mainly to develop in-house capabilities so that when the tech is mature, they already have experience*" (R8/PS).

Our findings are at odds with Tapscott and Tapscott [6], who claim that blockchain will have a transformational effect on business, including reinventing financial services, redefining organisational boundaries and enabling new business models (e.g., open networked enterprises). They are consistent with the more pragmatic analysis of blockchain's strategic business value by Carson et al. [88], which suggests that in the short term, the value of blockchain implementation in enterprises is cost reduction, rather than disintermediation or disrupting existing business models. Other research [e.g., 20,19,89] also supports Carson et al.'s conclusion. A more recent study by Higginson et al. [59] documents emerging doubts among industry leaders: despite billions of dollars of investment, blockchain has not yet become the game changer it was purported to be. Many of our respondents, while enthusiastic about blockchain's potential, did not seem to perceive it revolutionary either, at least not as yet.

Table 3
The expected value of blockchain adoption

Public Sector (permissioned / consortium)	Private sector (permissioned / consortium)	Start-ups (permissionless)
Championship of innovation	Industry leadership / being first to market	New opportunities and experimentation
Expectations of ROI	Expectations of ROI	No expectations of ROI
Business process improvements – improvement in processes, eliminating errors, standardization, better services for citizens, reliable and better information sharing between institutions, lower costs, faster services, 24/7/365 days a year services	Business process improvements – efficiency, cost, reduction, transparency, data sharing, efficient decision-making, standardization and automation	New industries / new business models / disruption of the status quo / "killing centralized platforms"
Improving customer experience	Improving customer experience	Agility
Data security / trust	Data security	Data control / privacy
	Learning – developing new capabilities	ICOs and STOs as a fundraising vehicle
Business mindset change	Business mindset change	
Tokenization of government services	Coordination	Decentralization
Coordination / interconnectedness / partnerships		Disintermediation
Shared benefits for the ecosystem		New business models

4.5.2. Public sector

One of our interviewees provided a detailed justification for why governments across the world are adopting blockchain: "*Governments are tasked with facilitating transparency especially in governance, distribution of resources and achieving greater efficiencies among other things. For these reasons, the governments of many countries have expressed interest in the technology. There's a lot of pressure on governments and large corporations to optimize their operations and business processes to be more efficient, cost-effective and competitive to sustain growth. They are looking to exploit emerging tech such as blockchain to achieve these objectives*" (E7/PUS).

We note many similarities between the public and private sectors – which was also reported by our respondents – especially in terms of efficiencies: "*… benefits are the same for blockchain in the private and public sector. Any organization whether small or large using Blockchain as a foundational platform for their solutions and services may benefit from the increased efficiency, trust, accountability, openness and fairness in their products and services*" (G1/ PUS).

The three broad types of business problems that blockchain can solve in the public sector include coordination failures, horizontal integration and decentralization, and our respondents explicitly mentioned at least two of those (coordination and decentralization). Prior research has identified additional benefits: eliminating taxation fraud [90]; maintaining accurate public health records [70] and increasing information security and trust [91] and, more generally, public services efficiency [8]. Data security and improving customer experience were seen as benefits by our respondents, and it is noteworthy that a change in mindset was also cited as a benefit. A number of respondents emphasised the shared benefits of blockchain adoption for the ecosystem at large, and not just for their own organisation.

4.5.3. Start-ups

Unlike the public and private sector entities, start-ups do not try to re-configure their existing business processes around blockchain technology; they build their ventures on blockchain from the start. It is not surprising, then, that start-ups are embracing very different business models – public blockchains where cryptocurrencies (tokens) play a central role in delivering digital services over the internet, aligning the participants' incentives and enabling new governance forms.

In stark contrast to the "business as usual" model for the private sector (i.e., focussed mostly on greater efficiencies), start-ups look for new opportunities to create new industries, disrupt the status quo and experiment with the technology. The following quote from a CEO of a blockchain start-up illustrates the difference: "[*the benefits for startups are]* 100% *different. Founders of blockchain companies are mainly looking to experiment with blockchains from a development point of view. There is a lot more experimentation which naturally means lots of failures*" (E3/Ent).

A recent survey of emerging disruptors, some of them pre-revenue start-ups [92], supports our key finding – start-ups are developing new business models and are less constrained by challenges, such as legacy systems in established enterprises that inhibit adoption, making them more fluid and agile. These disruptors tend to be more advanced in their deployment of blockchain and in designing and implementing novel

solutions to leverage blockchain's potential. Emerging disruptors are pioneers in blockchain exploration and experimentation. Hence they play an important role in the broader ecosystem: they are the first to identify and test viable solutions that enterprises and governments may adopt later on a larger scale. This symbiosis drives continued blockchain innovation, according to Pawczuk et al. [92].

The similarities and differences of expected value, emerging from the interviews between the three sectors, are presented below in Table 3.

4.5.4. End-users and society

According to our respondents, end-users are expected to reap economic, financial and social benefits from more efficient transactions (e.g., fast and inexpensive payments), increased transparency, verifiability and accuracy of the information, and ability to control own data and identity.

Our respondents are confident that blockchain will re-shape the future of the global society, open up new economic opportunities, will have an impact on the jobs market (both positive and negative), ensure financial and social inclusion and accelerate genuine P2P economies: "*[Implications] will be huge. DLT will be a bigger change to the entire society than the internet. DLT will kill centralized platforms. It will give the control of our own data back to people from these centralized online companies*" (R10/PS).

There is also an expectation that blockchain adoption will re-define citizens-governments interactions while reducing power abuse and corruption: "*On a social and institutional level, blockchain technology will without doubt dramatically improve the way citizens interact with their governments and public institutions. The concept of the administration as a venue will definitely be disrupted to the benefit of a digital administration that would be accessible and open 24/7/365 days a year for its citizens*" (E8/Ent).

Permissioned and permissionless blockchain expected socio-economic benefits are far-reaching, from crime and fraud-fighting, transparency, control and data empowerment, efficient and faster services, new economic opportunities, better entrepreneurship opportunities to financial and social inclusion [e.g., [8]]. We believe that they require more attention and in-depth analysis from a multidisciplinary perspective.

5. Blockchain technology adoption framework

Based on the results of the analysis and our theoretical positioning, we propose a conceptual framework (Fig. 1), which brings together the environmental, organizational and technological challenges of blockchain adoption and the socio-economic expected value from the perspective of main stakeholders in the ecosystem (i.e., private organizations, end-users and society, public sector and start-ups and entrepreneurs). This framework reinforces the mutual interactions between the dimensions observed: (1) a challenge that is not addressed will have an effect on the other challenges and consequently on the adoption and (2) the expected value created for one stakeholder will consolidate the benefits for the other stakeholders.

This framework has emerged as a result of an iterative cycling back and forth between the literature review on blockchain and blockchain adoption, the theoretical background, as well as concepts emerging from the data analysis. These concepts are related explicitly to the blockchain technology features (e.g., scalability, interoperability, security and privacy), the role of PPPs in fostering adoption, and externalities/network effects (which are common in decentralized systems). Furthermore, the framework considers broader socio-economic benefits of the adoption for ecosystem stakeholders.

The proposed framework distinguishes between the challenges and the expected value for each type of blockchain (permissioned and permissionless). Based on the evidence from our data, two challenges are

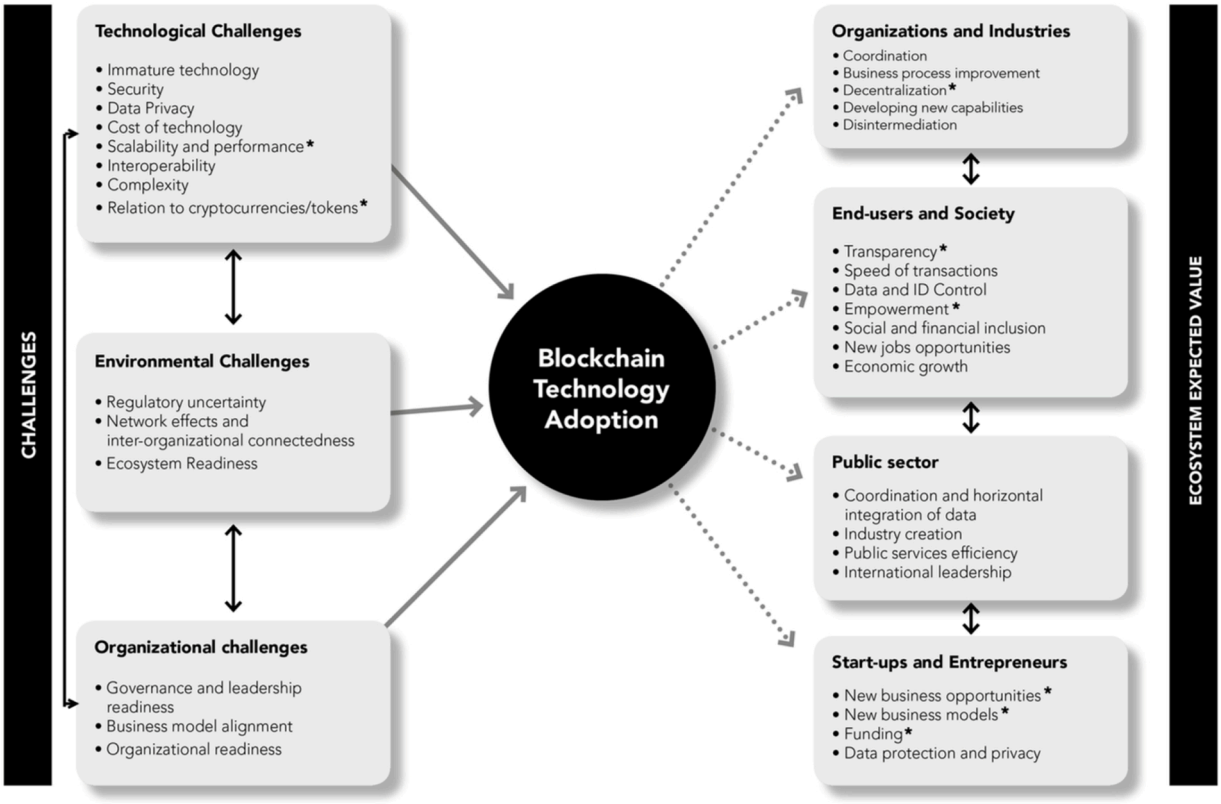


Fig. 1. Conceptual framework of blockchain technology adoption

identified as specific to permissionless blockchains, namely: scalability and performance and relation to tokens. Decentralization of organizations, transparency of data, empowerment of end-users and societies, radical, innovative business models, business opportunities and funding of start-ups are the expected benefits exclusively for permissionless / public blockchain.

Our conceptual framework contributes to the received literature by (a) confirming constructs in existing theoretical approaches of innovation adoption, and (b) identifying new theoretical constructs that advance our understanding of blockchain adoption. This contribution is discussed in the next section.

6. Discussion and implications

In their recent paper, Janssen et al. [10], have proposed the first comprehensive conceptual framework of blockchain adoption integrating change process, institutional, market and technology factors. Other influential studies [e.g., 65,60,8,4,3] have added to the knowledge of the various facets of adoption. Our paper extends this body of work based on qualitative empirical data from multiple industry sectors while adopting an ecosystem perspective. This approach allows researchers to glean useful insights into the nature of blockchain adoption and develop an empirically grounded framework. This section summarizes our main findings and discusses their theoretical and practical implications.

Despite the amounts of investments and the hype that surrounded blockchain in the last years, only few use cases in our study have called for blockchain (Li, n.d.; 19, 93], confirming Higginson et al.'s [59] and Pawczuk et al.'s [92] conclusions. It would seem that at least some of use cases of blockchain adoption so far have been driven by mimetic pressures, rather than an estimate of costs and benefits of the technology [39,41]. From a strategic point of view, we concur with Felin and Lakhani [17] that companies need to better understand how to configure and design blockchain solutions in unique ways (i.e., not widely available to competitors) while taking into account their capabilities and the problems they can solve for their stakeholders. An alternative interpretation of our results is that private sector organizations are well aware of the inherent market and technological uncertainty of blockchain, and so expect future technological improvements before committing to implementation, which leads to a slower rate of adoption [see, e.g., 37,33].

With respect to the first question (i.e., what are the barriers to, and challenges of blockchain technology adoption), our results show that despite an interest in adopting blockchain and the perception of value creation, our interviewees have openly discussed technological, environmental and organizational challenges that need to be overcome before the real value of the technology is realized. The decision to adopt blockchain is not merely a technological one; it is also a business decision that requires leadership at the micro- and macro-levels, and an innovative organizational mindset, and a set of contextual and environmental conditions that favour adoption. Given blockchain's "foundational" nature and societal impact (e.g., transparency and decentralization of data, empowerment of end-users, democratization of data, economic growth and efficiency) [e.g., [8]], it is vital that all stakeholders in the blockchain ecosystem participate in fostering adoption. Because the public sector and the government play a crucial role in cultivating an ecosystem of partners for the adoption of a foundational technology such as blockchain [e.g., [94]], they, as the results of our study show, can meaningfully support the adoption of blockchain. The latter can be done by being itself a user of the technology, a service provider of technological capabilities and solutions to citizens and businesses, a regulatory framework provider and a facilitator of new businesses. Blockchain as a foundational technology could be paralleled with the Internet at its beginning, where the public sector was the leader in the adoption, before allowing commercial use of the technology [94]. Olnes et al. [84] advocate for a shift from a technology-driven approach to a needs-driven approach, in which blockchain systems are customized to fit the requirements of administrative processes. Therefore, administrative processes should change to benefit from the technology.

Blockchain features (i.e., decentralization and disintermediation) represent new legal challenges. More flexibility, clarity and responsiveness in terms of regulations and taxation could impact how fast the technology develops and diffuses. Consortia, sandboxes, various actors and their collaborative initiatives to determine the appropriate standards, procedures, frameworks, protocols and formal policies will help in building the ecosystem and accelerating technology adoption. With the transformation blockchain technology is bringing to industries, entrepreneurs and end-users, legislators need to understand its potential, by clarifying compliance and regulations for entrepreneurs and businesses.

While permissioned and permissionless blockchains share similarities in challenges and expected value, our results have shown that most of the private and public institutions in the study are experimenting or adopting a private blockchain, while moving in future towards a permissionless blockchain. Permissioned blockchains make it difficult for enterprises to transact with a large network. However, on a public blockchain, just like on the public Internet, companies can easily interact with each other, provided that privacy, security and scalability and all other technical challenges identified by interviewees are resolved. E&Y's Global Blockchain Summit [95] explicitly points out that the future of B2B transactions is private, secure and regulatory compliant smart contracts on public blockchains.

Our research has shown similarities in challenges between incumbents from the private and public sectors (see Appendix 3). The most obvious differences are between the established organizations and start-ups. These differences can be explained by the type of blockchain adopted – permissioned blockchain for the private and public sectors, and permissionless blockchain in start-ups. ROI, horizontal integration of data, coordination between different organizational units and departments, and cost reduction were the main benefits expected by both public and private institutions. On the other hand, creation of innovative business models and application of the characteristics of blockchain (e.g., decentralization, openness and disintermediation) to new ideas, were the benefits expected by entrepreneurs and start-up founders.

The second research question sought to address the expected value of blockchain adoption for the ecosystem of stakeholders. Our interviewees have shown tremendous enthusiasm regarding blockchain value, believing that blockchain technology can solve a gamut of problems ranging from financial inclusion of the unbanked and access to financing for start-ups to solving supply chain issues, reducing operating costs for businesses, and cutting out intermediaries, supporting the literature [8; 70, 90].

Specifically, our results suggest that established companies in the private and public sectors using permissioned blockchains are more concerned with cost efficiencies, at least at this early stage of adoption [cf. 59]. By contrast, start-ups, free from constraints of legacy systems, are working on permissionless (public) blockchains and are actively experimenting with innovative business models. We label these different economic models "better ledgers" (for established enterprises and governments) versus "novel crypto-networks" (for start-ups). In the former case, a transformational technology (blockchain) is applied in an enterprise setting to solve business problems in a traditional way (mainly for cutting costs) while sacrificing some of the design properties (particularly trust, disintermediation, decentralization and openness) for privacy, speed and scalability. A crypto-network is an entirely new organizational model – in effect, a mini-economy – powered by tokens [96,97]. As mentioned previously, tokens are central to the functioning of the permissionless networks as they ensure incentive alignment of all stakeholders (developers, validators, users, investors, etc.) [96]. We hypothesize that only those digital services which thrive off decentralization will successfully organize and incentivize human activity using this new architecture.

Our conceptual framework confirms constructs from DOI theory as well as from the TOE framework. The findings demonstrate that the complexity of the technology, its (lack of) compatibility with existing business models, with legacy systems and existing skills, as well as the perception of relative advantage determine the adoption of blockchain. The latter is the degree to which blockchain is perceived as being better than previous technologies in term of efficiencies, speed, transparency, decentralization, disintermediation and immutability, among others. Our results are consistent with Rogers [28] in that perceived attributes of the innovation (complexity, relative advantage and compatibility) explain the rate of adoption of innovation. The observability and trialability attributes of innovation are not included in our model, as they are not relevant in the context of blockchain technology. The DOI theory proposes top management support in the organizational context as a driver for innovation adoption, which is consistent with our results and is included under governance and leadership readiness.

Additionally, our conceptual framework emphasizes the role of the external environment in fostering blockchain adoption, supporting the TOE model [30]. Although some characteristics are specific to blockchain technology, they support the technological context of the TOE model (i.e., characteristics of the technologies available for possible adoption by an organization). Our framework neglects the organization's characteristics in the TOE model, such as size, structure and presence of innovation. Organizational constructs in our framework that differ from the ones in the TOE model are specifically, business model alignment, and governance and leadership readiness. These dimensions interact with the environmental and technological constructs to influence technology adoption decisions.

The construct "network effects and inter-organizational connectedness" is in concordance with the network externalities theory which states that technology adoption is particularly challenging for technologies with network externalities/network effects [32], as externalities play an important role in adoption decisions. Adoption rates of such technologies may be sub-optimal and slow if some critical mass users are not reached, and even small inefficiencies can have massive consequences for consumer welfare [98]. When, however, the inflection point is reached, technology take-off and adoption follow an exponential trajectory as network effects unfold [99]. Blockchains, particularly the permissionless type, are subject to both direct and indirect network effects, with the utility of the network increasing as more distinct user groups (e.g., scientists, entrepreneurs, developers, investors) join the network.

To our knowledge, our framework is the first to address simultaneously both the challenges and the socio-economic value of adopting permissioned and permissionless blockchains at the ecosystem level. One of the critical insights that emerged during the interviews related to the value of the technology is the expectation of cost efficiency in organizations and governments versus business model innovation in start-ups. We propose that the societal value of innovative business models (crypto-networks) based on public blockchains – which are as much organizational innovations as they are technological ones – is likely to be disproportionately higher than cost efficiencies. These benefits will eventually spill over to the blockchain ecosystem.

The conceptual framework can be used by policymakers and organizations to develop policies and strategies to face the challenges, accelerate the adoption and create value. When the benefits of the new technology are uncertain or not well understood, adoption is likely to be slow. To speed up adoption, changes are required at the organizational level (e.g., in business processes and governance mechanisms); the environmental level (particularly related to regulation) as well as at the technological level (e.g., further research and development of solutions for interoperability and scalability). The framework highlights the need to understand the technological, organizational and environmental aspects which shape the way blockchain applications can be adopted and how this might create value for each of the ecosystem stakeholders while differentiating between permissioned and permissionless blockchains. Companies, start-ups, public actors and industries need to work together to define standards and share knowledge and experience for advancing the blockchain and stay ahead of the technology curve to accelerate adoption.

7. Conclusions, limitations and further research

Blockchain technology as a foundational innovation is among the most trending technologies attracting a lot of interest from academic and practitioner communities.

Our paper investigates the challenges and the expected value of blockchain adoption based on a qualitative research design and primary data collected from different actors in the blockchain ecosystem. While the framework contributes to explaining the adoption of blockchain, it remains contingent on the adoption context. A replication of the study in different settings and contexts represents a future research direction. Future research could also consider validating the framework using a quantitative research design.

In our research, we did not limit the focus to the organizational-level of adoption, and we expand the investigation to encompass an ecosystem perspective. We have included senior managers from various industry sectors, entrepreneurs of blockchain start-ups, consultants, lawyers, experts and public servants responsible for public policy and blockchain implementation within their departments. While this stakeholder set is considerably more inclusive than is common in extant research, it is nevertheless not exhaustive. Specifically, further research could investigate the role of investors, traders and speculators, miners/validators and other early users (e.g., of decentralized apps) in blockchain adoption. Further, the Gartner's hype cycle suggests that empirical research done too early in the hype cycle is likely to have a biased sample of companies, which may generate biased findings, because of sample characteristics. We invite researchers to follow the technology and continue investigating its challenges and value through the entire hype cycle.

Relatedly, our findings on the expected value of blockchain adoption suggest that one potential research direction could be rigorous academic studies of crypto-networks because they are a notable organizational innovation and a new model for providing internet-based digital services. Likewise, the measure of tangible and concrete benefits of blockchain adoption for each actor in the ecosystem could be of great interest in future research.

Although our paper offers a cross-sectoral analysis of the challenges and barriers to blockchain adoption, industry characteristics and market structure were not explicitly addressed. Moreover, we have excluded the impact of organizational size, which has a significant impact on the decision to adopt innovations [e.g., [100,101]], from the scope of this research. We invite researchers to investigate these factors and consider testing the weight of each challenge by industry, by type of blockchain technology or by stakeholder. Pawczuk et al.'s [92] report shows that legacy systems, regulatory issues and potential security threats are the main barriers to the adoption from the organizations' perspective. A quantitative research that compares the weight and magnitude of the effect of each challenge on the adoption by industry and across industries would be of value. The consumers' level of adoption, trust and acceptance of blockchain applications would also be a promising area for future research.

This study produced several useful insights, which would be of interest to academics, practitioners and policymakers. We hope that further research will extend our empirical work on blockchain adoption to duly acknowledge the technology's foundational nature.

Authorship contributions

Category 1

Conception and design of study: ET Toufaily; TZ Zalan; SBD Ben Dhaou

acquisition of data: ET Toufaily; TZ Zalan; SBD Ben Dhaou

analysis and/or interpretation of data: ET Toufaily; TZ Zalan; SBD Ben Dhaou

Category 2

Drafting the manuscript: ET Toufaily; TZ Zalan; SBD Ben Dhaou

revising the manuscript critically for important intellectual content: ET Toufaily; TZ Zalan; SBD Ben Dhaou

Category 3

Approval of the version of the manuscript to be published (the names of all authors must be listed):

ET Toufaily; TZ Zalan; SBD Ben Dhaou

Appendix 1 – Differences between public and private blockchains

Public blockchains (such as Bitcoin, Ethereum and Tezos) are open source (anyone can contribute a piece of code), decentralized, forkable and open to all participants. Anyone can join the network and run a node to provide a network service, such as transaction validation, read the database and participate in the consensus process [102]. Cryptocurrencies – also known as tokens and crypto assets – are the internal currency of public blockchains. Tokens align the incentives of the participants to work toward a common goal (growth of the network and appreciation of the token) and overcome the bootstrapping problem that hinders network development. To ensure a healthy functioning of the network, cryptocurrencies must be widely distributed amongst network participants [17]. Cryptocurrencies or tokens are important as a consensus mechanism on a public blockchain and are used as incentives to confirm transactions and adding new blocks to the chain.

In permissioned blockchains – including consortium blockchains (e.g., Ripple, Hyperledger Fabric) and private blockchains (e.g., Chain, JP Morgan Quorum) – the consensus process is restricted to a pre-selected set of nodes. In private blockchains, the write permissions are kept centralized to one organization, while read permissions may be open to the public or restricted to an arbitrary extent [102]. Permissioned blockchains do not require a token/cryptocurrency as an incentive mechanism. Enterprises and governments using permissioned blockchains typically start with open-source blockchain innovations and adapt them to their needs.

Appendix 2 Overview of the research streams on blockchain adoption

To better synthesize the current state of knowledge on blockchain technology adoption, a systematic approach to identify salient research articles on the topic of blockchain adoption has been used from two primary sources of data: (1) ABI Inform database for peer-reviewed articles and (2) SSRN (given the recency of the phenomenon under investigation, unpublished articles and papers in progress from SSRN we included). We searched the databases using keywords in the paper titles and abstracts, such as blockchain, DLT, adoption, use, implementation, as well as for cryptocurrencies in conjunction with adoption, use and implementation (for public/permissionless blockchains). In total, 378 peer-reviewed papers from ABI Inform database were identified with these keywords, with 45 articles overlapping. From the SSRN database, we identified 133 papers.

After reading abstracts and scanning the entire content of each paper, we have excluded technical papers, legal papers and those that are not related to the adoption, even though the keywords were mentioned in the title and/or the abstract. Besides, we excluded papers that overlapped between the SSRN and ABI Inform database. The end result of this selection process was 64 papers. These papers were summarized and categorized according to the objective or the research statement of the study, methodology, theoretical foundation, unit of analysis, primary versus secondary data, country and industry of the study as well the key findings. These summaries enabled us to identify nine streams of research related to blockchain adoption.

	Research streams #	Key insights	Representative studies
1	Challenges, barriers and benefits by industry sectors	Main benefits include: efficiency, new opportunities, increased transparency and accountability, securing finance to SME, facilitating consumers' purchase decisions, reducing transaction and monitoring costs, improving real-time data collection and analysis possibilities, and expanding participation opportunities for currently vulnerable, excluded, and underserved populations. The main challenges in the literature are risk of the technology (e.g., complexity, scalability), infrastructure requirements, lack of user-friendliness for Dapp adoption, regulatory uncertainty, scepticism of early decision-makers, the lack of required and new competencies.	[88,103,8,104,105]; [106–108]
2	Data protection, sharing, security and privacy	Some authors are optimistic about blockchain's ability to guarantee privacy and security of shared data and transactions; others are more sceptical. Very few papers examine the impact of blockchain's security and privacy features on adoption.	[20,18,91,109],
3	Socio-economic implications and macro-consequences of blockchain adoption	The implications are discussed under broad rubrics of financial impact (e.g., reducing the possibility of data falsification and manipulation), monetary system impact (e.g., currency competition), economic impact (e.g., cost efficiencies, enhancing entrepreneurship), social impact (e.g., increasing access to financial services for the unbanked, fighting poverty) and institutional impact (e.g., decentralized governance, de-hierarchization of organizations).	[21,8,110],
4	Impact of blockchain on business models and governance	The focus is on how blockchain will change organisations and ecosystems, by leading to innovative new business models (e.g., automated money, autonomous economic agents, DAOs), reaching new customers, increasing efficiency and transparency, decentralized governance.	[107,16,17]
5	Environmental factors, government and ecosystem role in blockchain adoption	This research stream considers the context, use-cases, the ecosystem and the environmental level variables for the adoption. Authors in this research stream advocate for an ecosystem creation inclusive of all stakeholders to facilitate blockchain-enabled economy and overcome barriers to innovation	[84,90,8]
6	Applications and use cases of blockchain adoption	Proposing prototypes, frameworks, models systems for adoption in specific use-cases, such as supply chain management for products and food traceability; in the motor industry for ownership, in healthcare for medical records, in the financial industry for KYC and payments, in insurance, transportation, among other industries and applications.	[103,111,62,112,113]
7	Factors affecting adoption	Blockchain adoption is driven by different factors and is industry-specific. For example, in supply chain management adoption is driven by the security of transactions, rapid processing, transparency, traceability of product origins and processes. In urban development, factors such as	[102,114,22]

(*continued on next page*)

(*continued*)

	Research streams #	Key insights	Representative studies
		decentralization, disruptive approach, the immutability of accountability are the factors affecting adoption	
8	State of blockchain adoption	Prediction of the stage and rate of the adoption of blockchain, based on secondary data analysis, web analysis, technology maturity model analysis and the diffusion of innovation stage. Researchers agree on the introductory, experimental and infant stage of the adoption.	[61,60,115]
9	Blockchain adoption and cryptocurrencies	Researchers focus on the notion of volatility and the exchange rate of cryptocurrencies, the mechanisms of valuing and investing in crypto-assets, the popularity of cryptocurrencies and reasons for their adoption in emerging markets, cryptocurrency features that impede or increase adoption, security and privacy measures in cryptocurrency adoption, the causes of adoption of cryptocurrencies by retailers, as well as the potential use of cryptocurrencies and their rate of adoption across countries.	[116,72,105,117,118, 65,119]

Appendix 3 Summary of challenges across the three panels and by type of blockchain

Challenges of blockchain adoption across panels[3]

Challenges of BC adoption/ Panel	Public sector	Private sector	Entrepreneurs and experts
1. Technological Dimensions			
Technology Life-cycle	Immature technology for both types of BC	Immature technology for both types of BC	Immature technology for both types of BC
Security	Security as a driver and a trust component, more secure business on blockchain for both BC	As a risk, security and cybersecurity concerns, software vulnerability of public blockchains, especially in financial institutions	NA
Privacy	NA	Mixed points of view: Transparency of transactions for the private sector with private BC. For some financial industry executives, it is a privacy issue for customers, conflicting with the banking tradition (for public BC)	Data control, owning data, privacy as a driver of public BC
Cost of the technology	Initial investment- less costly through collaboration	Initial investment- implementation, technology and people costs	NA
Scalability and performance	Limited scalability for public BC (challenge)	Limited scalability for public BC(challenge)	Limited scalability for public BC, but new protocols and various solutions are evolving
Interoperability	Challenge to integrate all the systems for both BCs	Challenge, but not mentioned by financial institutions' executives	Challenge, but will be overcome, as the future lies in multiple BCs.
Complexity	Complex tech, not clear, needs skills (challenge for both BCs)	Mixed results: respondents from the financial industry and some professionals from big tech companies do not perceive blockchain as a very complex technology	Simple technology
Blockchain in relation to cryptocurrencies	NA	NA	Advocating public blockchains and cryptocurrencies/tokens in accelerating the pace of blockchain adoption
2. Environmental/contextual Dimensions			
Regulatory uncertainty	Major challenge for both BCs, hence a need for regulation without stifling innovation	Major challenge for both BCs: No clear regulatory principles, compliance requirements and agreements	Lack of legal framework is stifling innovation. Outdated legislative landscape as a major obstacle for both BC
User-base externality	Challenge for both BCs – network effects required to speed up adoption	Challenge for both BCs – need universal acceptability of transactions- general adoption – leverage the network	Challenge for both BCs- needs a critical mass to keep it transparent and accurate
Ecosystem readiness – lack of awareness and education	Challenge for both BCs- critical mass, leverage network effects.	Challenge for both BCs-education and awareness, compliance.	Challenge for both BCs- lack of education from the ecosystem
3. Organizational Dimensions			
Governance and leadership readiness	Challenge for both BCs- Bureaucratic processes and mindset- Need for Leadership	Challenge for both BCs- Lack of collaborative governance body at the industry level.	Decentralized governance is a driver of adoption for entrepreneurs for public BC
Business model alignment	Seeking ROI and cost reduction with private BC	Cost reduction and business process improvement with private BC	New opportunities and blockchain-based business models (i.e., disintermediation, decentralization and openness) with public BC
Organizational readiness	Lack of talent, human capital and skills- a challenge for both BCs	Lack of skills and talents- a challenge for both BCs	Lack of skills, lack of seed funding Fundraising strategy as challenges for both BCs

[3] When the dimension has not been mentioned by any of the interviewees in the panel, an NA symbol was added. The content is based on the most representative quotes from each panel. BC is the acronym for blockchain.

References

[1] World Economic Forum, Deep Shift Technology Tipping Points and Societal Impact, retrieved from, 2015, http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf.
[2] P. Murck, Who controls the blockchain? Harv. Bus. Rev. (2017), 19 April.
[3] M. Friedlmaier, A. Tumasjan, I. Welpe, Disrupting Industries With Blockchain: The Industry, Venture Capital Funding, and Regional Distribution of Blockchain Ventures (September 22, 2017), Available at SSRN:, 2017 https://ssrn.com/abstract=2854756.
[4] M. Iansiti, K.R. Lakhani, The truth about blockchain, Harv. Bus. Rev. 95 (1) (2017) 118–127. Retrieved from, https://hbr.org/2017/01/the-truth-about-blockchain.
[5] D. Tapscott, A. Tapscott, The impact of the blockchain goes beyond financial services, Harv. Bus. Rev. (2016).
[6] A. Wright, P. De Filippi, Decentralized Blockchain Technology and the Rise of Lex Cryptographia (March 10, 2015), Available at SSRN: https://ssrn.com/abstract=2580664 or, 2015, https://doi.org/10.2139/ssrn.2580664.
[7] Atzori, Marcella, Blockchain Technology and Decentralized Governance: Is the State Still Necessary? (December 1, 2015). Available at SSRN: https://ssrn.com/abstract=2709713 or https://doi.org/10.2139/ssrn.2709713.
[8] C. Berg, S. Davidson, J. Potts, Institutional Discovery and Competition in the Evolution of Blockchain Technology (July 26, 2018), Available at SSRN: https://ssrn.com/abstract=3220072 or, 2018, https://doi.org/10.2139/ssrn.3220072.
[9] M. Risius, K. Spohrer, A blockchain research framework, Bus. Inf. Syst. Eng. (6) (2017) 385, https://doi.org/10.1007/s12599-017-0506-0.
[10] M. Janssen, V. Weerakkody, E. Ismagilova, U. Sivarajah, Z. Irani, A framework for analysing blockchain technology adoption: integrating institutional, market and technical factors, Int. J. Inf. Manag. 50 (2020) 302–309, https://doi.org/10.1016/j.ijinfomgt.2019.08.012.
[11] J. Fenn, Understanding Gartner's Hype Cycles, Strategic Analysis Report, 2003, https://www.bus.umich.edu/KresgePublic/Journals/Gartner/research/115200/115274/115274.pdf.
[12] D.E. O'Leary, Gartner's hype cycle and information system research issues, Int. J. Account. Inf. Syst. 9 (4) (2008) 240–252.
[13] J. Yli-Huumo, D. Ko, S. Choi, S. Park, K. Smolander, Where is current research on blockchain technology?—A systematic review, PLoS One 11 (10) (2016).
[14] L.W. Cong, Z. He, Blockchain disruption and smart contracts, Rev. Financ. Stud. 32 (5) (2019) 1754–1797.
[15] D. Yermack, Corporate governance and blockchains, Rev. Financ. (2017) 7–31.
[16] W. Nowiński, M. Kozma, How can blockchain technology disrupt existing business models? Entrep. Bus. Econ. Rev. 5 (3) (2017) 173–188.
[17] T. Felin, K. Lakhani, What problems will you solve with blockchain? MIT Sloan Manag. Rev. 60 (1) (2018) 32–38.
[18] Fabian, B., Ermakova, T., & Ahrary, N. (2018). Adoption of security and privacy measures in bitcoin–stated and actual behaviour transactions (In Barber et al. 2012, Brito and Castillo 2013), 8(20).
[19] D. Allen, C. Berg, S. Davidson, M. Novak, J. Potts, Blockchain TradeTech (May 2, 2018), Available at SSRN: https://ssrn.com/abstract=3171988 or, 2018, https://doi.org/10.2139/ssrn.3171988.
[20] S. Benjaafar, X. Chen, N. Taneri, G. Wan, A Permissioned Blockchain Business Model for Green Sourcing, Available at SSRN 3305792, 2018.
[21] B. Notheisen, C. Weinhardt, The blockchain, plums, and lemons: information asymmetries & transparency in decentralized markets (No. 130). KIT Working Paper Series in Economics, 2019.
[22] K. Francisco, D. Swanson, The supply chain has No clothes: technology adoption of blockchain for supply chain transparency, Logistics 2 (2) (2018) 1–13, https://doi.org/10.3390/logistics2010002.
[23] C. Perez, Technological revolutions and techno-economic paradigms, Camb. J. Econ. 34 (1) (2009) 185–202, https://doi.org/10.1093/cje/bep051.
[24] G. Dosi, Technological paradigms. And technological trajectories: a suggested interpretation of the determinants and directions of technical change, Res. Policy 11 (3) (1982) 147–162.
[25] G. Dosi, F. Malerba, Organization and Strategy in the Evolution of the Enterprise, Macmillan, London, 1996.
[26] T. Pinch, W. Bijker, The social construction of facts and artifacts: or how the sociology of science and the sociology of technology might benefit each other, in: W. Bijker, T. Hughes, T. Pinch (Eds.), The Social Construction of Technological Systems, The MIT Press, Cambridge, Mass, 1987, 1750.
[27] T. Oliveira, M. Thomas, M. Espadanal, Assessing the determinants of cloud computing adoption: an analysis of the manufacturing and services sectors, Inf. Manag. 51 (5) (2014) 497–510.
[28] E.M. Rogers, Diffusion of Innovations, fourth ed., Free Press, New York, 1995.
[29] E.M. Rogers, Diffusion of Innovations, fifth ed., Vol. 5th ed, Free Press, New York, 2003. Retrieved from, http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,url&db=edsebk&AN=1963937&site=eds-live&scope=site.
[30] L.G. Tornatzky, M. Fleischer, The Process of Technology Innovation, Lexington Books, Lexington, MA, 1990.
[31] K.K.Y. Kuan, P.Y.K. Chau, A perception- based model for EDI adoption in small businesses using a technology-organization-environment framework, Inf. Manag. 38 (8) (2001) 507–521, https://doi.org/10.1016/S0378-7206(01)00073-8.
[32] C.E. Tucker, Identifying formal and informal influence in technology adoption with network externalities, Manag. Sci. 54 (12) (2008), https://doi.org/10.1287/mnsc.1080.0897.
[33] R. Jensen, Adoption and diffusion of innovation of uncertain profitability, J. Econ. Theory 27 (1) (1982) 182–193, https://doi.org/10.1016/0022-0531(82)90021-7.
[34] E. Mansfield, Mansfield, The Economics of Technical Change, Retrieved from, Edward Elgar Publishing, 1993, https://econpapers.repec.org/bookchap/elgeebook/571.htm.
[35] Y. Fan, S. Sarkar, C. Zhang, The investment decision with technological and market uncertainties, Eur. J. Financ. 25 (2) (2018) 116–138, https://doi.org/10.1080/1351847X.2018.1486865.
[36] A.K. Dixit, S.R. Pindyck, Investment Under Uncertainty, Princeton University Press, Princeton, NJ, 1994, 1994, pp. 468.
[37] N. Rosenberg, Perspectives on Technology, Cambridge university press, 1976.
[38] A.M. Weiss, The effects of expectations on technology adoption: some empirical evidence, J. Ind. Econ. 42 (4) (1994) 341–360, https://doi.org/10.2307/2950442.
[39] P.J. DiMaggio, W.W. Powell, The Iron cage revisited: institutional isomorphism and collective rationality in organizational fields, Am. Sociol. Rev. 48 (2) (1983) 147.
[40] W.R. Scott, J.W. Meyer, Institutional Environments and Organizations, Sage, Thousand Oaks, CA, 1994.
[41] P. Frumkin, J. Galaskiewicz, Institutional isomorphism and public sector organizations, J. Public Adm. Res. Theory 14 (2004) 284.
[42] T.E. Zorn, A.J. Flanagin, M.D. Shoham, Institutional and noninstitutional influences on information and communication technology adoption and use among non-profit organizations, Hum. Commun. Res. 37 (1) (2011) 1–33, https://doi.org/10.1111/j.1468-2958.201001387.x.
[43] A.J. Flanagin, Social pressures on organizational web site adoption, Hum. Commun. Res. 26 (2000) 618–646.
[44] M.B. Miles, A.M. Huberman, Qualitative Data Analysis: an Expanded Sourcebook, Sage Publications, Thousand Oaks, California, 1994.
[45] N.K. Malhotra, D. Birks, P. Wills, Marketing Research: Applied Approach, fourth ed., Pearson, New York, NY, 2012.
[46] D.A. Mollenkopf, R. Frankel, I. Russo, Creating value through returns management: exploring the marketing- operations interface, J. Oper. Manag. 29 (5) (2011) 391–403.
[47] World Economic Forum, Inclusive Deployment of Blockchain: Case Studies and Learnings From the United Arab Emirates, January 2020, Accessed in May 2020, 2020, http://www3.weforum.org/docs/WEF_Inclusive_Deployment_of_Blockchain_Case_Studies_and_Learnings_from_the_United_Emirates.pdf.
[48] M. Tsujimoto, Y. Kajikawa, J. Tomita, Y. Matsumoto, A review of the ecosystem concept — towards coherent ecosystem design, Technol. Forecast. Soc. Change 136 (November) (2018) 49–58, https://doi.org/10.1016/j.techfore.2017.06.032.
[49] D.P. Hannah, K.M. Eisenhardt, How firms navigate cooperation and competition in nascent ecosystems, Strateg. Manag. J. (2017), https://doi.org/10.1002/smj.2750.
[50] R. Adner, Match your innovation strategy to your innovation ecosystem, Harv. Bus. Rev. 84 (4) (2006) 98.
[51] R. Adner, R. Kapoor, Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations, Strateg. Manag. J. 30 (3) (2010) 306–333.
[52] P. Evans, L. Aré, P. Forth, N. Harlé, M. Portincaso, A Strategic Perspective on Blockchain and Digital Tokens, Available at:, Boston Consulting Group, 2016 https://www.bcg.com/en-gb/publications/2016/blockchain-thinking-outside-the-blocks.aspx.
[53] R. Adner, R. Kapoor, Right tech, wrong time, Harv. Bus. Rev. (2016). https://hbr.org/2016/11/right-tech-wrong-time.
[54] K.M. Eisenhardt, Building theories from case study research, Acad. Manag. Rev. 14 (1989) 532–550.
[55] A. Langley, Strategies for theorizing from process data, Acad. Manag. Rev. 24 (4) (1999) 691–710.
[56] A. Strauss, J. Corbin, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, second ed., Sage Publications, Thousand Oaks, 1998.
[57] K. Charmaz, Constructivist and objectivist grounded theory, Handb. Qual. Res. 2 (2000) 509–535.
[58] F. Glaser, Pervasive decentralisation of digital infrastructures: a framework for blockchain-enabled system and use case analysis, Proceedings of the 50th Hawaii International Conference on System Sciences (2017), https://doi.org/10.24251/hicss.2017.186.
[59] M. Higginson, M.C. Nadeau, K. Rajgopal, Blockchain's Occam problem, McKinsey, 2019. https://www.mckinsey.com/industries/financial-services/our-insights/blockchains-occam-problem.
[60] H. Wang, K. Chen, D. Xu, A maturity model for blockchain adoption, Financ. Innov. 2 (12) (2016).
[61] T.C. Stratopoulos, V.X.Q. Wang, Blockchain Technology Adoption, Available at SSRN: https://ssrn.com/abstract=3188470 or 10.2139/ssrn.3188470, May 31 2018, 2018.
[62] J.P. Moyano, O. Ross, KYC optimization using distributed ledger technology, Bus. Inf. Syst. Eng. 59 (6) (2017) 411–423.
[63] Moody's Investor Service, Blockchain Improves Operational Efficiency for Securitisations, Amid New Risks, 11, accessed December 25, 2019, 2019, https://www.moodys.com/login?ReturnUrl=https%3a%2f%2fwww.moodys.com%2fresearchdocumentcontentpage.aspx%3fdocid%3dPBS_1138725.
[64] S. Nakamoto, Bitcoin: a Peer-to-Peer Electronic Cash System, White paper, Retrieved 23.02.2018, from, 2008, https://bitcoin.org/bitcoin.pdf.

[65] G. Hileman, M. Rauchs, Global Blockchain Benchmarking Study, Available at SSRN:https://ssrn.com/abstract=3040224 or 10.2139/ssrn.3040224, September 22, 2017, 2017.
[66] J. Amico, The Power of Open Networks Public Blockchain Adoption in Capital Markets, 2019. https://medium.com/fluidity/the-power-of-open-networks-public-blockchain-adoption-in-capital-markets-aee6bf1b002d.
[67] Ernest & Young, EY Launches Baseline Protocol, an Open-source Initiative for the Public Ethereum Blockchain, an be retrieved on https://www.enterprisetimes.co.uk/2020/03/11/ey-launches-baseline-protocol-for-public-ethereum/, accessed April 2020, 2020.
[68] S. Ammous, Blockchain Technology: What is it Good for?, August 8, 2016, Available at SSRN: https://ssrn.com/abstract=2832751 or, 2016, https://doi.org/10.2139/ssrn.2832751.
[69] J. Abadi, M.K. Brunnermeier, Blockchain Economics, December 2018, CEPR Discussion Paper No. DP13420. Available at SSRN:, 2018 https://ssrn.com/abstract=3310346.
[70] I. Radanovic, R. Likic, Opportunities to use of blockchain in technology in medicine, Appl. Health Econ. Health Policy 16 (5) (2018) 583–590.
[71] M. Swan, Anticipating the economic benefits of blockchain, Technol. Innov. Manag. Rev. 7 (10) (2017) 6–13.
[72] L. Cong, Y. Li, N. Wang, Tokenomics: Dynamic Adoption and Valuation, September 16, 2018, Columbia business School Research Paper No. 18-46; 2nd Emerging Trends in Entrepreneurial Finance Conference; Finance Down Under 2019 Building on the Best From the Cellars of Finance, Available at SSRN: https://ssrn.com/abstract=3153860 or 10.2139/ssrn.3153860, accessed March 2019, 2018.
[73] D. Wang, Commodity Trade Finance Platform Using Distributed Ledger Technology: Token Economics in a Closed Ecosystem Using Agent-Modelling, Available at SSRN 3152093, 2018, 2018.
[74] M.A. Jamison, P. Tariq, Five things regulators should know about blockchain (and three myths to forget), Electr. J. 31 (9) (2018) 20–23, https://doi.org/10.1016/j.tej.2018.10.003.
[75] R.T. Frambach, N. Schillewaert, Organizational innovaton adoption: a multi-level framework of determinants and opportunities for future research, J. Bus. Res. 55 (2) (2002) 163–176, https://doi.org/10.1016/S0148-2963(00)00152-1.
[76] T. Greenhalgh, G. Robert, F. Macfarlane, P. Bate, O. Kyriakidou, Diffusion of innovations in service organizations: systematic review and recommendations, Milbank Q. 82 (4) (2004) 581–629, https://doi.org/10.1111/j.0887-378X.2004.00325.x.
[77] C. Baden-Fuller, S. Heafliger, Business Models and technological innovation, Long Range Plann. 46 (6) (2013) 419–426, https://doi.org/10.1016/j.lrp.2013.08.023.
[78] J. Angelis, E.R. de Silva, Blockchain adoption a value driver perspective, Bus. Horiz. 62 (May-June (3)) (2019) 307–314, https://doi.org/10.1016/j.bushor.2018.12.001.
[79] D.C. De Leon, Aq. Stalick, A.A. Jillepalli, M.A. Haney, F.T. Sheldon, Blockchain: properties and misconceptions, Asia Pacific J. Innov. Entrep. 11 (3) (2017) 286–300, https://doi.org/10.1108/APJIE-12-2017-034.
[80] G.A. Aarons, M. Hurlburt, S.M.C. Horwitz, Advancing a conceptual model of evidence-based practise implementation in public service sectors, Adm. Policy Ment. Health Ment. Health Serv. Res. 38 (1) (2011) 4–23, https://doi.org/10.1007/s10488-010-0327-7.
[81] M.A. Hameed, S. Counsell, S. Swift, A meta-analysis of relationships between organizational characteristics and IT innovation adoption in organizations, Inf. Manag. 49 (5) (2012) 218–232, https://doi.org/10.1016/j.im.2012.05.002.
[82] S. Sharma, A. Rai, An assessment of the relationship between ISD leadership characteristics and IS innovation adoption in organizations, Inf. Manag. 40 (5) (2003) 391–401, https://doi.org/10.1016/S0378-7206(02)00049-6.
[83] F. Holotiuk, F. Pisani, J. Moormann, The impact of blockchain technology on business models in the payments industry, in: Paper Presented at 13th International Conference of the Association for Information Systems, Wirtschafts Nformatics, February 12-15 2017, 2017. https://aisel.aisnet.org/wi2017/track09/paper/6/.
[84] S. Ølnes, J. Ubacht, M. Janssen, Blockchain in Government: benefits and implications of distributed ledger technology for information sharing, Gov. Inf. Q. 34 (3) (2017) 355–364, https://doi.org/10.1016/j.giq.2017.09.007.
[85] T. Clohessy, T. Acton, N. Rogers, Blockchain adoption: technological, organisational and environmental considerations, in: H. Treiblmaier, R. Beck (Eds.), Business Transformation Through Blockchain, Palgrave Macmillan, Cham, 2019.
[86] C.L. Lacovou, I. Bendasat, A.S. Dexter, Electronic data interchange and small organisations: adoption and impact of technology, MIS Q. 19 (14) (1995) 465–485.
[87] Y.M. Wang, Y.S. Wang, Y.F. Yand, Understanding the determinant of RFID adoption in the manufacturing model of blockchain adoption, Financ. Innov. 2 (1) (2010) 1–5.
[88] B. Carson, G. Romaelli, P. Walsh, A. Zhumaev, Blockchain Beyond the Hype: What is the Strategic Business Value? McKinsey, 2018. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value.
[89] A. Pinna, W. Ruttenberg, Distributed Ledger Technologies in Securities Post-Trading Revolution or Evolution? (April 26, 2016), ECB Occasional Paper No. 172. Available at SSRN:, 2016 https://ssrn.com/abstract=2770340.
[90] H. Hyvärinen, M. Risius, G. Friis, A blockchain-based approach towards overcoming financial fraud in public sector services, Bus. Inf. Syst. Eng. 59 (6) (2017) 441–456.
[91] E. Noe, Y. Longzhi, C. Fei, C. Yi, A framework of blockchain-based secure and privacy-preserving E-government system, Wirel. Netw. (2018), https://doi.org/10.1007/s11276-018-1883-0.
[92] L. Pawczuk, R. Massey, D. Schatski, Blockchain Gets Down to Business: Deloitte's 2019 Global Blockchain Survey, Deloitte Insights, 2019. https://www2.deloitte.com/content/dam/Deloitte/se/Documents/risk/DI_2019-global-blockchain-survey.pdf.
[94] B.M. Leiner, V.G. Cerf, D.D. Clark, R.E. Kahn, L. Kleinrock, D.C. Lynch, J. Postel, L.G. Roberts, S. Wolff, A brief history of the Internet, ACM SIFCOMM Comput. Commun. Rev. (2009), https://doi.org/10.1145/1629607.1629613.
[95] P. Brody, Going Public, EY Global Blockchain Summit 2020, Online Summit can be retrieved on https://www.youtube.com/watch?v=-ycu5vGDdZw, accessed April 2020, 2020.
[96] N. Grossman, Cryptonetworks and Why Tokens are Fundamental, Blog accessible at https://www.nickgrossmanN.is/2018/cryptonetworks-and-why-tokens-are-fundamental/, accessed September 2019, 2018.
[97] J. Monegro, Fat Protocols, accessible at https://www.usv.com/writing/2016/08/fat-protocols/, assessed January 2019, 2016.
[98] G. Gowrisankaran, J. Stavins, Network externalities and technology adoption: lessons from electronic payments, J. Econ. 35 (2004) 260–276.
[99] A. Hagiu, S. Rothman, Network effects aren't enough, Harv. Bus. Rev. 94 (4 (April 2016)) (2016) 65–71.
[100] P.Y.K. Chau, K.Y. Tam, Organizational Adoption of open systems: a "technology-push, need-pull" perspective, Inf. Manag. 37 (2000) 229–239, https://doi.org/10.1016/S0378-7206(99)00050-6.
[101] G. Lee, W. Xia, Organizational size and IT innovation adoption: a meta-analysis, Inf. Manag. 43 (8) (2006) 975–985, https://doi.org/10.1016/j.im.2006.09.003.
[102] M.L. Marsal-Liacuna, Future living framework: is blockchain the next enabling network? Technol. Forecast. Soc. Change 128 (2018) 226–234, https://doi.org/10.1016/j.techfore.2017.12.005.
[103] F. Sander, J. Semeijn, D. Mahr, The acceptance of blockchain technology in meat traceability and transparency, Br. Food J. 120 (9) (2018) 2066–2079.
[104] J. Chod, N. Trichakis, G. Tsoukalas, H. Aspegren, M. Weber, On the Financing benefits of supply chain transparency and blockchain adoption, Manag. Sci. (2019), https://doi.org/10.2139/ssrn.3078945.
[105] D. Folkinshteyn, M. Lennon, Braving Bitcoin: a technology acceptance model (TAM) analysis, J. Inf. Technol. Case Appl. Res. 18 (4) (2016) 220–249.
[106] A. Arora, M. Arora, Digital-information tracking framework using blockchain, J. Supply Chain Manag. Syst. 7 (2) (2018). Available at SSRN: https://ssrn.com/abstract=3153860 or 10.2139/ssrn.3153860, accessed March 2019.
[107] E.D. Zamani, G.M. Giaglis, With a little help from the miners: distributed ledger technology and market disintermediation, Ind. Manag. Data Syst. 118 (3) (2018) 637–652.
[108] Zane Witherspoon, Advancing consumer adoption of blockchain applications, SSRN Electron. J. (2017), https://doi.org/10.2139/ssrn.2966321.
[109] B.K. Zheng, L.H. Zhu, M. Shen, F. Gao, C. Zhang, Y.D. Li, J. Yang, Scalable and privacy-preserving data sharing based on blockchain, J. Comput. Sci. Technol. 33 (3) (2018) 557–567.
[110] F. Ferranin, J. Maupin, M. Hinojales, Distributed Ledger Technologies for Developing Asia, ADB December, 2017, https://www.adb.org/publications/distributed-ledger-technologies-developing-asia.
[111] Ana Rutschman, Healthcare Blockchain Infrastructure: a Comparative Approach (July 2, 2018), Saint Louis U. Legal Studies Research Paper No. 2018-4. Available at SSRN: https://ssrn.com/abstract=3217297.
[112] V. Gatteschi, F. Lamberti, C. Demartini, C.S. Pranteda, V. Santamaría, Blockchain and smart insurance contracts: is technology mature enough? Future Internet 10 (2) (2018) 1–16.
[113] Elli Karaindrou, Distributed Ledger Technology and the Future of Payment Services (November 28, 2017), Available SSRN: https://ssrn.com/abstract=3078523 or 10.2139/ssrn.3078523, 2017.
[114] S. Prasad, R. Shankar, R. Gupta, S. Roy, A TISM modelling critical success factors blockchain-based cloud services, J. Adv. Manag. Res. 15 (4) (2018) 434–456, https://doi.org/10.1108/JAMR-03-2018-0027.
[115] J.M. Woodside, F.K. Augustine Jr., W. Giberson, Blockchain technology adoption status and strategies, J. Int. Technol. Inf. Manag. 26 (2) (2017).
[116] W. Bolt, M.R.C. van Oordt, On the Value of Virtual Currencies, working paper, Central Bank of Canada, 2016.
[117] N. Jonker, What Drives Bitcoin Adoption by Retailers?, De Nederlandsche Bank Working Paper No. 585, 2018.
[118] P. Ciaian, M. Rajcaniova, d'A. Kancs, The digital agenda of virtual currencies: can Bitcoin become a global currency? Inf. Syst. E-Bus. Manag. 14 (883-) (2016) 919.
[119] V. Buterin, On Public and Private Blockchains, Ethereum blog, accessible at https://blog.ethereum.org/2015/08/07/on-public-and-private-blockchains/ accessed on June 2019, 2015.

Elissar Toufaily: Dr Elissar Toufaily is an associate professor of marketing at the American University in Dubai and is a visiting professor at the graduate school of University Laval in Quebec – Canada. Her research papers and interests focus on the adoption of innovations, consumer trust in the case of technology-mediated transactions, e-service quality in the services industries and on the impact of disintermediation, decentralization and digitization of economic transactions on consumers and organizations. She has published dozens of scientific articles in peer-reviewed journals and has received different research grants and awards. She has supervised graduate theses on a variety of topics related to marketing in the digital economy.

Tatiana Zalan: Dr Tatiana Zalan is an associate professor of management at the American University in Dubai. She has 30+ years of experience in business and academia across Australia, Asia, Europe and the Middle East. In Australia, she was on the faculty of the University of Melbourne, University of South Australia and Torrens University. Tatiana's business experience includes two start-ups, one of them being a new private university in Australia, where she was the MBA Programme Director. She is now Academic Advisor to a start-up in Dubai. Tatiana has published in academic journals. Also, she has received research and teaching awards and she frequently presents at international academic and industry conferences on topics related to digital disruption, innovation, entrepreneurship, blockchain and cryptocurrencies.

Soumaya Ben Dhaou: Dr Soumaya Ben Dhaou is a research coordinator at UNU-EGOV, the United Nations University Operating Unit on Policy-driven Electronic Government and Invited Professor at the School of Engineering of the University of Minho. She coordinates the research line on the role of the "Emerging technologies for digital transformation in the public sector" as well as the research project on "Digital transformation strategy". Her research includes potential benefits and challenges of new technologies, such as blockchain and their implications on the public sector. She is also leading within UNU-EGOV, the research project Blockchain 4 smart cities part of the "United for Smart Sustainable Cities" (U4SSC) initiative managed by ITU, UN-Habitat and UNECE.