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The prospective value creation potential of Blockchain in business models: A delphi study

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ABSTRACT

Blockchain technology is gaining awareness and drawing attention in corporate practice and academia. Both fields expect a fundamental impact of blockchain on business and society. However, since blockchain research within the business model context is still in a nascent stage, more in-depth insights is required of blockchain's impact on firms' value creation and value capture. This study builds on a Delphi approach and aims to identify the future value creation potential of blockchain for organizations by 2030. Based on expert interviews, workshop insights, and prior literature, we developed a meaningful set of 36 projections of blockchain implications for business models. Our findings, based on the elements of the PEST framework, predict massive efficiency gains through technological progress and promise complementary offerings through various novel combination possibilities, novel forms of collaboration and business model opportunities, and a dissipation of the significance of blockchain types. The combined use of blockchain solutions with other technologies is likely to serve as the basis for ecosystem developments. Our projected finding is that the internet of value will replace the internet of information by 2030. Thereby, our research contributes to technological forecasting and strategic planning by providing managers clear indications of blockchain developments and action recommendations.

1. Introduction

Blockchain technology has recently attracted much attention in industry and academia (e.g., Beck and Müller-Bloch, 2017; Risius and Spohrer, 2017; Weking et al., 2019). Its specific attributes offer unprecedented opportunities. However, the technology's future development and business applications remain uncertain (Glaser, 2017). According to Gartner's 2020 Hype Cycle, the technology will soon reach its productivity level (Gartner, 2020). Corresponding to these expectations, blockchain consortia – inter-firm collaborations to further investigate the technology – are increasingly emerging (Zavolokina et al., 2020).

Several researchers compare the blockchain to the Internet (e.g., Swan, 2015; Underwood, 2016). Over the last three decades, the Internet has "fundamentally changed the way businesses created and captured value" (Iansiti & Lakhani, 2017, p. 5). Subsequently, the business model concept became a popular and powerful construct to describe a firm's value creation and value capture mechanisms (DaSilva and Trkman, 2014; Teece, 2010). While the transformational impact of blockchain may be of similar strength, its diffusion could accelerate due to "network effects of current widespread global Internet and cellular connectivity" (Swan, 2015a, p. xi). Tapscott and Tapscott (2016) referred to blockchain as "the technology most likely to change the next decade of business," and thus it stands out from other technologies like artificial intelligence or robotics (Tapscott and Tapscott, 2016). However, there are divergent evaluations of the technology's impact. While some scholars see blockchain as a radical innovation (e.g., Beck and Müller-Bloch, 2017), others emphasize its impact as a foundational technology (e.g., Iansiti & Lakhani, 2017). The high levels of residual uncertainty and expected challenges for incumbent firms (e.g., Iansiti & Lakhani, 2017) convert blockchain's impact on business models into an interesting research theme.

To date, regarding empirical and theoretical works, the technology has received limited attention within the ambit of information systems

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(IS) research (Rossi et al., 2019), mainly due to technological aspects being the major focus of interest (Risius and Spohrer, 2017). Due to its particular features, blockchain has attracted widespread attention (Yaqoob et al., 2020), as evidenced by its numerous application fields (e.g., Christidis and Devetsikiotis, 2016; Salah et al., 2019a and b; Yaqoob et al., 2020). We therefore often refer to blockchain as a "general--purpose technology" (e.g., Choo et al., 2020; Filippova, 2019; Ølnes et al., 2017). A special interest field is blockchain's combined application with other technologies. In particular, the Internet of Things (IoT) is seen as "one of the most popular applications of blockchain" (Choo et al., 2020, p. 983), especially in combination with smart contracts (Suliman et al., 2019). Other noticeable technological combinations include blockchain's interaction with Artificial Intelligence (AI) (e.g., Salah et al., 2019b) and digital twins (e.g., Yaqoob et al., 2020). Within management, *supply chain and logistics* are among blockchain's most relevant application fields (Choo et al., 2020). These applications range from blockchain-based solutions that track and trace soybeans in agricultural supply chains (Salah et al., 2019a), to reducing the transaction costs and increasing the security of financial transactions (Choo et al., 2020).

Blockchain's impact on business models has similarly attracted limited attention to date. Where studies were done, they focused on, among others, a literature review of blockchain's generic implications for business models (Nowiński and Kozma, 2017), an analysis of the business model implications in the music and entertainment industries (Dutra et al., 2018), the development of a taxonomy of blockchain-based business models (Weking et al., 2019), or a conceptual discussion on how blockchain changes value creation (Schneider et al., 2020). Other research streams concentrated on Delphi studies within the blockchain and business model context, shedding light on the technology in the machine economy (Schweizer et al., 2020), on blockchain's prospective application in the business landscape (White, 2017), and on blockchain's business model implications in the payments sector (Holotiuk et al., 2017). However, we need to better understand blockchains' potential use, governance, and value mechanisms, especially in light of the technology's uncertain development (Lacity, 2018; Risius and Spohrer, 2017). We also require further theoretical development, including the creation of frameworks to better "understand key concerns of IS research on blockchain" (Rossi et al., 2019, p. 1394). Consequently, the business model offers a promising lens to assess how blockchain can lead to new forms of value creation and value capture (Iansiti & Lakhani, 2017). In response, this research addresses the following research question: ***How will blockchain create value for business models by 2030?***

Our study builds on a comprehensive Delphi approach, which leverages the technological and business expertise of well-respected professionals and academics. The Delphi method represents a powerful tool to explore the potential implications of uncertain developments in complex contexts (Linstone and Turoff, 2002; Loo, 2002). Through it, we forecast blockchain's impact by 2030. We do so by investigating its prospective macro environment from a political, economic, socio-cultural, and technological (PEST) perspective (Wilson and Gilligan, 2009).

By identifying blockchain's value creation potential for businesses by 2030, we contribute to the emerging stream of literature on its business value within the broader body of management literature. The lens of the business model allows us to link the results of experts' evaluations of a blockchain-enabled future with well-established theoretical foundations of value creation, including transaction cost theory, network theory, theory on value chains, the resource-based view, and the theory of innovation. We build on and extend the existing knowledge of value creation in the e-commerce context produced by Amit and Zott (2001), by analyzing the design themes within which blockchain is expected to create value. Through our empirical study, we create a picture of blockchain's future development and support strategic planning by reducing the uncertainty concerning the prerequisites for blockchain's value creation.

2. Literature

2.1. Blockchain technology in general

A "blockchain is shared in a decentralized network of computers and based on mathematics and advanced cryptography, where each transaction can be verified by the entire network that can be either public or private" (Beck and Müller-Bloch, 2017, p. 5390). A blockchain is a distributed ledger in which all actors instead of a single actor possess control over transaction information (Ølnes et al., 2017; Underwood, 2016). Every node in the network has complete information as identical information is stored at each node (Ølnes et al., 2017). The users on the blockchain network have to verify a transaction's validity through cryptographic algorithms. The majority of users have to reach consensus about a transaction's validity, which allows adding a new block into the blockchain (Underwood, 2016). If there exists no consensus among the users, "the network automatically rejects the entry as invalid" (Casey and Vigna, 2018, p. 13). Hacking or changing recorded data in the blockchain is challenging as the ledger replicates on an enormous scale (Grewal et al., 2018). Furthermore, "the blockchain is an append-only data store" because it only adds but does not update or delete transactions (Xu et al., 2016, p. 7). Moreover, the blockchain ensures the encryption of transaction data (Underwood, 2016). It is nevertheless security prone because, among others, it is resilient and tolerant to faults (Lacity, 2018).

Even though we only occasionally distinguish between the different types of blockchains, it is worthwhile emphasizing some of the key differences between public, private, and hybrid blockchains. In a public blockchain, the access to data is open as all nodes of the network can read and enter transactions into the network (Buterin, 2015; Peters and Panayi, 2016). Current algorithm mechanisms that simultaneously make complex mathematical calculations (Salah et al., 2019b), like proof-of-work, consume large amounts of energy for mining (Swan, 2015) due to a critical consensus of 51% nodes (Salah et al., 2019 b). Throughput and latency challenges exist as these blockchains, because of their block sizes, process fewer transactions than other networks like VISA, and users have to wait for the completion of the transaction's addition to the network (Meiklejohn, 2018; Swan, 2015). In private blockchains, access is restricted. Only a selected set of users receives access to the network and is allowed to read or enter transactions (Buterin, 2015; Peters and Panayi, 2016). Because of their permissioned nature, nodes in the network are known and authenticated so that these private blockchains are more efficient in respect of complex calculations (Dinh et al., 2017; Salah et al., 2019 b). In consortium or hybrid blockchains, pre-defined nodes have data access, but decentralization is only partly fulfilled (Buterin, 2015; Glaser, 2017). Consortium blockchains also control permission access. Furthermore, only some participants have reading and writing rights, and the algorithmic calculations also require less energy and consume less time (Salah et al., 2019b).

2.2. Blockchain's potential

Blockchain is a powerful technology because of its interplay of distribution and digital recording of transactions (Felin and Lakhani, 2018). Blockchain's peer-to-peer principle (Nakamoto, 2008) makes trusted intermediaries redundant (Ying et al., 2018) as they represent "a central point of mistrust, failure, hacking, and compromise" (Suliman et al., 2019, p. 1). The non-use of an intermediary accelerates reconciliation, which occurs in real-time (Christidis and Devetsikiotis, 2016; Morabito, 2017). Complex industries and supply chain networks benefit from increased efficiencies and reduced transaction times, lower costs, and reduced risks (Gaur and Gaiha, 2020; Nowiński and Kozma, 2017; Ying et al., 2018). The cryptographic proof ensures the verification of updates as it makes them traceable by forming an "auditable trail of information" (Christidis and Devetsikiotis, 2016, p. 2299), which is why the blockchain can potentially "become the system of record for all transactions" (Iansiti & Lakhani, 2017, p. 5). The blockchain can cause a transition from an internet of information to a decentralized internet of value (Lima, 2018; Tapscott and Euchner, 2019), due to the possibility of registering, authenticating, and processing transactions involving different types of assets, objects, and ownership (Gaur and Gaiha, 2020; Lima, 2018; Montecchi et al., 2019; Swan, 2015). Any property type can be converted to a smart property by "encoding every asset to the blockchain with a unique identifier such that the asset can be tracked, controlled, and exchanged (bought or sold) on the blockchain" (Swan, 2015, p. viii). Blockchain further enables the storage of files (Swan, 2015; Xu et al., 2016) and transaction data (Xu et al., 2016). Blockchain's most essential promise is its reduction of cost of trust, whereas centralized intermediaries with the task to ensure trust, among others, demand fees, or create tensions (Casey and Vigna, 2018). Cryptography ensures transaction authorization and smart contracts provide the automatic execution of workflows, processes, and payments (Christidis and Devetsikiotis, 2016; Felin and Lakhani, 2018; Suliman et al., 2019). Smart contracts are based on their pre-defined programming to avoid misunderstandings and malevolent behavior (Beck et al., 2016). These control mechanisms, combined with encryption, ensure accountability and transparency (Yaqoob et al., 2020). The provision of accountability and transparency, in turn, helps to resolve actors' misaligned interests as the technology decreases information asymmetries (Casey and Wong, 2017; Gaur and Gaiha, 2020). Besides smart contracts, blockchain's decentralized consensus mechanisms also reduce information asymmetries, especially considering the authenticity verification of every participant entering the blockchain network (Cong and He, 2019). Furthermore, blockchain could increase the efficiency of businesses as it lays the foundation for decentralized autonomous organizations (DAOs), following rules of governance programmed in the blockchain (Beck et al., 2018; Swan, 2015).

Recently, numerous investigations made use of blockchain and its applications. For example, in the IoT context, Suliman et al. (2019) used smart contracts to monetize data resulting from IoT devices in an automated manner. Salah et al. (2019a) developed a blockchain solution that allows the tracking and tracing of soybeans throughout the agricultural supply chain by testing algorithms of smart contracts, to ensure that interactions between essential participants are carried out correctly. In the financial context, invoice financing, for example, became a subject of investigation. In response, Guerar et al. (2020) suggested a blockchain solution that supports "fully open and group-restricted auctioning of invoices" (p. 1). The authors ensured confidentiality by storing the encrypted data in an InterPlanetary File System (IPFS) and storing the related hash in the smart contract running on the Ethereum blockchain (Guerar et al., 2020).

2.2. Blockchain's adoption barriers

Even though the blockchain shows tremendous potential, its broad adoption faces numerous barriers (Prewett et al., 2019; Yaqoob et al., 2020). We summarize these adoption barriers with reference to the dimensions of the PEST framework.

2.2.1. Technological aspects

Being an emerging technology, the blockchain currently faces various technological challenges (e.g., Hackius and Petersen, 2020; Reyna et al., 2018; Yaqoob et al., 2020). Interoperability challenges arise due to the heterogeneous parameters of different networks (Yaqoob et al., 2020) like cryptocurrency and token display, the management of transactions and smart contracts, and consensus mechanisms (Gramoli and Staples, 2018; Yaqoob et al., 2020). These challenges make it more difficult to integrate blockchain with organizations' traditional legacy systems (Gramoli and Staples, 2018; Underwood, 2016; Yaqoob et al., 2020). Enhancing interoperability is possible through standardization, which implies a technical industrial baseline (Gramoli and Staples, 2018). However, standards are not in place at present (Lacity, 2018). Nevertheless, several organizations have initiated standardization initiatives (Gramoli and Staples, 2018). A high demand for end-to-end functioning interoperability standards will prevail due to the increasing complexity of cases of blockchain use across organizations and business domains (Lima, 2018). Since well-established ERP systems provide user and application programming interfaces (APIs), they can cope with demanding product workflows. By contrast, blockchain requires that software development is done manually, even for the most simple purposes (Hackius and Petersen, 2020). Hence, blockchain requires customized solutions, as well as gateways for APIs (Prewett et al., 2019). The highly fragmented market of existing blockchains, in combination with interoperability and standard challenges (Gramoli and Staples, 2018; Lima, 2018), is accompanied by a "cost, effort, and expertise necessary to build custom interfaces" (Prewett et al., 2019, p. 3). Scalability represents another technical challenge as a lack of speed results "from network stress," caused by higher transaction throughput (Yaqoob et al., 2020, p. 8). At present, blockchain cannot cope with enormous transaction volumes, as experienced in the IoT (Biswas et al., 2018). Since blockchains make use of consensus mechanisms, the majority of networks demand high energy consumption resulting from high computing power, at immense costs. Consequently, there is need for more cost-efficient consensus mechanisms (Yaqoob et al., 2020). Furthermore, blockchains face the challenge of size or storage capacity (Hepp et al., 2018; Swan, 2015). Hence, it is commonly the case to retain only meta data on the blockchain (on-chain) and private or big (raw) data off the blockchain (off-chain) (Xu et al., 2016).

2.2.2. Political aspects

The lack of blockchain's regulation challenges organizations interested in using blockchain technology. Blockchain is not defined from a regulatory standpoint, and current laws and regulations do not acknowledge blockchain's attributes. The decentralization and immutability of data, in particular, could cause compliance issues with prospective laws and regulations, especially with laws regulating data protection (Hackius and Petersen, 2020). The *General Data Protection Regulation* of the European Union (EU) is a specific example, considering that blockchain cannot comply with it as EU inhabitants can demand the deletion of personal data (Madnick, 2019). Currently, firms must invest in developing an understanding of how other existing regulations affect blockchain, as a prerequisite to ensure that their blockchain solutions do not violate existing laws (Lacity, 2018). Moreover, even though regulatory incompatibilities may exist between different countries (Hackius and Petersen, 2020), blockchain solutions for supply chain and logistics that cross national borders must be compatible "with the laws and regulations of the intended target countries" (Hackius and Petersen, 2020, p. 34999). The absence of regulations for cryptocurrencies also creates uncertainty (Obie and Rasmussen, 2018). In contrast to legal currencies, cryptocurrencies such as bitcoin do not have the backing of a central authority like a government (Sullivan, 2015; Van Alstyne, 2014), infusing them with volatility (Weaver, 2018). Since blockchain is not completely anonymous, but pseudo-anonymous, it is prone to fraudulent actions requiring regulation (Crosby, 2016). Blockchain's pseudonymity results from cryptography, which combines public and private keys. Consequently, "blockchain systems, such as Bitcoin, are popular for illegal transactions, such as ransomware payments, making them effectively untraceable" (Madnick, 2019, p. 5). Weaver (2018) even stated that the success of cryptocurrencies would lead to a growth in criminal activities. Consequently, there is also no regulation of Initial Coin Offerings (ICOs), which presents an inherent risk to investors (Arnold et al., 2019). Gupta et al. (2020) described ICOs as "heretofore unregulated crowdfunding ventures launched on a blockchain platform" (p. 144). ICOs or "token sales" follow the creation of novel cryptocurrencies (Kastelein, 2017). The ICO's value is not determined by a central institution, but by the participants in the respective blockchain network (Kastelein, 2017). ICO's nature is virtual, and pseudonyms and missing definitions of their characterization pose a challenge to the management of ICOs from a regulatory perspective (Arnold et al., 2019).

2.2.3. Economic aspects

Economic aspects also pose several challenges to blockchain. Even though Iansiti and Lakhani (2017) expected blockchain to have a high impact on "economic and social systems" (p.4), they contended that it would require several decades to complete its implementation in these systems' infrastructures. The main reason is the gradual adoption inherent to accelerated dynamics in terms of technology and institution-related changes (Iansiti & Lakhani, 2017). For example, by conducting a Delphi study of blockchain in the context of the machine economy, Schweizer et al. (2020) found that blockchain's scalability seriously influences blockchain's function in this economy. Even if technology's scalability improves, it continues to be "a potential hindrance for the widespread use of blockchain infrastructures" (p. 10). Furthermore, Torbensen and Ciriello (2019) identified the existence of perceptions that the role of intermediaries still adds value, which is why the likelihood of complete decentralization – in this case the music industry – is low (Torbensen and Ciriello, 2019). The blockchain economy assumes a decline in the costs of coordination in terms of economic activities (Beck et al., 2018). However, Beck et al. (2018) found that the governance of DAOs is expensive, despite the use of smart contracts. The reason for this is that smart contracts are autonomously executed, which contains risks inherited from, for example, coding errors. Consequently, negotiating these contracts to alleviate these threats, may result in coordination costs (Beck et al., 2018).

2.2.4. Socio-cultural aspects

It is also essential to understand which blockchain features support or hinder blockchain's diffusion in society (Risius and Spohrer, 2017). Beck et al. (2016) outline that individuals can reject the use of blockchain technologies when facing unfamiliar payment methods. Furthermore, blockchain's decentralization principle raises (data) privacy issues (Yaqoob et al., 2020). Each participant in the network possesses a copy of the blockchain ledger, making data protection issues particularly challenging when utilizing the technology (Taylor et al., 2020). This is very important, considering that users have to authenticate themselves (Beck et al., 2018) in the blockchain network. To solve the privacy issue, it should become possible "to perform transactions without leaking identification information" (Yaqoob et al., 2020, p. 8). The download and local storage of the blockchain, in the form of a copy, is essential for users to validate transactions. While state-of-the-art computers can manage the storage of hundreds of GBs, this becomes rather challenging for devices with limited resources, like smartphones or, prospectively, the IoT (Marsalek et al., 2019). Even though blockchain provides several benefits for developing countries (Underwood, 2016), like corruption or fraud reduction (Kshetri and Voas, 2018), "it will take decades for blockchain to seep into our economic and social infrastructure" (Iansiti & Lakhani, 2017, p. 4) due to prevailing problems with its large-scale implementation (Underwood, 2016).

Blockchain also poses challenges to organizations on both the business model level (e.g., Beck and Müller-Bloch, 2017) and the organizational level (e.g., Hackius and Petersen, 2020). On the business model level, the blockchain technology provides a threat to organizations whose business models depend on a third party to ensure trust as well as verification (Beck and Müller-Bloch, 2017). On the organizational level, Chang et al. (2020) found that "not all (…) organizations have been entirely ready for the Blockchain adoption" (p. 9). Technical readiness is an essential prerequisite for organizations that intend to implement blockchain technology (Hackius and Petersen, 2020). Barriers in terms of usability, relating for example to technical issues, prevail and constitute a challenge when integrating blockchain with existing software like ERP systems (Hackius and Petersen, 2020). The integration of blockchain with legacy systems requires time, and the absence of interoperability can incur costs (Wiatt, 2019). Managerial issues in the form of "standards, regulations, shared governance and building a viable ecosystem" (Lacity, 2018, p. 203) prevent many firms from moving beyond the proof of concept phase (Lacity, 2018). The impact of uncertainties on organizations, stemming from long-run regulatory issues and the absence of valid experiences and applications, constitutes adoption barriers (Hackius and Petersen, 2020). Iansiti and Lakhani (2017) also forecast that the current practice of adopting smart contracts would take several decades without institutional involvement (Iansiti & Lakhani, 2017). The missing experience on the part of the developers of blockchain software is another adoption obstacle (Hackius and Petersen, 2020).

3. Theory

3.1. Creating value through business models

The emergence of both information and communication technologies and Internet-based companies increased the attention given to the business model concept (DaSilva and Trkman, 2014), since technology only creates then economic value if "it is commercialized in some way via a business model" (Chesbrough, 2010, p. 354). As a result, the Internet not only influenced business models by questioning existing business value creation and value capture mechanisms (Teece, 2010), but also produced novel possibilities of creating value (Amit and Zott, 2001). Because of its unique characteristics, the blockchain similarly provides a promising foundation for firms to create business value (Lacity, 2018), as well as to challenge established and create new business models (Iansiti & Lakhani, 2017).

By studying e-commerce firms, Amit and Zott (2001) found that business models provide a focal firm with four sources of value creation: efficiency, complementarities, lock-in, and novelty – called the business model's "design themes" (Zott and Amit, 2010). Each value creation source builds on a well-established theoretical foundation: the value chain analysis, transaction cost theory, the resource-based view, Schumpeterian innovation, and network theory, respectively (Amit and Zott, 2001). Each theoretical foundation adopts a different perspective of value creation: the value chain analysis focuses on the activities of firms; the transaction cost theory emphasizes transactions; the resource-based view focuses on the resources and capabilities of a firm; the Schumpeterian innovation concentrates on the firm itself; and the network theory focuses on the network of firms (Amit and Zott, 2001).

Amit and Zott (2001) identified the *business model* as an appropriate unit of analysis to explain value creation potential in e-commerce firms. The business model is representative of a membrane, which simultaneously allows the consideration and connection of different but relevant theoretical perspectives (Ritter and Lettl, 2018). Hence, "a business model depicts the content, structure, and governance of transactions designed to create value through the exploitation of business opportunities" (Amit and Zott, 2001, p. 511). The content, structure, and governance of a transaction form a business model's "activity system" (Zott and Amit, 2010). Content refers to the exchange of information or goods and the capabilities and resources required to do so. Structure describes the actors' participation in the exchange mechanism and their linkages, and includes the ordering of transactions (Amit and Zott, 2001). Governance describes the actors performing and controlling the transactions (Amit and Zott, 2001; Zott and Amit, 2010).

The aspect of value creation is central to the definition, as the business model construct "mediates between technology development and economic value creation" (Chesbrough and Rosenbloom, 2002, p. 532). Value creation is the result of all actors participating in the value creation process. The customer's willingness to pay minus the supplier's opportunity costs constitute value creation. Bargaining costs are decisive in the value appropriation of every actor in the value creation process (Brandenburger & Stuart, 1996). Value capture refers to the benefits received by the focal firm in return for the value it creates, for example through the firm's acquisition and retention of consumers' payment (Priem, 2007).

Business model research can be grouped into "seven schools of thought" (Gassmann et al., 2016), one of which is the activity system perspective of Amit and Zott (2001; 2010). In this school of thought, "a business model is a set of interdependent activities spanning firm boundaries" (Gassmann et al., 2016, p. 8). Our study builds on the activity system perspective for several reasons. First, the four identified interdependent dimensions of Amit and Zott (2001) – lock-in, efficiency, novelty, and complementarities – enable us to view the business model through a dynamic lens. As changes or developments in one dimension can lead to changes or developments in other dimensions, which is the case with blockchain, this framework suits our purpose. Second, this perspective places a unique emphasis on value creation and the underlying value drivers, which enables us to understand how blockchain technology changes the way value is created. Third, as the activity system perspective emerged from observing Internet-caused changes to value creation, we find ourselves in a comparable situation in the blockchain context. Furthermore, as Amit and Zott's (2001) framework is one of the few business model concepts that builds on a strong theoretical foundation (Foss and Saebi, 2018), it assists us in framing the analysis of the blockchain's implications.

3.2. Theoretical framework – value chain analysis

A firm comprises activities performed to create value. Accordingly, its value chain consists of these interdependent value activities, which also determines the firm's competitive advantage. Value creation occurs through a firm's primary and support activities. Primary activities (inbound and outbound logistics, operations, marketing, and sales and service) are responsible for the creation of value. The support activities (human resources, technology development, infrastructure, and procurement) support the primary activities (Porter, 1998). Based on the contribution of the value activities, a focal firm can achieve a competitive advantage through a differentiation or a low-cost approach (Porter, 1998). Thus, in a value chain analysis, a decomposition of "a firm into its strategically relevant activities in order to understand the behavior of costs and the existing and potential sources of differentiation" takes place through the value chain (Porter, 1998, p. 33). However, competition and the sources of competitive advantage have changed in an increasingly digitalized business environment (Bharadwaj et al., 2013; Porter and Heppelmann, 2014). Not only did processes and strategies in business change as a result of the diffusion of digital technologies, but also on account of its products, services, and capabilities (Bharadwaj et al., 2013). In addition, interfirm collaborations emerged where value creation started to occur beyond a firm's boundaries (Bharadwaj et al., 2013; Parker, 2017). The emergence of digital technologies challenges the creation of competitive advantages, with the result that interlinking instead of selling and positioning became the firms' focus. Owning assets has become less relevant and the creation of networks more relevant; instead of capturing market shares, it has become more important to expand the market (Birkinshaw, 2019).

3.3. Theoretical framework – transaction cost theory

The transaction cost approach emphasizes transactions as the underlying unit of analysis (Williamson, 1985). According to Williamson (1981), "a transaction occurs when a good or service is transferred across a technologically separable interface. One stage of activity terminates and another begins" (p. 552). Three dimensions explain a transaction: the degree of uncertainty involved, exchange frequency, and the transaction specificity extent of investments, whereby an organization is only efficient if it's governance form matches these dimensions (Williamson, 1979). Transactions can become less efficient, primarily as a result of information asymmetries, the bounded rationality of agents, opportunistic behavior, and the emergence of complexity and uncertainty (Williamson, 1975, 1985). Unnecessary transaction costs are incurred when a complex form of governance is used to manage a simple transaction. Paradoxically, they can also be incurred when making use of a simple form of governance to manage a complex transaction (Williamson, 1979). More specifically, costs occur when "planning, adapting, and monitoring task completion under alternative governance structures" (Williamson, 1981, p. 553).

Efficiency builds on Williamsons' (1975) transaction cost theory. Amit and Zott's (2001) findings aligns with this theory because a decrease in costs increases the efficiency of e-business transactions. E-businesses provide the most recent information in a reasonable manner, hence they reduce information asymmetries. They can transfer information in a fast and easy way, which improves decision making (Amit and Zott, 2001). Another benefit is the reduction of bargaining costs (Williamson, 1975). Achieving efficiency gains becomes feasible by increasing the transparency of transactions, thus informing buyers and suppliers about the processing of products (Amit and Zott, 2001). Online business models reduce costs to process transactions by increasing their volume (Garciano and Kaplan, 2001), and they also ensure a reduction in communication and bargaining costs (Lucking-Reiley and Spulber, 2001).

3.4. Theoretical framework – resource-based view

The resource-based view (RBV) addresses the sustainable competitive advantage and strategic assets of a firm. If a firm's resource is valuable, rare, imperfectly imitable, and non-substitutable, then it represents "a source of sustained competitive advantage" (Barney, 1991, p. 115). Other (potential) rivals do not simultaneously pursue a firm's strategy to create value, and duplication is impossible (Barney, 1991). Based on the RBV, value creation through strategic assets can occur through complementarity (Amit and Schoemaker, 1993). Increasing value through complementarities is possible by combining different products and services that allow for higher value creation than the separate, individual offering of the same components (Amit and Schoemaker, 1993; Brandenburger & Nalebuff, 1997; Gulati, 1999). The strategic assets of a firm represent a combination of resources and capabilities and, thus, they constitute a potential source of competitive advantage for the firm (Amit and Schoemaker, 1993). Several instances relate to strategic assets and include: "technological capability; […] control of, or superior access to, distribution channels; a favorable cost structure; buyer-seller relationships; the firm's installed user base […] and so forth" (Amit and Schoemaker, 1993, pp. 36–37).

3.5. Theoretical framework - network theory

Strategic networks are a form of long-term, inter-organizational collaborations that allow companies to gain "access to information, resources, markets, and technologies" (Gulati et al., 2000, p. 203). Companies can learn from each other and can collectively achieve economies of scale and scope, share risks, or outsource activities (Gulati et al., 2000). In addition, strategic networks enable a company to reduce its products' time-to-market (Kogut, 2000). Since strategic networks help partners to instill confidence, they also build trust among the network's members (Gulati, 1995). Decreasing asymmetries of information result in lower transaction costs because of own learning effects and knowledge creation about partners (Gulati et al., 2000). Networks require network externalities of a specific size, both from the production and the demand-side viewpoint, to achieve economies of scale and to be valuable. The links between several networks can increase the value of a firm's network (Shapiro and Varian, 1999).

Discussions of *complementarities*, in terms of value creation and strategic assets, occur in RBV (Amit and Schoemaker, 1993). In network theory, complementary assets lay the foundation for a firm to select suitable partners to participate in its network (Gulati, 1999). It is possible to leverage value creation by linking complementarities to the main business of a firm (direct or indirect) or by executing complementarities in different ways (horizontally or vertically). Complementarities can assume the form of information, products, or services to which customers gain access. Through e-business, the online world can be connected to the offline world in terms of complementary resources, capabilities, or transactions. Also, activities can complement each other, for example, when integrating different supply chains. Complementing a focal firm's technology with the technology of a participant also creates value (Amit and Zott, 2001).

The idea of *lock-in* builds on switching costs (Williamson, 1985), the creation of network externalities (Katz and Shapiro, 1985; Shapiro and Varian, 1999), and resource-based theory (Barney, 1991). The transfer of information from one system to another, depending on the easiness of and security when transferring information, creates lock-in. The training of personnel has a similar effect, due to the investment of time and effort. Thus, lock-in occurs with high switching costs (Shapiro and Varian, 1999). E-business firms create value by providing reliable and safe transactions through third parties who demonstrate independence and high credibility (Amit and Zott, 2001).

3.6. Theoretical framework – schumpeterian innovation

Schumpeter (1939) described innovation in economic terms as "doing things differently" (p. 84). Innovation is about novel combinations, which create a novel function of production, altering economic processes. An innovation can be a novel commodity, a novel form of organization, or even the development of a novel market. It can also refer to a novel feature of production, which might be driven by the change in technologies or novel sources of supply. Innovation refers to anything done differently (Schumpeter, 1939). To measure how new an innovation is, the most often referred measure to do so is "innovativeness" (Garcia & Calantone, 2002). Garcia and Calantone (2002) found that although different researchers view innovativeness from different perspectives, they always see innovativeness as the extent to which discontinuity occurs in factors concerning either marketing and technology, or marketing or technology. The macro standpoint views innovativeness as a novel innovation's capacity "to create a paradigm shift in the science and technology and/or market structure in an industry" (Garcia & Calantone, 2002, p. 113). By contrast, the micro standpoint views innovativeness as a novel innovation's capacity "to influence the firm's existing marketing resources, technological resources, skills, knowledge, capabilities, or strategy" (Garcia & Calantone, 2002, p. 113). Hence, the innovation itself is a source of value creation.

Novelty fosters value creation through innovative products and services or the inclusion of new actors and novel connections between actors (Schumpeter, 1934). The organization of transactions is important in e-business. Creating value is possible in two ways: by linking unknown actors or by introducing new methods to conduct transactions, which in turn enhances efficiencies of processes. Other value creation possibilities address the still unknown needs of consumers or stem from the introduction of new business models (Amit and Zott, 2001).

4. Method

We apply the Delphi method – a technology forecasting technique (Linstone and Turoff, 2002) – to develop and learn from future scenarios regarding blockchain's impact on business models by 2030. Not only is there credible literature on the application of the Delphi method to systematically develop future scenarios (e.g., von der Gracht and Darkow, 2010; Kameoka et al., 2004), but also on the use of Delphi studies as an established method to investigate blockchain-related research questions (e.g., Durach et al., 2020; Holotiuk et al., 2019; Schweizer et al., 2020). The Delphi method facilitates the solidification of the opinions held by groups of experts. It follows an interactive, anonymous, and multistage approach (Rauch, 1979). It is particularly applicable when use is made of the judgment of people in cases where vital data about a particular topic are missing, or where other statistical approaches fail to produce results (Rowe and Wright, 1999).

Technological advancements can have huge impacts, which necessitate the dealing and managing of them (Branson et al., 2002) by looking into their future (Saritas and Oner, 2004). Foreseeing the future is challenging (Schoemaker, 1995) emanating from an environment characterized by change and uncertainty (Wilson and Gilligan, 2009). Therefore, it is essential to predict the environment through the lens of the PEST framework (Wilson and Gilligan, 2009). While scenario planning is suitable for the analysis of disruptive innovations (Drew, 2006), it "attempts to capture the richness and range of possibilities, stimulating decision makers to consider changes they would otherwise ignore" (Schoemaker, 1995, p. 27). Business models, in particular, require adjustments to emerging technological innovations, in order to sustain their assurance of value creation (Chesbrough and Rosenbloom, 2002).

The literature declares blockchain as a promising breakthrough technology (e.g., Beck and Müller-Bloch, 2017). However, blockchain's rapid pace of development (Leonardos et al., 2020) and its current, highly fragmented market (Lima, 2018) challenge the technology's diffusion. The general-purpose technology (Choo et al., 2020; Ølnes et al., 2017) provides opportunities for many applications (e.g., Christidis and Devetsikiotis, 2016; Gramoli and Staples, 2018; Salah et al., 2019a and b). However, "it will take decades for blockchain to seep into our economic and social infrastructure" (Iansiti & Lakhani, 2017, p. 4). In light of the technology's uncertain development (Lacity, 2018; Risius and Spohrer, 2017), especially regarding its political, economic, sociocultural, and technological aspects, the Delphi method is a suitable approach to investigate blockchain's uncertain future. Thus, this research addresses the following research question: *How will blockchain create value for business models by 2030?* The research studies blockchain's prospective macro environment by 2030, based on the PEST framework.

Despite the Delphi method's advantages, it comes with drawbacks (e.g., Hill and Fowles, 1975; Story et al., 2000) and its reliability and validity is criticized (e.g., Hill and Fowles, 1975). In response, standardization has emerged as a means to ensure the reliability in Delphi studies (e.g., Hill and Fowles, 1975; Kastein et al., 1993). Following Kastein et al. (1993), we ensured standardization throughout our entire study by systematically recruiting (and selecting) our expert panel, by applying the same questionnaire design in two of the three rounds, by retaining our questionnaire's content from the first to the last round, and by addressing the same participants from the previous round(s) for their participation in the next round. As a result, we standardized the decision-making process for our participants in each round. To ensure validity, we placed particular emphasis on in-depth interviews with blockchain experts and on their analyses to derive meaningful projections, followed by a systematic approach based on von der Gracht and Darkow (2010).

4.1. Projection evolution

By applying judgmental sampling, we selected appropriate interview partners (Saunders et al., 2009). In order to identify them, we screened conference participants, relevant journals, and newspaper articles dealing with blockchain. We also used professional social networks like LinkedIn and drew on contacts from our networks. In total, we interviewed 31 blockchain experts. Our interview guide (Appendix A) followed the PEST framework and covered specific blockchain-related questions. In addition, we researched relevant blockchain and business model literature. We specifically concentrated on Amit and Zott (2001) and Zott and Amit (2010), as these studies – by investigating sources of value creation in the business model context – provide the basis for our study. We complemented and triangulated the insights gained from the expert interviews with findings from a two-year blockchain workshop series conducted by the authors with representatives from firms in different industries.

Afterwards, we derived the projections. To capture the full spectrum of possibilities at hand, we included extreme projections (Gausemeier et al., 1998) and carefully revised our initial set of projections to avoid redundancy (Jiang et al., 2017; von der Gracht and Darkow, 2010). To ensure validity, we reviewed the projections again and checked for completeness and content credibility (von der Gracht and Darkow, 2010). This procedure led to a final set of 36 projections aligned with the PEST framework (Table 1). Regarding the socio-cultural projections, we further distinguished between projections with an organizational and a consumer focus respectively, to better understand the developments in these two areas.

4.2. Expert panel definition

The choice of experts is an essential part of a Delphi study (Gordon and Pease, 2006). Forming a panel of experts does not follow the principle of statistical representativeness (de Loë et al., 2016). Instead, it depends on the research problem and how much expertise is required to solve it (Loo, 2002). Thus, the sample size is not decisive and can vary (de Loë et al., 2016; Loo, 2002).

Since it is essential for a Delphi panel to represent a wide spectrum “of interests and expertise” in the particular discipline (Lemmer, 1998, p. 543), we followed a clear rationale in identifying and evaluating our expert panel. First, the experts had to possess superior knowledge (Ericsson, 2018) and, second, they had to be informed (McKenna, 1994) in the field of blockchain. Therefore, the experts final evaluation followed specific criteria: the expert’s know-how of blockchain, their overall work experience with blockchain or applications, their interest in the technology, their occupation, their function within the organization, and their field of work (e.g., Jiang et al., 2017). We identified experts through personal networks, blockchain newspaper articles, blockchain conference participants, previous academic blockchain publications, and searches in social networks (LinkedIn/Slack). We further searched for blockchain startups on the Internet, which helped us to identify entire teams of people working with blockchain. Furthermore, we relied on the experts’ personal recommendations. We further included experts known to the researchers through a two-year workshop series on blockchain technology. Previous literature showed that heterogeneous groups reduce decision biases as their preferences converge (Yaniv, 2011). We therefore identified experts from various industries with diverging states of the technology’s diffusion, such as the pharmaceutical industry, machinery and plant engineering, and finance. Furthermore, we included experts who stemmed from a wide range of nationalities, who came from corporate and academic backgrounds (e.g., start-up, corporate, university), and who occupied different positions (e.g., CEO, founders, blockchain consultants). Almost all of our experts, however, have an industry rather than an academic background. Initially, we identified 363 potential experts who seemed to be well-informed (McKenna, 1994) and who would be able to contribute their expertise (Lemmer, 1998) on blockchain technology.

The recruitment of panelists follows a purposeful procedure since their knowledge or their positions are relevant (de Loë et al., 2016). Whenever possible, we tried to contact the identified potential experts, mainly through social networks and rarely directly via e-mail. In the end, we were able to contact 193 experts. The experts who eventually agreed to participate (de Loë et al., 2016) provided us with their e-mail addresses, so we were able to contact them directly. When contacting the potential experts, we explicitly pointed out that we were looking for blockchain "experts". We gave no further consideration to those who did not deem themselves to be profound blockchain experts, and excluded them from our study.

Our final panel consisted of 74 experts who participated in the first Delphi round. In the second round, 51 experts participated (31,1% dropout), whereas 46 participated in the final round (9,9% dropout), marking a final dropout rate of 37,8%. Our dropout rate compares well with other Delphi studies, for example with the study conducted by

Table 1
Blockchain projections for the year 2030.

#	By 2030, …
Technological projections	
#01	… only public and hybrid blockchain-based solutions will have prevailed, building on a series of substituting generations of blockchain technologies.
#02	… blockchain-based solutions will be in use in combination with other technologies, enabling an interconnected machine economy through automation and intelligent decision-making systems.
#03	… blockchain-based solutions will easily connect with other (traditional) IT systems through a standard interface.
#04	… new algorithm mechanisms will have ensured that blockchain-based value transactions have become highly time-efficient enabling real-time and cost-efficient transactions, thus ensuring blockchain’s scalability.
#05	… blockchain will act as a single source of truth in a collaborative setting through automatization and reconciliation avoidance, leading to reduced information asymmetries and thus to the replacement of centralized databases.
#06	… blockchain-based off-chain storage solutions will have become the standard, so that data availability can be specifically restricted without hindering data exchange and evaluation.
Socio-cultural projections with a focus on consumers	
#07	… the majority of consumers will prefer blockchain-based solutions to traditional intermediaries (such as banks) for transactions due to higher trust.
#08	… the majority of consumers will have become familiar with and thus willing to use blockchain-based solutions, triggering its mass adoption.
#09	… the majority of consumers will have become more empowered as blockchain-based peer-to-peer systems allow them to participate in sharing-economy solutions while simultaneously maintaining control over their personal information.
#10	… blockchain will have led to sustainable stabilization of developing countries as it serves as the standard to eliminate tax evasion and money laundering.
#11	… blockchain will have become the standard for identifying misconduct by enforcing honesty and thus acting as a trust machine between unknown parties.
#12	… blockchain will have developed as the foundation for payment infrastructures for regions without a stable local currency, making full-backed currency systems redundant and emphasizing microcredits.
Socio-cultural projections with a focus on organizations	
#13	… blockchain-based solutions will have created new inter-organizational structures with flat hierarchies and made traditional leadership roles superfluous through autonomous power assurance, transparency and trust.
#14	… smart contracts will have become the standard for automated processes, leading to improved process efficiency and hence to drastic layoffs of employees.
#15	… blockchain-based solutions will have become standard in small and medium-sized enterprises, ensuring a mass adoption of blockchain-based solutions in this organizational context.
#16	… blockchain-based solutions will have become standard in large enterprises, ensuring a mass adoption of blockchain-based solutions in this organizational context.
#17	… blockchain-based solutions will have become standard for authorization and verification in cross-organizational supply chains, thereby enhancing transaction transparency and making trust intermediaries redundant.
Political and regulatory projections	
#18	… blockchain-based digital currency will have become a vehicle for automated transactions, however FIAT currencies will remain the dominant means of payment.
#19	… blockchain will have become embedded in an international legal and regulatory framework, which forms the foundation for blockchain-based international trade activities.
#20	… cryptocurrencies will have been declared as proper currency from a legal point of view and a change into FIAT currencies will also be possible.
#21	… a unified cross-country legal framework will have clarified how Initial Coin Offerings (ICOs) can be launched.
#22	… a legal framework for all different kinds of blockchain-based tokens (e.g. security or utility token) will have been launched, creating the conditions for treating different tokens in a regulated manner.
#23	… the legal obligations and regulations of smart contracts will have been clarified through the development of a corresponding legal framework.
#24	… blockchain-based solutions will have prevailed as the backbone of property rights by having established themselves as a common mode in the public sector (e.g. public authorities).
#25	… blockchain-based solutions will have prevailed as the backbone of property rights by having established themselves as a common mode in the private sector (e.g. companies).

(*continued on next page*)

Table 1 (*continued*)

#	By 2030, …
#26	… regulations of data protection will have been created, allowing blockchain-based off-chain data storage possibilities to guarantee data protection.
Economic projections	
#27	… bottleneck actors will have become transparent through blockchain and they will have gained more power.
#28	… enforced honesty will have reduced risk premiums in transactions due to lower transaction costs.
#29	… blockchain-based solutions will have emerged as the new standard for value transactions across industries.
#30	… pay-per-use business models enabled through blockchain will have become standard.
#31	… blockchain-based "to-go-services" will have replaced traditional payment mechanisms for services (e.g. insurance services), as payments will be immediately and automatically made upon demand on pre-defined claims.
#32	… blockchain-based sharing business models will have dominated the market and have made previously involved intermediaries redundant for transactions due to increased trust.
#33	… blockchain-based solutions will have facilitated standard-based machine-to-machine communication, ensuring that devices are able to transact with each other.
#34	… blockchain-based solutions will have contributed to the facilitation of automatic cross-border transaction execution, which has enabled new activities and economic growth.
#35	… blockchain-based micro transactions (=>either in the form of money, data or information) will have become standard through reduced transaction costs and efficient transaction processing, enabling entirely new business models.
#36	… one dominant blockchain will have developed in most industries, forcing organizations to participate.

Meijering and Tobi (2016) with dropout rates of 36% in the second round and 16% in the third round. It is normal that the number of participants in Delphi studies declines, especially when conducting several Delphi rounds (Evans, 1997; Landeta, 2006; Landeta et al., 2008). Reasons for this include time exposure, underestimating the work that comes with participation, and fatigue (Mitchell, 1991; Webler et al., 1991). To keep the dropout rate as low as possible, we tried to actively engage the experts and included participation-reminder mailings.

4.3. Delphi study

We applied the conventional Delphi method and conducted three Delphi rounds, which is the usual number (Loo, 2002). Each round followed the same procedure. For the first round, we used “Qualtrics” (http://www.qualtrics.com) to conduct the online survey. To access their surveys, our experts received individual links forwarded to their e-mail addresses. When opening the survey link, the experts were introduced to the study’s objective and were given additional but essential information, like the rounds’ duration (Gnatzy et al., 2011) and procedure. To evaluate the projections, and also to avoid them being overwhelmed by information, each expert received one projection on one page (Gnatzy et al., 2011). The experts assessed the projections in accordance with their occurrence likeliness, in percentages, until the year 2030 (e.g., Markmann et al., 2013; von der Gracht and Darkow, 2010). The year 2030 set the planning scope to build a target-oriented technological foresight (Drew, 2006).

Each expert received two participation reminders during each round. Afterwards, in order to provide them with feedback, we statistically calculated the individual results of the experts as well as the anonymous aggregated results of all participants (Flostrand, 2017; Rauch, 1979). We calculated the mean, the interquartile range (IQR), and the standard deviation (SD) (Ecken et al., 2011). By calculating the IQR, we could determine consensus achievement among the expert panel. The SD showed us the dispersion of our results (von der Gracht, 2012). We thereafter sent each participant the respective assessments to provide access to controlled feedback (Nowack et al., 2011). Based on the provided feedback, the experts reconsidered their initial answers (Flostrand, 2017; Jiang et al., 2017). We did not include projections that received consensus among experts, in the next round (von der Gracht, 2012). For the two final rounds we used Microsoft Excel, as it enabled us to summarize the previous results. After completion of the two final rounds, we calculated the descriptive statistics (Table 2).

We subsequently derived future developments based on the experts’ assessments of our projections. We specifically determined the likeliness of occurrence and the consensus rate among the experts (e.g., Jiang et al., 2017; Keller and von der Gracht, 2014).

Following Keller and von der Gracht (2014), we grouped our projections according to their likeliness of occurring, represented by the mean. Projections with an expected probability (EP) > 70% are expected to occur unambiguously, whereas those with an EP > 60% are expected to highly enter. Projections with a low degree of occurrence made up an EP > 50%, whereas those with an EP < 50% showed a low degree of non-occurrence. Projections with an EP between 30% and 40% showed a high degree of non-occurrence (Keller and von der Gracht, 2014). In order to determine consensus among experts, we used the IQR as a frequently used indicator (Gordon and Pease, 2006; Keller and von der Gracht, 2014; Warth et al., 2013). The experts reached consensus when a projection achieved “an IQR of ≤ 25%” (Keller and von der Gracht, 2014, p. 86). To classify projections with an IQR above 25%, we followed a similar classification scheme as Jiang et al. (2017) by differentiating between developments that are more certain and less certain. We re-calculated their scales to our study, by defining projections with an IQR between 25% and 31,25% as marking a higher degree of uncertainty compared to projections showing an IQR ≤ 25%. Since none of our projections showed an IQR between 50 and 70%, we decided to define the projections with an IQR above 31,25% as highly uncertain.

5. Results

Our investigations show that seven (# 02, 03, 04, 06, 18, 26, 34) of the 36 projections are unambiguously expected to occur as their EP exceeds 70%. Nine projections (# 09, 17, 22, 23, 28, 29, 30, 33, 35) reveal a strong expectation of occurrence (EP ≥ 60%). A rather low likeliness of occurrence is shown by 11 projections (# 01, 08, 12, 16, 19, 20, 21, 25, 31, 32, 36) with an EP above 50%. By contrast, seven projections (# 05, 07, 11, 14, 15, 24, 27) show an EP below 50%, indicating a low probability of not occurring. Two projections (# 10, 13) are highly probable of not occurring (30 ≤ EP ≥40). Overall, 27 of 36 projections (75%) show an EP of over 50% (Appendix B).

The first round achieved no consensus among the experts for the projections. The experts consented to eight of the 36 projections (22,2%) after round two (# 02, 04, 08, 17, 27, 30, 31, 34) and a final total of 11 projections (30,6%) after the third round (+ # 06, 07, 13).

5.1. Future developments for Blockchain by 2030

We look at a single development that is *most likely* to occur, whereas the other development is *still likely but less certain* to occur (e.g., Jiang et al., 2017). We define the *most likely* development as the development that includes those projections showing an EP ≥ 60% and a *high certainty* among experts (IQR ≤ 25%). Projections with an EP ≥ 60% have a high probability of entering (Keller and von der Gracht, 2014). This includes projections 02, 04, 06, 17, 30, and 34, as well as those with the lowest probability of occurrence (30% ≤ EP ≥40%), but still high confidence (IQR ≤ 25%) among experts (# 13). We excluded projection 13 in our discussion section, as the experts were highly certain that it will not occur by 2030 and that it will not accrue any business value. The development that is *still likely* to occur (EP ≥ 60%), but which involves a *higher degree of uncertainty* (25% ≤ IQR ≥ 31,25%), includes projections 03, 18, 22, 26, 28, 33, and 35.

Those developments that are *unlikely* to occur include the projections with an EP between 30% and ≥ 50%, including an IQR ≥ 31,25%. Due to their unlikeliness of entering, we excluded them from the further analysis. We also did not include projection 07 and 27. Even though both

Table 2
Results of the descriptive statistics.

Projection	Round 1 $N = 74$			Round 2 $N = 51$			Round 3 $N = 46$			Round 1 vs. Round 3	
	IQR	x̄	SD	IQR	x̄	SD	IQR	x̄	SD	Mean Change	SD Change
Technological projections											
#01	48,5	51,3	29,0	35,0	53,7	22,2	30,0	52,2	20,2	−0,11	−5,35
#02	30,0	80,4	21,8	**20,0**	80,2	16,5	NA	NA	NA	0,48	−2,19
#03	41,3	74,6	26,8	30,0	74,0	22,8	30,0	72,3	21,1	−0,11	−4,15
#04	28,5	76,8	21,3	20,0	76,9	19,7	NA	NA	NA	−1,43	−1,96
#05	40,5	49,1	28,5	31,0	46,5	23,8	29,3	45,8	20,7	−2,46	−6,88
#06	33,5	70,8	23,7	29,0	73,4	18,8	**21,5**	72,4	17,8	−0,57	−4,72
Socio-cultural projections customers											
#07	31,3	46,9	25,1	30,0	46,0	18,9	**21,3**	45,6	18,3	−2,57	−5,29
#08	35,5	60,4	25,5	21,0	57,9	23,0	NA	NA	NA	−0,28	−2,03
#09	34,5	58,3	26,5	35,0	61,6	23,2	36,3	61,6	22,7	1,54	−4,20
#10	46,5	35,9	25,2	40,0	33,6	23,9	40,0	33,0	23,0	−1,87	−3,41
#11	40,3	51,1	25,8	35,0	49,8	23,8	36,3	49,3	22,6	−1,26	−5,01
#12	50,3	57,1	29,2	47,0	55,0	26,7	37,8	54,4	25,1	−0,04	−3,53
Socio-cultural projections organizations											
#13	37,0	33,0	24,4	33,0	33,5	22,4	**25,0**	34,4	21,9	0,02	−2,19
#14	47,3	49,6	28,0	45,0	47,8	25,3	45,0	47,7	23,7	−3,24	−5,26
#15	34,5	44,7	24,5	36,0	43,3	22,8	30,0	43,7	21,2	−1,85	−4,42
#16	37,3	56,1	24,7	30,0	54,3	23,3	26,3	55,0	21,3	−0,02	−3,57
#17	27,3	66,5	23,3	20,0	67,2	21,5	NA	NA	NA	0,11	−1,61
Political projections											
#18	38,3	70,0	24,2	30,0	72,4	22,0	30,0	72,2	21,1	0,54	−2,31
#19	41,5	59,1	27,7	37,0	56,6	23,8	32,0	56,1	21,9	−0,33	−6,03
#20	59,8	54,7	31,5	45,0	52,1	26,2	41,0	52,9	23,8	0,24	−5,90
#21	52,5	57,5	31,0	43,0	53,1	27,0	40,0	53,9	24,9	1,83	−6,74
#22	39,3	66,0	27,0	30,0	64,4	22,8	30,0	64,2	21,0	0,20	−6,21
#23	40,0	67,7	26,6	40,0	66,6	22,5	32,5	65,8	21,3	0,46	−5,32
#24	42,8	49,0	27,3	40,0	46,4	25,1	35,3	47,0	23,6	−0,76	−4,44
#25	40,0	53,2	26,1	37,0	51,8	22,6	35,0	51,6	20,7	0,76	−5,18
#26	40,0	68,1	25,1	37,0	69,0	22,0	28,8	70,5	18,4	1,87	−5,95
Economic projections											
#27	30,0	46,1	22,1	**14,0**	46,9	19,4	NA	NA	NA	0,87	−1,45
#28	39,3	57,9	26,2	37,0	60,2	23,6	31,3	61,2	21,2	1,87	−5,26
#29	32,0	60,2	24,9	35,0	59,1	23,8	33,3	60,5	21,8	0,30	−4,82
#30	38,5	60,0	25,2	**25,0**	61,3	20,4	NA	NA	NA	1,67	−4,22
#31	34,8	57,8	25,0	**25,0**	59,1	21,7	NA	NA	NA	0,11	−2,17
#32	42,5	55,4	25,7	35,0	57,4	22,0	32,0	57,6	20,9	−0,93	−4,52
#33	32,5	62,7	28,4	30,0	64,6	25,6	25,5	63,7	25,3	−1,98	−2,68
#34	27,8	68,0	23,1	**22,0**	70,5	20,5	NA	NA	NA	1,67	−1,76
#35	32,8	70,4	26,6	30,0	71,0	24,3	31,3	69,7	23,8	−0,57	−3,52
#36	51,3	50,2	29,0	40,0	50,2	25,2	34,8	51,2	24,3	−0,43	−4,27

Bold =consensus achieved; x̄ = mean

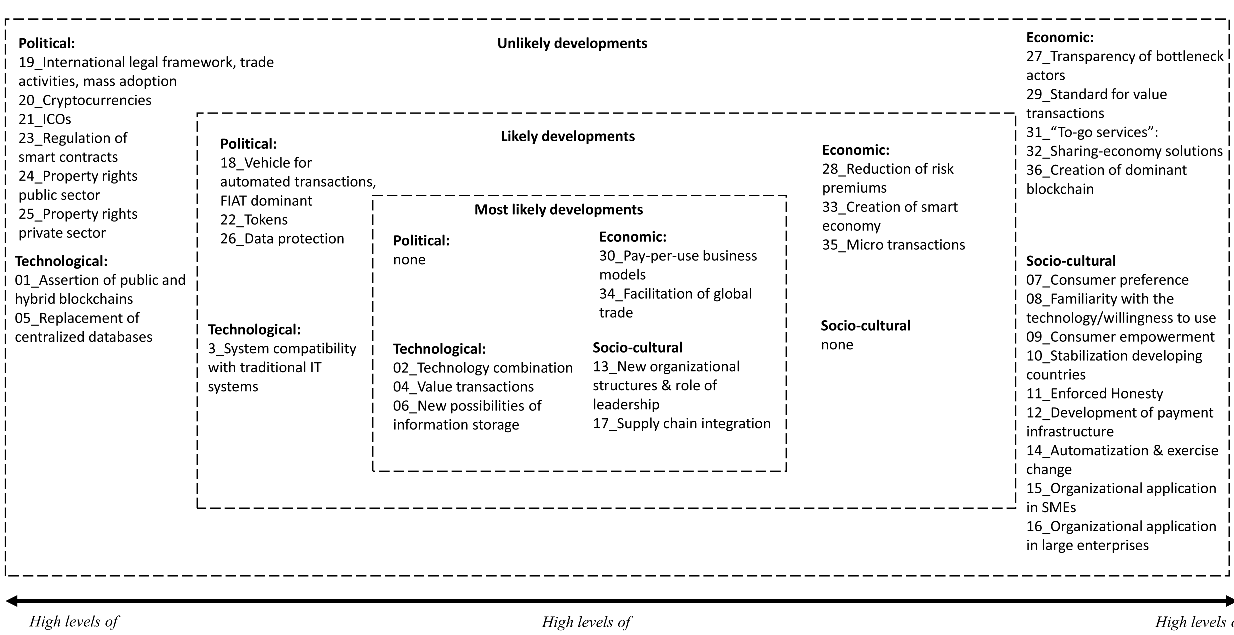

Fig. 1. Future Developments of Blockchain based on Expert's Certainty Levels.

showed an IQR below 15%, their expected probabilities exceeded 40%. Fig. 1 depicts all projections according to their likeliness of occurrence and their certainty among experts.

5.1.1. *Most likely developments*

The experts are highly confident that until 2030, blockchain-based solutions will coexist and interact with other digital technologies. This combination enables an interconnected machine economy, powered by automation and intelligent, potentially autonomously acting decision-making systems. This projection is the one most likely to occur. The experts are confident that new algorithmic mechanisms will ensure that blockchain-based value transactions are highly time-efficient, thereby enabling real-time, cost-efficient transactions. This, in turn, ensures that blockchain becomes scalable. The experts are sure that by 2030, blockchain-based, off-chain storage solutions will be standard. While this restricts the possible availability of data, it does not impede data exchange and evaluation. There is a high certainty among experts' opinions that blockchain will contribute to the facilitation of cross-border transaction's automatic execution, by providing opportunities for new activities and economic growth. The experts are highly confident that blockchain will form the standard for authorization and verification in cross-organizational supply chains. It is therefore possible to improve transparency among transactions and make trust intermediaries redundant. Through blockchain, pay-per-use business models will be the standard by 2030. By contrast, the experts are highly confident and agree that blockchain *does not* create new inter-organizational structures, does not create flatter hierarchies and does not make traditional leadership roles superfluous through autonomous power assurance, transparency, and trust.

5.1.2. *Likely developments*

micro payments

The experts agree that by 2030, blockchain-based solutions will easily connect with other (traditional) IT systems through a standard interface. They also believe that it is likely that blockchain-based digital currencies will emerge as a vehicle for automated transactions. However, FIAT currencies (legal currencies like the Euro) are expected to remain the dominant means of payment. With an even lower degree of uncertainty, experts agree that efficient regulations for data protection will be in place, allowing blockchain-based, off-chain data storage, which in turn could offer solutions for data protection guarantees. The experts are confident that blockchain-based micro transactions will be standard, building on expectations of reduced transaction costs and efficient transaction processing, which will enable entirely new business models. With an expected lower probability of occurrence and a higher uncertainty, the experts believe that the launch of a legal framework for all kinds of blockchain-based tokens will have taken place by 2030. The legal framework will allow treating all types of tokens in a regulated manner. The experts highly agree that blockchain-based solutions will facilitate standard-based, machine-to-machine communication, but its likeliness to occur is lower. The experts believe that devices will be capable of transacting with each other, even though they think that the probability of occurrence is lower. The experts are rather sure that enforced honesty, ensured through blockchain technology, will reduce risk premiums in transactions because transaction costs will decrease. This is the least likely projection to occur.

5.1.3. *Unlikely developments*

The experts generally display low levels of agreement on the *political factors* and most projections are deemed rather unlikely to enter. By contrast, only two *technological* projections are rather unlikely to enter, with low degrees of expected occurrence and with an even lower consensus among the experts. The majority of *economic* projections are rather unlikely, and none of our a priori developed projections on *socio-cultural aspects concerning the consumer* are likely to enter. Concerning the *organizational aspects*, the experts have a somewhat clearer picture in mind, even though most projections will not enter by 2030. Overall, these results show the residual uncertainty and lack of clarity of blockchain's implications.

6. Discussion

We focus the discussion on the most likely developments of blockchain by 2030 and all subsequent projections, unless otherwise indicated, are for this time horizon. Using the insights gained from expert judgments, we discuss blockchain's expected impact on a focal firm's value creation. We thereby build on the four value drivers identified by Amit and Zott (2001) in the e-commerce setting – efficiency, novelty, complementarities, and lock-in – and compare them to the blockchain context. Table 3 provides an overview of the identified effects.

6.1. *Efficiency*

A focal firm's business model can increase the value it creates through efficiency gains (Williamson, 1979). Our findings reveal numerous opportunities for efficiency gains through blockchain. By 2030, transaction speed and volume (Garciano and Kaplan, 2001) are likely to increase in blockchain-enabled business models. Blockchain's expected compatibility with other technologies (# 02) shows that standards (Lima, 2018), interoperability (Gramoli and Staples, 2018), and scalability (Biswas et al., 2018; # 04) challenges can be overcome. Currently, blockchain enables a variety of new exchange mechanisms through its P2P principle (Nakamoto, 2008) and its secure transaction transfer, corresponding to the e-commerce findings of Amit and Zott (2001). Novel algorithmic mechanisms will replace the energy-intensive procedures used at present (e.g., Swan, 2015), thereby enabling blockchain's scalability (# 04) and efficient and real-time value transactions (# 04) of all types of assets (Swan, 2015), as well as an improvement of current transaction throughput issues (Meiklejohn, 2018; Swan, 2015; Yaqoob et al., 2020). Hence, the blockchain is likely to positively impact efficiency (# 02, 04, 06, 17, 30, 34). Consequently, the technology is likely to provide the foundation that enables blockchain ecosystems to grow and mature. Blockchain-related efficiency gains emerge across organizational boundaries (# 17 & 34) in particular, thereby enabling new and previously cost-inefficient business models (# 30). Through its technological progress (# 02, 04), combined with its P2P principle (Nakamoto, 2008) and reconciliation acceleration (Christidis and Devetsikiotis, 2016), blockchain will simplify transactions, especially when crossing organizational boundaries (# 17 & 34). However, off-chain solutions (# 06) are likely to increase transaction complexity (Williamson, 1979). Presently, blockchain reduces bargaining and communication costs through its P2P principle (Nakamoto, 2008) and automation (smart contracts) (# 02, 04, 17, 30, 34). Since blockchain will enable the interconnected machine economy by 2030 (#02), bargaining as well as communication costs will further decrease due to automation and intelligent decision making across entire blockchain or machine-based networks (#02). In this respect, off-chain storage solutions (# 06) are likely to cause a negative impact. In contrast to network theory (Gulati et al., 2000), the blockchain creates the network and makes information available by likewise influencing how people, machines, or devices will make decisions. Through its technological progress (# 02, 04), blockchain is likely to cope with enormous transaction volumes (# 04), similar to the IoT (Biswas et al., 2018), making even more information available. By reducing the necessity of trust intermediaries, more information also becomes available in blockchain-based business models (# 02, 04, 17, 30, 34). By contrast, off-chain storage solutions (# 06) ensure the restriction of information or data availability, which can influence decision making, however without the impediment of data exchange and evaluation. Overall, blockchain will drastically reduce transaction costs (# 02, 04, 17, 30, 34) and increase efficiency by 2030. For off-chain storage solutions (# 06) we expect a positive and negative impact as transaction costs decrease for reasons of simplicity, but increase as a result of incomplete

Table 3
Sources of value creation through Blockchain technology by 2030.

Value Sources		Projections 02 technology combination	 04 value transactions	 06 off-chain storage	 17 supply chain integration	 30 pay-per-use business models	 34 facilitation of global trade
Efficiency	Information made available as a basis for decision-making	↑	↑	0	↑	↑	↑
	Transaction transparency and simplicity	↑	↑	↓	↑	↑	↑
	Reduction of information asymmetries	↑	↑	0	↑	↑	↑
	Transaction speed and scalability of transaction volume	↑	↑	↑	↑	↑	↑
	Bargaining and communication cost, and cost for transaction processing	↑	↑	↓	↑	↑	↑
	Exchange mechanism	↑	↑	↑	↑	↑	↑
	Transaction cost	↑	↑	↑↓	↑	↑	↑
Complementarities	Complementary products, services, and information, data*, assets*, machines*, (blockchain) technologies*, devices*	↑	↑	↓	↑	↑	↑
	Access to complementarities through firms, partner firms, customers, machines*, assets*, (blockchain) technologies*, devices*	↑	↑	↓	↑	↑	↑
	Complementary customers, assets*, machines*, technologies*, blockchains*	↑	↑	↓	↑	↑	↑
	Combination of online and offline resources and transactions	↑	↑	↑	↑	↑	↑
	Technology combination with participants	↑	(↑)	(↑)	↑	↑	↑
Lock-in	Promotion of trust through no third party*	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓
	Entry barriers	0	0	↑	0	0	0
	Customers control use of personal information	↑	↑	↑	↑	↑	↑
	Switching costs	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓
	Network externalities	↑	↑	↑	↑	↑	↑
	Information flow security and transaction reliability	↑	↑	↑	↑	↑	↑
Novelty	New activities/ combinations of products, services, and information, assets*, machines*, (blockchain) technologies*	↑	↑	↑	↑	↑	↑
	New governance (role and actors)	↑	↑	0	↑	↑	↑
	New structures (new linkages)	↑	↑	↑	↑	↑	↑
	New collaborations*	↑	↑	↑	↑	↑	↑
	New business model opportunities*	↑	↑	0	0	↑	0
	File and data storage*	↑	↑	↑	↑	↑	↑

↑: positive impact; 0: no impact; ↓: negative impact; (↑) partially positive impact.
*Additions to the Amit and Zott (2001) model, which blockchain creates.

information.

6.2. Complementarities

A focal firm's business model can benefit from complementary offerings within one activity system by creating synergies between the offerings (Zott and Amit, 2010). Our findings reveal numerous opportunities to create complementarities through blockchain by 2030. Similar to e-commerce, where the bundling of complementary products, services, and information creates value (Amit and Zott, 2001), the blockchain is likely to allow the bundling of and access to data, assets, machines, and (blockchain) technologies (# 02, 04, 17, 30, 34) or devices like those used in the IoT. Blockchain thus reaches new customers, (partner) firms, but also non-human actors like machines, other (blockchain) technologies, assets, and devices. Through the combination and interaction of multiple human and non-human actors and sources, the blockchain is likely to provide the grounds to engage in complementary activities (# 02, 04, 17, 30, 34) by 2030. In contrast to e-commerce, blockchain offers the specific complementary opportunity of conducting transactions and storing data on the chain (e.g., Xu et al., 2016). Since blockchain will become scalable by 2030 (# 04) and the interconnected machine economy is expected to prevail (# 02), blockchains and machines will also act as complementary actors and not only customers. However, despite their frequent use (Xu et al., 2016), we find that off-chain storage solutions (# 06) are likely to limit the availability of complementary information or data and that it can thus hinder engagement in complementary activities. Value creation can also occur by combining participants' technologies (Amit and Zott, 2001), as companies are expected to combine their blockchain networks (# 02, 17, 30, 34). These developments lay the foundation for the emergence of a blockchain ecosystem by 2030. The utilization of off-chain storage solutions as a standard by 2030 (# 06) will allow the specific restriction of data and thus obstruct value creation. However, by 2030, no data exchange and evaluation will occur when using off-chain storage solutions. Thus, off-chain storage solutions can have partially positive value creation effects. Another value creation aspect is the combination of online and offline resources and transactions, similar to the e-commerce context (Amit and Zott, 2001), since the transfer of every resource and transaction from the analog world into a blockchain becomes feasible (# 02, 04, 06, 17, 30, 34).

6.3. Lock-in

A focal firm can furthermore drive its value creation by locking in customers and partners (Amit and Zott, 2001). Our findings disclose only a few opportunities for focal firms to use the blockchain to create lock-in effects. We observed a reduction in lock-in effects through blockchain because trusted third parties become redundant, which trust

corresponds to previous literature (Schneider et al., 2020). In contrast to e-commerce, the promotion of trust (Amit and Zott, 2001) through blockchain occurs without a third party (Casey and Vigna, 2018; Christidis and Devetsikiotis, 2016) and is a blockchain-specific attribute. Thus, there is a reduction of lock-in effects through each of our projections. However, through blockchain, trust into conventional networks (Gulati, 1995) becomes obsolete. Instead, participants need to trust the blockchain, which in turn means a shift of trust from networks to blockchain. Schneider et al. (2020) found that low entry barriers to the public blockchain network exist without a present intermediary. Lower entry barriers also exist due to the removal of information asymmetries (Cong and He, 2019). Concerning a private network, Schneider et al. (2020) found the existence of some lock-in effects, because of the prior verification and validation of nodes desiring to enter the network (Schneider et al., 2020). Thus, lock-in depends on the blockchain type and whether the customer or user can control their personal information. However, since off-chain storage solutions (# 06) will become standard by 2030 and will restrict data availability, we believe that, prospectively, the blockchain type might not matter in future, leaving lock-in effects unaffected. Switching costs (Williamson, 1975) further decline because participation in a blockchain network no longer requires trust between two parties (Schneider et al., 2020). Blockchain usage will provide access to new actors (# 02, 04, 17, 30, 34), thereby providing a greater choice of actors and blockchain networks to market actors. Thus, switching costs are likely to decrease and the creation of a lock-in effect is to become difficult (Shapiro and Varian, 1999). As long as standardization remains low, the combination of the blockchain with other technologies (# 02) will cause a lock-in effect through high switching costs (Shapiro and Varian, 1999) (# 02, 04, 06, 17, 30, 34). However, as network interoperability and scalability (# 02, 04) increase, a potential lock-in effect is likely to disappear. The interlinkage of several networks can make a firm's network more valuable (Shapiro and Varian, 1999). The upcoming scalability (# 04), in particular, will lay the foundation to create network externalities. Blockchain will further create network externalities through the prospective development of the interconnected machine-economy (# 02) and through blockchain-based, pay-per-use business models (# 30). Support for the creation of network externalities (Shapiro and Varian, 1999) stems from the participation of new actors (# 02, 04, 17, 30, 34) and off-chain storage solutions being standard (# 06).

6.4. *Novelty*

A focal firm's business model can further increase its value through novel content, structure, or governance (Zott and Amit, 2010). Our findings reveal manifold opportunities for blockchain-enabled novelties. By 2030, it will be possible to combine blockchain with other technologies (# 02), which is likely to permit novel combinations of products, services, and information (Amit and Zott, 2001), as well as assets, machines, and technologies (# 02, 04). Novel combinations (# 02, 04, 06, 17, 30 34) align with Schumpeter's (1939) theory of innovation. Blockchain's scalability (# 04) will lay the foundation for entirely new business model opportunities, such as pay-per-use (# 30) or machine-based business models (# 02). In line with Swan (2015) and complementary to the e-commerce characteristics, the transfer of different kinds of novel value assets will become feasible as technological process provides scope for faster and more efficient solutions (# 04). Thus, by 2030 the internet of information is likely to have been replaced by the decentralized internet of value. In addition, the blockchain is likely to combine more novel actors – including autonomous machine agents – than e-commerce is capable of achieving (Amit and Zott, 2001). An example is smart contracts, which are in use at present. Technological advancements (# 02) lay the foundation for machines to become serious novel actors in the blockchain ecosystem, and thus also devices like those used in the IoT (Suliman et al., 2019). These developments also create new connections among actors (Amit and Zott, 2001). Another novelty compared to e-commerce is blockchain's storage possibility (e.g., Swan, 2015; Xu et al., 2016). Since off-chain storage solutions will apply as a standard by 2030 (# 06), we assume that they will lay the foundation to securely store sensitive data. Therefore, in respect of additional five projections (# 02, 04, 17, 30, 34), we assume that the impacts on value creation will be positive.

7. Conclusion

With the intention to investigate how blockchain can create value by 2030, we developed a most likely scenario and discussed the blockchain-enabled value drivers. Our forecasting study built on aggregated expertise and extended existing literature on value creation in the digital era, especially concerning blockchain-enabled business models. By comparing the findings of Amit and Zott (2001) on value creation in e-business to the blockchain context, we shed light on how a focal firm will create value through blockchain by 2030, in terms of a business model's design themes (Amit and Zott, 2001; Zott and Amit, 2010). Our results revealed promising value creation opportunities across all four design themes of a business model (Amit and Zott, 2001; Zott and Amit, 2010). We furthermore identified novel value creation mechanisms in three of the four design themes.

Even though no novel mechanism appeared in the design theme *efficiency* (Amit and Zott, 2001), it presents promising opportunities. Blockchain's technological developments by 2030, including the provision of standards (Lima, 2018), interoperability (Gramoli and Staples, 2018), and predicted scalability, will lay the foundation for blockchain ecosystems. Blockchain will especially become able to handle enormous transaction volumes as a pre-requisite for the IoT (Biswas et al., 2018). This finding shows that blockchain will create efficiency gains when crossing organizational boundaries. Even though blockchain currently enables efficiency gains by reducing transaction costs, as outlined in Williamson's (1979) transaction cost theory, these gains will become more important as the savings, in turn, make allowance for the emergence of new, previously unfeasible business models. However, the use of off-chain storage could have a negative efficiency impact. Changes in *complementarities* appear through blockchain. The various opportunities that blockchain provide through combination seem most promising for business models. Extending the findings of Amit & Zott (2001), we find that the combination of more non-human actors in particular will create value in blockchain-enabled business models by 2030, demonstrating that their roles will become stronger. We furthermore find that firms will prospectively combine their blockchain technologies, thus laying the foundation for a blockchain ecosystem to emerge by 2030. These results show the significance and value of the blockchain as a strategic asset. In the design theme "*lock-in*" (Amit and Zott, 2001), new elements emerged that influence value creation prospectively. Our findings demonstrate that a standard usage of off-chain storage solutions will, prospectively by ensuring control over personal information, cause blockchain types (public vs. private) to no longer matter. Due to blockchain's technological progress by 2030, a substantial creation of network externalities (Shapiro and Varian, 1999) follows, laying the foundation for the interconnected machine economy and for blockchain-based, pay-per-use business models to become a reality. Since a combination of various blockchains will follow, we expect that lock-in effects will overall decrease by 2030. New elements emerged in the *novelty* design theme (Amit and Zott, 2001). By 2030, new business model opportunities will develop, like pay-per-use business models and machine-based business models. In addition to e-commerce (Amit and Zott, 2001), the transfer of different kinds of value assets (Swan, 2015) will become feasible, mainly due to solved time and cost efficiency issues. This development will ensure that the decentralized internet of value (Lima, 2018; Tapscott and Euchner, 2019) will replace the internet of information. Since technological developments enable a blockchain ecosystem to develop by 2030, machines and devices emerge as novel actors in the business model context to create value (Amit and Zott, 2001). By using of off-chain storage solutions as standard, blockchain will become a serious competitor of central data bases in terms of storage possibilities.

Our findings show that the most likely projection that will occur by 2030 has a technological emphasis: *By 2030, blockchain-based solutions will coexist and interact with other digital technologies. This combination will enable an interconnected machine economy, powered by automation and intelligent, potentially autonomously acting, decision-making systems.* This projection implies blockchain's improvement in terms of interoperability (Yaqoob et al., 2020), allowing cases of complex blockchain use between companies or business domains (Lima, 2018) and, standard by 2030, creating a technical baseline for industry (Gramoli and Staples, 2018). This projection reveals that blockchain will be mature in terms of scalability. It also shows that a firm will create value when it combines blockchain with other technologies. Novel possibilities arise for firms to do things differently, paving the way for innovations (Schumpeter, 1939) or creating value through complementarities (Amit and Zott, 2001). Hence, by 2030, blockchain will lay the foundation that enables the resonation of different technologies like AI or IoT.

We agree with Tapscott and Tapscott (2016), who referred to blockchain as "the technology most likely to change the next decade of business." Consequently, from a technological perspective, these developments allow the creation of an ecosystem. However, to create "a viable ecosystem" (Lacity, 2018, p. 201), it is also necessary to solve other problems like regulations or shared governance (Lacity, 2018). Consequently, we agree with Iansiti and Lakhani (2017) and regard blockchain as a foundational technology.

We contribute to the emerging literature stream that discusses blockchain's value for business and value creation (Schneider et al., 2020; Zavolokina et al., 2020), particularly by complementing the current, limited empirical findings (Weking et al., 2019) about the technology's expected implications for business models. Based on well-established theoretical frameworks, we bridge existing gaps regarding missing theoretical contributions (Rossi et al., 2019) by investigating blockchain's value creation potential. We showed that even though blockchain will change the way in which firms will create value, this change will be less revolutionary than many experts predict (e.g., Zhao et al., 2016). We especially expect a change in business when a blockchain is combined with other technologies, laying the foundation for the decentralized internet of value (Lima, 2018; Tapscott and Euchner, 2019) and the emergence of blockchain ecosystems by 2030. Although the application of the Delphi method in IS research is rare (e.g., Skinner et al., 2015), our study is among the first to extend the scope of blockchain's technological aspects (Risius and Spohrer, 2017) by also explicitly investigating its political, socio-cultural and economic aspects. Our Delphi data demonstrate the need to further develop the technology and to establish frameworks that create a widespread adoption of blockchain; needs that are evident in the numerous uncertainties of political and socio-cultural aspects, as assessed by the expert panel. Our scenario-based approach within the Delphi process allowed us to strategically investigate blockchain's future by identifying prospective development paths, which in turn foster the creation of certainty about the current unclear state-of-the-art of blockchain (e.g., Glaser, 2017). Our combination of technological forecasting and the investigation of well-established theoretical frameworks highlights the innovativeness and uniqueness of this paper.

Despite the growing academic awareness of blockchain, corporate practice will benefit from this study's findings by understanding its future development. Blockchain can ensure enormous efficiency gains for organizations, especially in terms of streamlining processes. The resulting scalability causes blockchain to create new business model opportunities like pay-per-use business models and the interconnected machine economy, creating the conditions for blockchain ecosystems to emerge by 2030. Hence, blockchain will create value for business models in isolation, but more specifically when embedded in an ecosystem (either firm or technology-based). Complementarities in blockchain-based business models, in particular, create value by prospectively bundling data, virtual assets, machines, other (blockchain) technologies, and devices. Hence, managers have to consider that blockchain causes non-human actors' roles to become stronger. An important finding for corporate practice is that off-chain storage solutions will become standard by 2030, resulting in the prospective that blockchain types (public vs. private) will no longer matter. Consequently, public blockchains are expected to be of interest for an organizational setting, rather than private blockchains. Besides enabling entirely new business models, blockchain will ensure the decentralized internet of value, thus replacing the current internet of information. Organizations should furthermore seriously consider the prospect of using blockchain as storage possibilities rather than central data bases.

The future impact of the blockchain technology on business and society remains highly uncertain. Our findings provide managers with a first guideline to develop a blockchain strategy by showing how the blockchain can create value. By revealing the underlying value drivers, our analysis provides a starting point to identify relevant application fields for the technology in the organizational context, with some of them being more obvious than others. We support long-run strategic planning by fostering the understanding that blockchain will create value in combination with other technologies. Our results clearly underline the potential of blockchain technology. We also flag the remaining uncertainties, in particular the policies and regulations in respect of which our experts struggled to agree on the most likely scenario, as the main challenges confronting the technologies' diffusion.

Our study is not without limitations. Despite the Delphi method's advantages, it remains a forecasting technique that suffers from the uncertainty of future developments and the experts' subjective judgments involved in the data collection. Over time the use of additional forecasting techniques, which cater for short-term predictions and qualitative empirical work that monitor the developments caused by blockchain in markets and society, could complement and enhance the findings of this study. Blockchain's diffusion into different industries and observations of the business model transformations it causes, especially in businesses in which trust and privacy prevail, provide interesting avenues for future research. This study specifically emphasized the implications of a single digital technology used in isolation. As the most likely projection foresees blockchain to interact with other digital technologies, a better understanding of resulting interdependencies emerges as a promising future research avenue. Finally, our analysis reveals several areas in which experts have widely divergent expectations. Although this is not an unexpected outcome of Delphi studies, it reveals rewarding avenues for future research that can reduce the remaining uncertainties about the developments caused by blockchain technology.

Author statement

No author statement submitted.

Appendix A. Interview Guide

List of Questions

A **Background**

- Could you please briefly introduce yourself and describe your current role at <<COMPANY>>?
- Which experiences have you made with the blockchain technology so far?
- Since when do you deal with the blockchain technology?

B **Technological aspects**

We would like to start now with the first of five dimensions considered in this interview, the technological implications. How would you in general describe the technological potentials of the blockchain?

- Which chances and potentials through the blockchain technology do you see?
- Which efficiency potentials do you relate to the blockchain technology?
- Which technical limitations do you relate to using the blockchain technology?
- Which drivers for adopting blockchain technology do exist?
- Which adoption obstacles do you relate to blockchain?
- Where do you already use blockchain applications either in a private or a business context?
- How do you see blockchain to be interdependent on other (digital) technologies?
- Which technological strategy do **"early pioneers"** and in contrast "followers" follow in developing and implementing blockchains?

C **Economic Aspects**

We now focus on the next dimension of the interview, the economic aspects. Which economic implications do you expect blockchain to have?
Economic Implications

- According to your assessment with regards to the technology, where do you see economic chances that become realizable through blockchain?
- How can *__blockchain applications__* provide economic chances?
- Which economic threats can arise through the blockchain technology?

Business Model Implications

- In your opinion, how will competitive advantages within existing business models be challenged by the blockchain technology?
- Which impact will the blockchain technology have on already existing business models?
- Which impact do you think will the blockchain technology have on new business models?
- Which industries do you think will be impacted? And how?

D **Policy aspects**

Moving on the third dimension covered in this interview, policy aspects. Which implications does blockchain have on politics and regulators?

- How do you perceive the current legal framework for blockchain technology?
- Given the fact that blockchain is not constrained by country borders, which role do legal systems play for the blockchain technology from your point of view?
- How do you see data protection in blockchain transactions?
- In your opinion, how will governments regulate blockchain solutions in the future? In Germany? In Europe? Do you see any difference between countries? If so, which? When?
- Which impact do you think will the blockchain technology have on property rights?
- From your point of view, which role do lobbyism and protectionism of existing systems (e.g. banking sector) currently play in the context of the blockchain technology?

E **Socio-cultural aspects (referring to potential shifts in consumer behavior and demand)**

We now move on to the fourth dimension, the socio-cultural aspects. Which socio-cultural implications with regard to *__potential shifts in consumer behavior and demand__* do you relate to the blockchain?

- Which impacts of a peer-to-peer principle on the society do you see? relates to perceived benefit for society construct
- Which impact will the blockchain technology have on developing countries?
- How useful do you perceive the blockchain technology for the individual?
- How useful do you perceive the blockchain technology for the society overall?
- How easy is the usage/handling of the blockchain technology for individuals?
- How easy is the usage/handling of the blockchain technology for the society overall?

F **Socio-cultural aspects (referring to "within organizational aspects")**

Which socio-cultural implications with regard to *__within organizational aspects__* do you relate to the blockchain?

Individual

- Which implications on employees through the blockchain technology do you expect?

Organizational

- Which impact has the blockchain on power structures and power balances within organizations?
- How easy do you think is the usage of the blockchain technology for organizations?

Appendix B. Classifications of Projections regarding EP and Consensus based on Keller and von der Gracht (2014)

Classification	# Projection	EP	Consensus
High degree of expected non-occurrence	10_Stabilization developing countries	32,98	40,00
	13_New organizational structures & role of leadership	34,37	25,00
Low degree of expected non-occurrence	15_Organizational application in SMEs	43,65	30,00
	07_Consumer preference	45,61	21,25
	05_Replacement of centralized databases	45,80	29,25
	27_Transparency of bottleneck actors	46,86	14,00
	24_Property rights public sector	47,00	35,25
	14_Automatization & exercise change	47,70	45,00
	11_Enforced honesty	49,26	36,25
Low degree of expected occurrence	36_Creation of dominant blockchain	51,17	34,75
	25_Property rights private sector	51,63	35,00
	01_Assertion of public and hybrid blockchains	52,24	30,00
	20_Cryptocurrencies	52,91	41,00
	21_ICOs	53,89	40,00
	12_Development of payment infrastructure	54,43	37,75
	16_Organizational application in large enterprises	54,98	26,25
	19_International legal framework, trade activities, mass adoption	56,11	32,00
	32_Sharing-economy solutions	57,63	32,00
	08_Familiarity with the technology/willingness to use	57,94	21,00
	31_"To-go services":	59,10	25,00
High expectation of occurrence	29_Standard for value transactions	60,52	33,25
	28_Reduction of risk premiums	61,20	31,25
	30_Pay-per-use business models	61,31	25,00
	09_Consumer empowerment	61,63	36,25
	33_Creation of smart economy	63,67	25,50
	22_Tokens	64,17	30,00
	23_Regulation of smart contracts	65,83	32,50
	17_Supply chain integration	67,20	20,00
	35_Micro transactions	69,72	31,25
Unambiguous expectations of occurrence	26_Data protection	70,50	28,75
	34_Facilitation of global trade	70,55	22,00
	18_Vehicle for automated transactions, FIAT dominant	72,17	30,00
	03_System compatibility with traditional IT systems	72,35	30,00
	06_New possibilities of information storage	72,41	21,50
	04_Value transactions	76,94	20,00
	02_Technology combination	80,18	20,00

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