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Blockchain: A business model innovation analysis

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ABSTRACT

The adoption of blockchain-based technologies by organisations can bring benefits in terms of firms' profitability, productivity and efficiency, making companies rethink their existing business models. However, as the technology is still developing and the research on the implications of the different types of blockchain networks (i.e. public, private, consortium) is scarce, their role in business model innovation requires closer attention. To address this gap, the paper provides a conceptual insight into the role of blockchain technology in companies with different value configurations by examining the technological conditions that can impact business models and probing the role of technology benefits in driving company value. The analysis contributes to the literature by discussing the business implications of innovative technologies and uncovering their positive and negative consequences for the value creation, delivery and capture activities. Such analysis sheds light on the functions of blockchains that have a differentiating impact on business processes. Also, the paper puts forward managerial implications by discussing the paths of business model innovation using blockchain technologies.

1. Introduction

A business model is the logic of doing business and a firm's activities directed at creating competitive advantage and improving company offerings to deliver value for all stakeholders involved (Amit & Zott, 2012; Johnson, Christensen, & Kagermann, 2008; Morris, Schindehutte, & Allen, 2005; Timmers, 1998). Firms digitalise their business models to improve business competitiveness in the realities of the dynamic market, technological innovations and changing customer needs (Kraemer, Dedrick, & Yamashiro, 2000; Li, 2020; Schallmo, Williams, & Boardman, 2017; Weill & Woerner, 2013). One of the technological innovations that has disrupted the way of doing business is the 'blockchain' (Frizzo-Barker et al., 2020; Nowiński & Kozma, 2017; Upadhyay, 2020). This is a distributed ledger technology that records and stores digital data in blocks across multiple locations in the network connected via cryptography, thus ensuring the immutability of records (Albayati, Kim, & Rho, 2020; Li & Whinston, 2020; Notheisen, Cholewa, & Shanmugam, 2017). Originally used in the financial sector, nowadays the blockchain has found an application in digital data transactions across industries. A blockchain can create capabilities for organisations by changing how parties connect in digital exchange (He, Meadows, Angwin, Gomes, & Child, 2020; Weking et al., 2019; Zhu, Peko, Sundaram, & Piramuthu, 2021). The utilisation of blockchains in business processes brings far-reaching consequences, including the authentication of transactions, the facilitation of disintermediation, the improvement of efficiency and trust among the members of an organisational ecosystem (Abbas, Martinetti, Moerman, Hamberg, & Van Dongen, 2020; Ali, Ally, & Dwivedi, 2020; Notheisen et al., 2017; Rimba et al., 2020). These benefits can radically change business processes in organisations. However, the technology is still developing and research studies have raised concerns around technological challenges during implementation, ethical issues and security threats (Fotaki, Voudouris, Lioukas, & Zyglidopoulos, 2021; Kumar, Ramachandran, & Kumar, 2020; Lacity, 2018; Yli-Huumo, Ko, Choi, Park, & Smolander, 2016).

The literature on business model innovation and blockchains is under-researched. The majority of the research adopts a technical perspective for providing the conceptual models of blockchain-based information systems and discussing the architecture of the technology enabling value creation (Kavanagh & Ennis, 2020; Pereira, Tavalaei, & Ozalp, 2019; Valtanen, Backman, & Yrjölä, 2018; Yang, Chen, Chen, & Wu, 2019). Scholars have explored the design perspective of the technology and focused on specific applications of the blockchain for

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business processes, such as supply chain management (Wang, Chen, & Zghari-Sales, 2021). The focus on technical aspects hinders the evaluation of the practical value of the innovation in the organisational context. Several studies analysed the impact of blockchains in creating strategic capabilities (Erceg, Damoska Sekuloska, & Kelić, 2020; Schneider, Leyer, & Tate, 2020) and explained the implications of the technology for the introduction of new activities, and the change in the governance and structure of existing activities (Schneider et al., 2020). However, the studies have not explicitly explored the role of technology characteristics in value creation, delivery and capture across businesses with different value configurations (Erceg et al., 2020; Schweizer, Schlatt, Urbach, & Fridgen, 2017). Researchers have tended to discuss only positive contributions of the technology to organisational performance and paid no attention to technology functions potentially lowering business value (Chong, Lim, Hua, Zheng, & Tan, 2019; Morkunas, Paschen, & Boon, 2019; Schlecht, Schneider, & Buchwald, 2021). As a result, the conditions under which a blockchain-based business model can contribute to the success of business development and justify investments are unclear (Dinger & Hartenstein, 2006). Therefore, an analysis is needed to understand the role of blockchain technology in creating, delivering and capturing value, and the technological conditions that could impact business models.

To fill the gaps in research, the objective of this study is to understand the role of blockchains in value shops, value networks and value chains. To address the objective, first, the paper examines different types of blockchain and their technical characteristics. We analyse the literature on blockchains to explore how public, private and consortium blockchain networks differ by the degree of control, participants' access to data and operational complexity. Then, the paper draws on prior literature in the domain of business model innovation to explore what benefits different types of blockchain technology bring to business models functioning as value shops, value networks and value chains. The analysis of the blockchain literature, in turn, enables us to propose the potential risks that different technical characteristics bear for business models. The identified benefits and risks are mapped and explained in relation to business model functions, namely, value creation, delivery and capture. Second, the paper discusses the implications of blockchains for business model innovation. Specifically, the paper discusses how the benefits of blockchain networks drive the value of the firm by introducing new business activities or changing the way to carry out existing ones.

By addressing the above objectives, the study makes two contributions. First, the paper provides a list of technical characteristics and explains their functions, which serves as a point for differentiation when it comes to analysing the consequences of blockchain adoption in organisations. The findings of such an analysis add to the discussion in the current body of knowledge, which offers insights into blockchains without discriminating between dissimilar functions created by different blockchain networks (Brilliantova & Thurner, 2019; Chang et al., 2020; Kimani et al., 2020). Second, the analysis of benefits and risks in terms of value creation, delivery and capture help understand the paths for business model innovation through blockchain integration. The study explains the conditions for unlocking or hindering the utility of the technology in companies' value chains, value shops and value networks. These findings contribute to the literature, which has predominantly focused on the benefits of blockchains for business models, paying no regard to the potential value destructive consequences of blockchain adoption (Chong et al., 2019; Fernando, Rozuar, & Mergeresa, 2021; Morkunas et al., 2019; Tiscini, Testarmata, Ciaburri, & Ferrari, 2020).

The following section will present the key concepts in the business model innovation literature, which reflect the functions of business models. The second section will describe the conceptual approach underpinning the review and analysis of the benefits and risks in the literature. The third section will present a synthesis of the blockchain literature on the differences among the blockchain networks underpinning the functions of the business model. The fourth section will present a review of the benefits and risks different types of blockchain technology bring to business models functioning as value shops, value networks and value chains. The fifth section will analyse the ways of innovating business models with different value configurations enabled through the adoption of the private, consortium and public blockchain. The paper concludes with limitations and future research suggestions.

2. Business model innovation

A business model defines the logic of a firm by articulating the methods of value creation and delivery, and outlining associated costs and revenues (Teece, 2010). The innovation of the business model concerns the changes in company value creation, value delivery and value capture functions (Bhatti, Santoro, Khan, & Rizzato, 2021; Chesbrough, 2007; Coskun-Setirek & Tanrikulu, 2021). Value creation is rooted in resources/capabilities, technology, partnership networks and activities. Those assets represent the sources of competitive advantage that are required to create a company offering to satisfy customers' needs. The value delivery function defines solutions for customers and the ways they are offered (Chesbrough, 2007; Clauss, 2017; Sorescu, Frambach, Singh, Rangaswamy, & Bridges, 2011). It includes the modelling of company offerings, identifying customer segments/markets, customer relationship and promotion channels (Bucherer, Eisert, & Gassmann, 2012; Chesbrough, 2007; Ibarra, Ganzarain, & Igartua, 2018). Business models can be innovated to either create new markets or better serve existing markets (Amit & Zott, 2012). Value capture concerns the activities that are directed at ensuring the company's long-term development (Bucherer et al., 2012; Chesbrough, 2007; Clauss, 2017). Firms may innovate the value capturing mechanism by adjusting revenue generation schemes and cost structures (Bucherer et al., 2012, Chesbrough, 2007, Clauss, 2017).

The changes in value creation, delivery and capture can reflect the introduction of new activities, a new structure and/or a new form of governance of company activities (Amit & Zott, 2001; Amit & Zott, 2012). When it comes to digital transactions, activities can represent new information exchanged online or services offered. The structure of existing activities in digital transactions refers to a new way of connecting parties or a new order in which transactions take place. Governance concerns the changes in the control over the provision of services and the flow of transactions (Amit & Zott, 2001). Such transformations result in the creation of novel customer experiences and offerings or lead to operational improvements captured by four value drivers, namely novelty, lock-in, complementarity and efficiency. Novelty captures the degree of innovation introduced to activities. Lock-in refers to the value-added and bundled to an existing offering, which increases switching costs. Complementarity relates to a value-enhancing added offering. Efficiency refers to cost-savings realised by interrelating activities (Amit & Zott, 2012). Based on the above evidence from the literature (Bhatti et al., 2021; Chesbrough, 2007; Coskun-Setirek & Tanrikulu, 2021), the innovation of a business model, namely its value creation, value delivery and value capture functions, helps introduce new company activities, new structures and new forms of the governance of company activities. These implications, in turn, potentially add value to company offerings.

The adoption of the blockchain can create a novel digital infrastructure in organisations that could drive business model innovation (Chong et al., 2019; Hinings, Gegenhuber, & Greenwood, 2018; Morkunas et al., 2019; Tiscini et al., 2020). The transformation of business models enabled by digital and/or innovative technologies, such as the blockchain, leads to the creation of different variants of value configurations, which can be grouped into value shops, value chains and value networks (Chong et al., 2019; Fjeldstad & Snow, 2018). Business models modelled as value chains are the most common among the three value configurations (Chong et al., 2019). They describe sequential business processes that result in the transformation of a company's inputs into products. Activities may include logistics, marketing, services and operations, among others (Stabell & Fjeldstad, 1998). In digital business models, technologies are used to innovate value chains by revolutionising existing business practices (Chong et al., 2019). Value shops offer tailored solutions to customers through iterative, cyclical and interrelated activities. This implies an intensive use of technology for identifying customers' problems, their solutions, control and evaluation (Stabell & Fjeldstad, 1998). Value networks link multiple stakeholders (e.g. customers, suppliers, business partners) through mediating technologies, enabling multiple activities to go on in parallel (Chong et al., 2019). Differences in value configurations lead to the discrepancies in the value creation, delivery and capture logics of business models (Chong et al., 2019). Hence, the role of blockchain technology needs to be realised in relation to business model functions and value configurations.

The following section discusses the approach adopted by this study to explore the role of the blockchain in innovating business processes, as well as the implications of the technology for the design of a business model.

3. A conceptual approach

The study adopts a conceptual approach to investigating the implications of the blockchain for business model innovation. First, we analysed the literature on blockchains to identify the characteristics of the technology and their potential advantages and disadvantages for business processes. Although it has been suggested that technology can offer a novel service and an efficient and reliable channel of data exchange (Garg et al., 2021; Morkunas et al., 2019; Ribeiro-Navarrete, Botella-Carrubi, Palacios-Marqués, & Orero-Blat, 2021; Tönnissen & Teuteberg, 2020), it can cause privacy, scalability and interoperability challenges (Lacity, 2018; Marikyan, Papagiannidis, Rana, & Ranjan, 2022; Moyano & Ross, 2017; Yli-Huumo et al., 2016). Such risks can undermine the value of a firm's offerings. Hence, the lack of clarity in the literature requires an analysis of blockchain technical characteristics that could bear the risks or benefits for business model innovation, and in consequence have positive or negative implications for companies operating as value shops, value networks and value chains. Then, we mapped the identified characteristics of blockchains in terms of their benefits and risks for transforming the value creation, value delivery and value capture functions of business models with different value configurations, which were drawn from the literature on business model innovation (Bhatti et al., 2021; Chesbrough, 2007; Chong et al., 2019; Coskun-Setirek & Tanrikulu, 2021; Fjeldstad & Snow, 2018). The second step in the analysis was an exploration of the implications of blockchain technologies for businesses, for which the categorisation of business model design elements (i.e. new activities, new structures, or new governance) was adopted (Amit & Zott, 2001; Amit & Zott, 2012). The third step was probing potential value drivers (i.e. lock-in, complementarity, efficiency, novelty) that BMI implications capture. Fig. 1 demonstrates the framework of the analysis of the literature on blockchain technologies and business models. The results of the synthesis of the literature are discussed in the following sections.

4. Value creation, delivery and capture: a blockchain perspective

4.1. Blockchain technical characteristics

A blockchain is defined as *"a technology which made possible to build an immutable, distributed, always available, secure and publicly assessable repository of data (ledgers), which relies on a distributed consensus protocol to manage this repository* (e.g., to decide what valid new data to include) *in a distributed manner"* (Sankar, Sindhu, & Sethumadhavan, 2017). Technically, a blockchain is not a single technology, but rather a protocol operated on a distribution ledger (Aujla et al., 2020; Bauer, Zavolokina, Leisibach, & Schwabe, 2019; Zheng, Xie, Dai, Chen, & Wang, 2017). The distribution system works as a *data validation mechanism,* making data exchange secure and trustable. Data is inscribed into blocks that are stored on the computers of all actors of the network. The sequence of boxes created reflects the sequence of transactions, which end up in the chain of cryptographically protected blocks, thus making data difficult to tamper with. The inclusion of a new piece of data (i.e. block) is controlled by the consensus mechanism – the consent of all participants across the network. The conditions of transactions are written in a smart contract (Tönnissen & Teuteberg, 2020). This is triggered automatically when the conditions of digital transactions are met, thus eliminating the need for a trusted intermediary to oversee a transaction (Queiroz, Telles, & Bonilla, 2019).

The benefits and risks of blockchain adoption differ depending on the type of blockchain, which can be public, consortium or private. Although all blockchain types have robust *data validation* mechanisms, they are differentiated by the degree of *data accessibility*, *decentralised control* and *operational complexity* they provide (Bauer et al., 2019; Morkunas et al., 2019; Zheng et al., 2017). A public blockchain does not restrict access to data, as the participation in the network is free for all actors (Bauer et al., 2019). The fact that all parties can see transactions makes it the subject of privacy concerns (Morkunas et al., 2019). Since records are duplicated for a large number of participants, it is almost impossible to alter data, which is more secure. Public blockchain services are completely decentralised and uncontrollable by any party (Zheng et al., 2017). Given that a public blockchain is larger because of the number of actors, it requires more computational power and complex mechanisms to keep data secure (Morkunas et al., 2019; Zheng et al., 2017). Private and consortium blockchains are similar in terms of the conditions of participation in transactions (Zheng et al., 2017). The participation is based on permission, which means that the details of transactions are accessible for reading and validation only by the participants of the network (Bauer et al., 2019). The networks are smaller, which implies some risk of data tampering, although they are easier to operate and produce greater throughput (the frequency of transactions per second) (Morkunas et al., 2019, Zheng et al., 2017). When it comes to the degree of decentralisation, a private blockchain is fully controlled

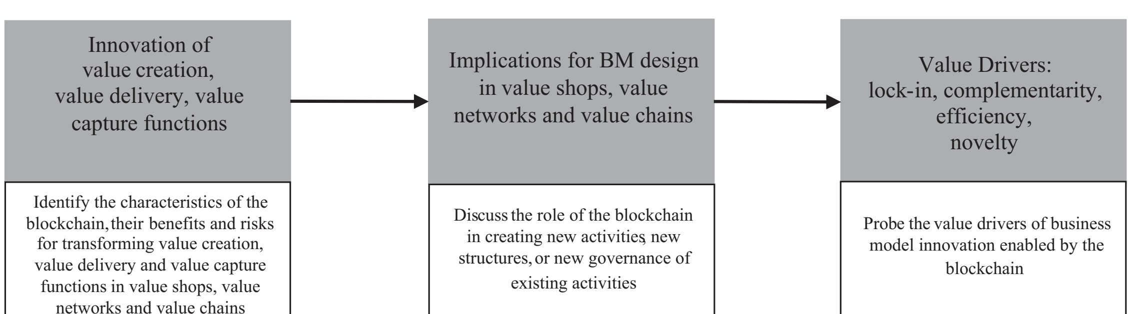

Fig. 1. Business model innovation and the blockchain.

(centralised), while a consortium one is partially centralised (Zheng et al., 2017).

Table 1 presents the mapping of the benefits and risks stemming from the technical characteristics (data accessibility, operational complexity and decentralised control) of public, consortium and private blockchain networks for business models functioning as value shops, value networks and value chains. Specifically, value creation is contingent on two capabilities. The first one is the capability of fostering collaborations between network actors. On the one hand, data validation increases confidence in transaction security, thus facilitating trustable collaborations (Bauer et al., 2019; Caro, Ali, Vecchio, & Giaffreda, 2018; Chong et al., 2019; Maull, Godsiff, Mulligan, Brown, & Kewell, 2017). On the other hand, data validation makes transactions irreversible, reducing the flexibility in experimentation and interactions between actors (Chen & Bellavitis, 2020). The second capability reflects the opportunity to control transactions. By tracing the quality of services and the customer's journey, firms redefine the value creation process by adjusting firms' offerings (Bauer et al., 2019; Behnke & Janssen, 2020). However, control can compromise users' privacy, which has the opposite effect on value creation (Lu et al., 2019; Tiscini et al., 2020). The role of a blockchain in value delivery reflects the degree to which technology facilitates the efficiency of service delivery, measured by two factors. First, a successful process is rooted in fast and secure operations ensured by the disintermediation mechanism, increasing the turnover of transactions (Chen & Bellavitis, 2020; Morkunas et al., 2019). However, in permission-less networks, disintermediation adds operational complexity, creating challenges in the manageability of service delivery and increasing the risk of operational disruption (Behnke & Janssen, 2020; Chong et al., 2019; Janssen, Weerakkody, Ismagilova, Sivarajah, & Irani, 2020). Second, value delivery efficiency reflects the ability to reach a wider audience. Although the blockchain can create network effects, the provision of access to data by an excessive number of users could be at the expense of system scalability (Gervais et al., 2016; Kundu, 2019). When it comes to value capture, the blockchain has a conflicting effect on an organisational cost-revenue scheme. While evidence suggests that the adoption of a blockchain can help reduce the transaction costs associated with tracing, monitoring and securing data (Ahluwalia, Mahto, & Guerrero, 2020; Morkunas et al., 2019), the deployment and the maintenance of blockchain infrastructure require enormous investments (Notheisen et al., 2017). A detailed discussion of the technical characteristics of public, consortium and private blockchain technologies underpinning their benefits and risks in relation to business model functions and value configurations is provided in the following section.

Table 1
Mapping blockchain technical characteristics, benefits & risks in relation to business model functions and value configurations.

Functions of BM	Blockchain Benefits and Risks	Value shop	Value network	Value chain
Value creation	**Trustable collaboration**	Public Consortium	Public Consortium	Public Consortium
	Inflexible transactions	Public Consortium	Public Consortium	Public consortium
	Controlled value		Private Consortium	Private Consortium
	Privacy issues		Public	Public
Value delivery	**Service Delivery**		Public Private Consortium	Public Private Consortium
	Service Disruption		Public	Public
	Network Effect	Public	Public	Public
	Scalability Challenge	Public	Public	Public
Value capture	**Cost Efficiency**	Public Consortium	Public Private Consortium	Public Private Consortium
	Increased Investment	Public	Public	Public
Blockchain type	**Technical characteristics of the blockchain**			
Public Blockchain	accessibility – permission-less, control over transactions – decentralised, complexity - high			
Consortium Blockchain	accessibility – permissioned, control over transaction – partially decentralised, complexity – medium			
Private Blockchain	accessibility – permissioned, control over transactions – centralised, complexity – low			

4.2. Value creation

4.2.1. Trustable collaboration – inflexible transactions

Benefit: Blockchain technology can enable the development of a platform facilitating collaborative interaction, affecting the company's business models and value configurations. *Trustable collaboration* is an important asset for value creation as it ensures the development of ideas and the co-creation of value by horizontally integrating company stakeholders (Bauer et al., 2019; He et al., 2020; Scekic, Nastic, & Dustdar, 2018; Zavolokina, Ziolkowski, Bauer, & Schwabe, 2020). Collaboration between stakeholders serves as a strategic success factor for the creation of novel solutions (Kiel, Arnold, & Voigt, 2017). Stakeholders receive the ability to control the development of value offerings by leveraging the blockchain system for maintaining the free exchange of ideas (Scekic et al., 2018). Trustable collaborations are facilitated by the networks, which are more inclusive in terms of the number and the type of stakeholders involved in value creation and exchange (Morkunas et al., 2019; Zavolokina et al., 2020). Technically, such conditions are provided by public or consortium blockchains, offering strong data validity and high data accessibility (Bauer et al., 2019; Caro et al., 2018; Chong et al., 2019; Maull et al., 2017). Data validity is enabled by the blockchain system and smart contracts, ensuring that data records are immutable, and transactions are trust-free and disintermediated. The trust-free disintermediation mechanism guarantees that stakeholders receive verified data about value offering (Bauer et al., 2019). The smart contract contributes to collaborative activity by processing data in such a way as to achieve pre-defined and targeted consequences, thus ensuring the accuracy of the end result (Beck, Stenum Czepluch, Lollike, & Malone, 2016; Kowalski, Lee, & Chan, 2021). This mechanism enforces the fulfilment of contractual obligations and helps determine rewards or inflict a penalty for the breach of the transaction's conditions (Scekic et al., 2018). The second determinant of trustable collaborations is high data accessibility. The transaction data, which is recorded and synchronised at every node in the system and which is validated by consensus mechanisms, is accessible by every member of the network (Maull et al., 2017; Tiscini et al., 2020). This makes the history of transactions traceable at any point in time (Chong et al., 2019). Such a feature helps determine company capabilities and resources for the development of the strategy of product and service offerings (Caro et al., 2018; Chong et al., 2019).

Value configurations: The ability to collaborate freely in the networks enabled by public and consortium blockchains is manifested across business models with different value configurations. *The value shop company,* such as ChainArchitect, utilises a public blockchain to offer an open-access platform and open innovation opportunities to different organisations. The company capitalises on trustable collaborations to offer resources that customers can use to tailor customisable business applications (Chong et al., 2019). Public blockchain-based platforms, such as Sensorica and http://Blockchain.info, create value by giving access to a variety of online open-source services (Kazan, Tan, & Lim, 2015; Pazaitis, 2020). Their stakeholders are software developers and public entities, who collaboratively work on the provision of innovative products and services (Kazan et al., 2015). The transparent nature of relations between stakeholders encourages a fair distribution of created value among the members who have access to the platform (Pazaitis, 2020). An example of the consortium-based value shop business model is the Linux-based Hyperledger platform, which embraces over 200 firms co-developing IT applications. Its stakeholders co-create value by developing solutions for finance, manufacturing, supply chains and other sectors (Morkunas et al., 2019).

Value network business models facilitate inter-organisational collaboration and the development of a business ecosystem, aiding the implementation of common business tasks (Zavolokina et al., 2020). For example, in the service provision industry, public blockchains can be applied to create an open online learning platform, securely connecting education providers and accrediting bodies, thus giving online learners the opportunity to receive certified education on-demand. The trust-based environment facilitates value creation, whereby the intellectual property of providers and learners' records are secured by sophisticated validation mechanisms (Paraschiveanu, Richardson, & Voicu-Dorobantu, 2020; Sun, Wang, & Wang, 2018). Public blockchains can also disintermediate traditional trade relations by introducing digitalised payment validation systems. They increase trust between trading partners, improve the efficiency of financial transactions and facilitate inter-party collaborations (Chang, Chen, & Wu, 2019; O'Leary, 2017). In consortium companies operating as value networks (ChainFinance), the introduction of a blockchain-based system mediating business entities facilitates the process of achieving consensus among stakeholders and data sharing (Chong et al., 2019). For example, ChainFinance encourages value creation by ensuring that all employees follow quality assurance policies. Trust-based disintermediation also enables the company to control the cash inventory and carry out precise cash allocation, increasing the efficiency of the use of resources (Chong et al., 2019). Similarly, in the consulting sector, a consortium blockchain can connect industry-specific providers who can collaboratively create turn-key solutions satisfying specific customers' needs (Gerth & Heim, 2020).

Companies operating as *value chains* produce and co-produce products, such as Libra and Bitcoin. The public access to data fuelling trustable interactions between the parties in public blockchains brings market value. The transparency eliminates the possibility of information asymmetry, thus increasing the assurance that blockchain-enabled assets are traded in accordance with the fair conditions of transactions (Chen & Bellavitis, 2020; O'Leary, 2017). ChainNova utilises a public blockchain to produce a rice traceability system that transforms existing processes in the agricultural sector. The invention of the technology became possible due to the cooperation of organisations, fuelling their data to the system securely. Such cooperation results in the added value to their customers enjoying safe and traceable product delivery (Chong et al., 2019). An example of a consortium blockchain platform is ChainDraft. The company creates value for business customers by introducing a trusted value exchange system, simplifying pre-existing business practices, such as purchasing management (Chong et al., 2019).

Risk: The data accessibility and validity offered by the public and consortium blockchains have a value destructive consequence too, due to the *inflexible nature of the transactions*. The collaboration between stakeholders in value shops, networks and chains can be impeded as achieving consensus among stakeholders in the network is challenging. As a result, the progress in transactions can stall (Chen & Bellavitis, 2020). The data validation mechanism implies the irreversibility of records, which adds rigidity and inflexibility, eliminating the possibility of ad-hoc experimentation between a company, its customers, suppliers and institutional bodies. If transactions have been processed erroneously, a distributed system of storing and recording data does not make it possible to retrieve the data (Ahangama & Poo, 2016). The deployment of smart contracts is bound to the programming code. Therefore, changes that were not predicted and factors that were not considered cannot be handled during data transactions (Christidis & Devetsikiotis, 2016). Therefore, owing to the irreversibility of the records, once commenced the transaction proceeds without functionalities, which could be crucial for outcome accuracy (Schweizer et al., 2017). Such technical functions are useful for hypothesis-driven experimentation, whereby the technology is tested for different business scenarios and applications (Beck & Müller-Bloch, 2017). However, they are not favourable for unexpected discoveries through trial and error and the influx of new ideas (Chen & Bellavitis, 2020). The inflexibility of the transactions reduces the possibility of the exploration of new routes for business development and the innovation of firms' offerings (Schweizer et al., 2017).

4.2.2. Controlled value – privacy

Benefit: The adoption of a blockchain can make it possible to *control value* by tracking the use of services and goods to identify the degree to which the quality is met and determine customer preferences to customise offerings (Bauer et al., 2019; Behnke & Janssen, 2020). On the other hand, customers become the co-creators of value, as insights driven from their transactional data give an opportunity for companies to improve products or services and provide value-added complementary offerings (Sena, Bhaumik, Sengupta, & Demirbag, 2019; Urbinati, Bogers, Chiesa, & Frattini, 2019). Customisation creates lock-in effects (the motivation to participate in repeated transactions), maximises customer loyalty and increases switching costs (Amit & Zott, 2001; Direction, 2017; Hänninen, Smedlund, & Mitronen, 2018). It does not radically change the offering, but rather enhances the value of the product (Frank, Mendes, Ayala, & Ghezzi, 2019; Kohtamäki, Parida, Oghazi, Gebauer, & Baines, 2019). Value control through customisation and quality management is contingent on data accessibility, data validity and centralised control. The customer's approval to access data is possible when customers build trust in the company and confidence that the data will not be misused (Bauer et al., 2019). Trustable relations between the company and customers are fostered by the mechanisms of verifying and authorising the data supplied by different actors in the system (Zheng et al., 2017). To obtain information and create added-value service, companies dynamically access data by being assured that the data stored in the system is correct (Bauer et al., 2019). Therefore, technically, the ability to control value is inherent to public and consortium blockchain networks, where data can be traceable by all parties that have access to those networks (Behnke & Janssen, 2020; Chang & Chen, 2020; Longo, Nicoletti, Padovano, D'atri, & Forte, 2019; Zheng et al., 2017).

Value configuration: The benefit of value control is offered in business models acting as value chains and value networks (Chong et al., 2019; Zhang, Yi, & Wang, 2021). In *value shop* companies, such as open innovation platforms, control over the transactions and the created value is transferred from organisations (i.e. service providers) to third parties accessing the platform (Chong et al., 2019). That means that customers adjust value offering through the cyclical process of problem-finding, problem-solving, execution and evaluation (Stabell & Fjeldstad, 1998). In *value network* organisations in the finance sector, the data harvested through the consortium blockchain helps build risk-control and complex credit models, offering instant service delivery and decreasing financial risks for customers and the company (Chong et al., 2019; Xu et al., 2019). The control in the blockchain-based consortium network between trading parties is manifested as validation and assessment of sensitive business data, driving the cooperation among the actors in the network (Chang & Chen, 2020; Rahmanzadeh, Pishvaee, & Rasouli, 2020). Smart contracts embedded at every stage of the trading processes automatically monitor and cross-validate processes based on predetermined rules (Dai & Vasarhelyi, 2017). This helps importers track and understand bottlenecks in transactions and the supply chain and solve the root cause of the problem (Chang & Chen, 2020). Other companies can adopt private blockchain technologies (e.g. ChainSecurity) to transform business models into value networks whereby all interactions between stakeholders are mediated. Mediation increases the efficiency of business processes and brings benefits for stakeholders in terms of investment risk reduction and cost efficiency, which would not be possible without control (Chong et al., 2019). Also, disintermediated interaction between customers and firms increases customers' trust in companies, which positively affects the customer journey (Kumar et al., 2020).

When it comes to *value chains*, in the aircraft industry, private blockchain networks can be exploited by manufacturers to create digital twins of their supply chain, making it possible to control flight operations and maintenance, and evaluate the outcome of product repair and innovation (Mandolla, Petruzzelli, Percoco, & Urbinati, 2019). In the agri-food sector, private blockchain technologies help transform contemporary practices of production and goods delivery (Zhao et al., 2019). High data accessibility through distributed ledgers gives users the opportunity to track the product's journey in the supply chain and get reassurance that companies are complying with safety, quality and regulatory standards (Tiscini et al., 2020). Upward and downward traceability of all stages of the food supply chain can become possible by integrating all actors of the supply chain in one system – i.e. a consortium (Behnke & Janssen, 2020). Another example of a consortium blockchain platform is ChainDraft. This empowers business customers by enabling a trusted value exchange system simplifying pre-existing business practices, such as purchasing management (Chong et al., 2019). Similarly, the adoption of the technology in a consortium between IBM and Maersk resulted in the creation of a system digitalising all documentation and giving both parties full visibility over the supply of products (O'Leary, 2017).

Risk: Decentralised control and data accessibility compromise on data *privacy* and this increases the risk of unauthorised data usage (Lu et al., 2019; Tiscini et al., 2020). Privacy is an important aspect to consider in business practices, as privacy issues can undermine the value that a business stands for from the social perspective (Bocken, Short, Rana, & Evans, 2014; Dempsey, Bramley, Power, & Brown, 2011; Evans et al., 2017). The risk of privacy intrusion is higher in public blockchains (Feng, He, Zeadally, Khan, & Kumar, 2019). In such scenarios, the entry into the network is permission-less, which provides more favourable conditions for unauthorised activities (Notheisen et al., 2017). Privacy measures, such as the implementation of proof-of-costs, proof-of-stake and proof-of-space mechanisms, create barriers for malicious intrusion into public blockchain networks, although they massively increase the complexity of the system and resources for deploying these mechanisms (Anderson, Holz, Ponomarev, Rimba, & Weber, 2016; Ateniese, Bonacina, Faonio, & Galesi, 2014; Kiayias, Russell, David, & Oliynykov, 2017). In contrast, private and consortium blockchain-based networks are more selective and exclusive. The identities are known for other actors in the group, as the members are pre-validated. The decision to admit new members into the groups is laid on either the group authority or the existing members of the network. The closed nature of transactions increases privacy (Morkunas et al., 2019). Secondly, although the central authority of the network controls the transactions in permissioned blockchains (i.e. private and consortium), the data is accessed with the permission of the members of the network (Zheng et al., 2017). Therefore, users of private and consortium blockchain technologies are the subjects of the consented provision of personal data.

4.3. Value delivery

4.3.1. Service delivery – service disruption

Benefit: The deployment of a blockchain contributes to *service delivery* due to efficient and secure interactions between organisational stakeholders, enabled by a high degree of data validity and accessibility (Chen & Bellavitis, 2020; Karamchandani, Srivastava, & Srivastava, 2020; Morkunas et al., 2019). Due to the decentralised trust system, organisations remove a middleman between a provider and a receiver, which improves interoperability and optimises inter- and intra-organisational processes (Bauer et al., 2019; Chen & Bellavitis, 2020; Morkunas et al., 2019). Through the decentralised connection with multiple organisations, a blockchain makes it possible to leverage on cross-organisation efficiencies. Data provided by customers is accessible by each party in the transactions, which makes business activities simpler and more effective (Morkunas et al., 2019). Data validation mechanisms ensure that the records available in the blockchain network are secure and will not be tampered with (Bauer et al., 2019). Disintermediation and data accessibility and validity are conducive to both permissionless and permissioned blockchains (Chen & Bellavitis, 2020; Chong et al., 2019; Morkunas et al., 2019; Zavolokina et al., 2020). Therefore, blockchain-enabled business models in diverse sectors can benefit from service delivery optimisation. For example, blockchain-based logistics systems ensure seamless integration of all parties of the supply chain to fulfil the terms of inter-organisational agreements. Smart contracts automatise the transfer of asset ownership from one actor of the logistics system to another by autonomously responding to data entry to finalise the agreements (Caro et al., 2018). In seller-buyer relationships, smart contracts facilitate the closure of deals by authenticating records pertinent to the transaction. This reduces the time of purchase for all parties involved (Morkunas et al., 2019). A blockchain also optimises relations between end-users by disintermediating transactions. During the financial exchange, users can transfer money across borders, bypassing centralised banks and currency exchange services (Morkunas et al., 2019).

Value configuration: The probability of service delivery efficiency is different across value shops, value chains and value networks. Service delivery is harder to observe in *value shops.* In such business models, customer-company relationships are not traditional in terms of the provision and consumption of services and products. Relations between the company and stakeholders are cyclical, rather than uni- or bidirectional. Value shops act as a platform on which customers co-create their applications. Therefore, service delivery is largely dependent on the users of platform services (Chong et al., 2019; Stabell & Fjeldstad, 1998). In *value networks,* digital mediation or disintermediation of conventional processes using private blockchain technology increases the efficiency of resources and data exchange circulating within the company. Blockchain technology helps reinvent conventional supply chains to deliver products and services in a faster way (Chong et al., 2019). The integration of organisations utilising private blockchain networks into a consortium makes it possible to cut down the service throughput time in two ways (Chang, Luo, & Chen, 2019; Gerth & Heim, 2020). In cross-border trading, the parties can benefit from export efficiency resulting from the disintermediation of inter-organisational data exchange (Chang, Luo, & Chen, 2019). Blockchain technology can become a solution for creating on-demand online services, which end users can utilise without privacy risks (Gerth & Heim, 2020; Li, Barenji, & Huang, 2018). Similarly, public blockchains can realise the benefit of online learning services, which would make the attainment of education certificates and degrees simpler (Sun et al., 2018).

Companies functioning as *value chains* can capitalise on fully permissioned blockchain networks. The technology can be used in manufacturing industries to monitor the process of component production and their rapid prototyping, thus reducing the time from concept creation to market rollout (Mandolla et al., 2019). Applications based on consortium blockchains help members of the consortium network to achieve efficiency in business operations (Chong et al., 2019; Qiao, Zhu, Wang, & Qin, 2018). For example, in commercial transactions, smart contracts automate payment processing, thus expediting the validation of purchases and making the delivery of goods faster (Chong et al., 2019). As far as public blockchain networks are concerned, they are applied in systems enabling the traceability of the entire food production chain. The newly-built system enables and gives customers access to a service that had not existed before (Chong et al., 2019).

Risk: By adopting a blockchain, organisations could also face the risk of *service disruptions* (Behnke & Janssen, 2020; Chong et al., 2019; Janssen et al., 2020). Such a risk is higher for public blockchain networks, whose mechanisms validating data and regulating access to data differ from the private or consortium networks. The manoeuvrability and interoperability are higher in private and consortium blockchain networks for three main reasons (Chong et al., 2019; Zavolokina et al., 2020). First, private and consortium blockchain technologies impose restrictions on new actors of the group, whereby the access to the group can be granted by the participants of the group, the regulatory authority or a consortium (Morkunas et al., 2019). In contrast, transactions in a public distributed ledger can result in latency. External users create a large volume of traffic in the public blockchain, leading to delays in data processing (Okon et al., 2020). Hence, restrictions regarding data access and participation in the network help keep the number of participants manageable, thus increasing the throughput, decreasing latency and the size of bandwidth (Morkunas et al., 2019; Wang, Wu, Wang, & Shou, 2017). Second, the security mechanism is one of the weakest points of the public blockchain (Zheng et al., 2017). To ensure security in public networks the system needs more time to verify each digital record entry added onto a block (Yli-Huumo et al., 2016). The cryptographic protocols used to secure data could either be flawed and make data vulnerable to public exposure (El Ioini, Pahl, & Helmer, 2018; Gennaro, Goldfeder, & Narayanan, 2016) or might consume too much computational power (Morkunas et al., 2019). This means that security vulnerability can cause disruption in the delivery of value (Zheng et al., 2017). Thirdly, the heterogeneity of actors in the public blockchain communities can result in blockchain splits – i.e. the divergence of the blockchain into separate branches, resulting in the change of rules in the system and potentially causing disruptions in the value chain (Islam, Mäntymäki, & Turunen, 2019).

4.3.2. Network effects – scalability challenge

Benefit: *A network effect* is an intrinsic capability of the blockchain, revolutionising the way in which people exchange digital and physical goods and services (Schmidt & Wagner, 2019). Network effects have become possible primarily due to the disintermediated system of blockchains, leading to the integration of all actors in the platform (Kundu, 2019). Blockchains accelerate activities among actors, leading to the extension of the network scope in the long term (Fu, Wang, & Zhao, 2017). High data accessibility and decentralised control are important for achieving a positive network effect. The distributed ledger enables access to a wide range of participants, triggering the mass utilisation of the services delivered through the blockchain. The more people adopt the technology, the more widely the system becomes adopted (Schmidt & Wagner, 2019). For open-access platforms with decentralised authorities offering security solutions, network effects facilitate the diffusion of services among the target audience (Abbatemarco, De Rossi, Gaur, & Salviotti, 2020). At the same time, with the increasing number of actors in the network, the decentralised trust system ensures that no single entity gains a power over the network, thus enabling all participants to have equal transaction possibilities (Chen & Bellavitis, 2020). Given that for the creation and delivery of value a sufficient diffusion of the blockchain is needed, the technical precondition for this capability is to deploy a public blockchain. The permission-less nature of participation drives the growth of the network, while it remains decentralised (Schmidt & Wagner, 2019).

Value configuration: Network effects are inherent to all firms adopting a public blockchain irrespective of the value configurations they have (Abbatemarco et al., 2020; Chen & Bellavitis, 2020; Miraz & Donald, 2019; Perboli, Musso, & Rosano, 2018; Zachariadis, Hileman, & Scott, 2019; Zhang et al., 2021). For example, in *value shop* companies serving as platforms for the co-development of IT solutions (Chong et al., 2019; Pazaitis, 2020) and bitcoin-related services (Kazan et al., 2015), access-based participation scales up operations and facilitates the development of multilateral relationships. Multilateral participation, in turn, stimulates cross-side and same-side network effects (Wu & Tsai, 2022). That means that the usage of the platform by either of the parties stimulates the growth on both the supply and demand-side.

When it comes to *value networks*, the utilisation of a blockchain in crowd-based enterprises has become a powerful tool for creating network effects that increase the profitability of the business model (Chen & Bellavitis, 2020; Leeming, Cunningham, & Ainsworth, 2019; Paraschiveanu et al., 2020; Sun et al., 2018). In crowdfunding, the technology facilitates the creation of validated connections between potential investors. By leveraging on technical features that enable trust-free, transparent and secure transactions, the technology helps eliminate bureaucratic procedures and establish direct channels of communication and value delivery with organisations' stakeholders (Chen & Bellavitis, 2020). In peer-to-peer learning, an extra layer of security makes the integration of blockchain technologies in online learning platforms promising (Paraschiveanu et al., 2020; Sun et al., 2018). Data validation in a distributed manner improves the protection of intellectual property (Sun et al., 2018). The security feature could potentially lead to an increase in demand for services by capitalising on network effects. In medical services, the removal of privacy-related barriers can foster the adoption of applications having access to personal health records (Leeming et al., 2019). Widespread adoption creates network effects by increasing the utility of the application for its users (Ayers, Menachemi, Ramamonjiarivelo, Matthews, & Brooks, 2009).

As far as *value chains* are concerned, a blockchain-based system of transactions is especially advantageous for global payment systems (Chen & Bellavitis, 2020). For example, Bitcoin reaps benefits from the large market share due to the network effect (Worley & Skjellum, 2018). The networks similar to Bitcoin process from 7 to 15 transactions per second. However, the downside of the public blockchain is that, if the load on the network increases, the capacity is likely to go down (Miraz & Donald, 2019). The creation of network effects by adopting public blockchain technology can be beneficial in non-commercial transactions too (Gong, Wang, Frei, Wang, & Zhao, 2022). The technology found its applications in the development of decentralised recycling value chains. The transparency and open access to data about waste management shared through the system can instigate collaborative actions of the public towards sustainable consumption and production. Such visibility can also facilitate the wider adoption of blockchain-based waste management solutions in non-sustainable industries (Gong et al., 2022).

Risk: On the other hand, a public blockchain creates *scalability issues.* Scalability concerns the limit to the number of transactions per second that can be managed through blockchain platforms (Gervais et al., 2016). To ensure data validity, the decentralised system requires data to be stored and processed at multiple locations and replicated across the network to keep the nodes updated. These system characteristics increase the reliability of the data, although they add enormous operational complexity. The complexity causes a delay in transactions and transaction throughput (Notheisen et al., 2017). The challenge to address data validity, decentralised control and scalability has been coined the scalability trilemma. The trilemma indicates the difficulty of addressing all three aspects and the need to prioritise any two of the three capabilities. Consequently, a public blockchain offers decentralised control and security, which is the precondition of the network effect, while compromising on scalability (Miraz & Donald, 2019, Perboli et al., 2018, Zachariadis et al., 2019). In a permission-less blockchain, a relatively higher number of decentralised transactions affects the size of a block and the interval between the creation of blocks, thus decreasing the frequency of transactions per second (Gervais et al., 2016). The seriousness of the scalability challenge for the business depends on the sectors and the area of application. A public blockchain is not adaptable for finance – a sector characterised by dynamic and frequent transactions (Perboli et al., 2018). It is not usable for large markets either, such as the German automobile market, where delays in transactions can cause serious value delivery disruptions and undermine competitive advantage (Notheisen et al., 2017).

4.4. Value capture

4.4.1. Cost efficiency – increased investments

Benefit: Due to its distributed consensus algorithms, the blockchain has been considered to hold business value as it makes it possible to restructure the revenue - cost scheme to ensure value capture (Chalmers, Matthews, & Hyslop, 2019; Zheng et al., 2017). The reduction of costs can be achieved in three ways. First, data access and validation reduce the transaction costs on the coordination of activities, tracing data and the integration of resources (Beck, Müller-Bloch, & King, 2018; Queiroz et al., 2019; Zhang, Daim, & Zhang, 2018). This is enabled by the distributed system of data recording and storage at multiple locations in the network and among all nodes of the transaction through the copies of a ledger. Put differently, the disintermediation and the removal of associated labour costs decrease the time spent on verifying and accessing data, optimising transactions and decreasing the cost of product supply (Queiroz et al., 2019; Zhang & Wen, 2017). Second, the disintermediated exchange requires less power consumption for a consumer due to the cut of around 20% of the price, which is usually added by a middleman. Consequently, the reduction in costs affects other firms' pricing models, thus leading to the refinement of cost structures across the energy market (Brilliantova & Thurner, 2019; Hou, Wang, & Luo, 2020). Third, the firms whose transactions are operated based on a blockchain protocol benefit from decreased security and financial fraud risks due to the immutability of the transactions (Zhang & Wen, 2017). As cost reduction is largely attributed to the disintermediation mechanism (Queiroz et al., 2019, Zhang & Wen, 2017), the deployment of public, private and consortium blockchain networks can result in the benefit of cost efficiency.

Value configuration: The potential to save costs by deploying the public, consortium or private blockchain technology depends on the value configuration underpinning organisations' business models. In *value shops* cost efficiency is enabled by public and consortium blockchains (Chong et al., 2019; Kazan et al., 2015; Pazaitis, 2020). These networks help build the platform with multiple contributors, exchanging value with each other. The main value capture asset for value shop business models is the ability to innovate on open-access platforms. Co-development reduces the complexity and cost of innovation processes (Chong et al., 2019; Kazan et al., 2015).

When it comes to *value networks*, where the main cost driver is the scale of business practices (Stabell & Fjeldstad, 1998), the removal of intermediary connecting parties within and between organisations cuts down transaction time and associated costs (Chang, Chen, & Wu, 2019). For example, in public and consortium networks, cost-efficiency can result from the faster attainment of online education services, the simplification of payment processes between the trading parties or the validation of documents in accounting services (Chang, Luo, & Chen, 2019; Dai & Vasarhelyi, 2017; Paraschiveanu et al., 2020). Also, digital mediation or disintermediation of conventional processes using private blockchain technology increases the efficiency of resources and data exchange circulating within the company. For example, blockchain technology helps companies reinvent conventional supply chains to deliver products and services in a faster way (Chong et al., 2019).

The value capture mechanism in organisations operating as *value chains* can benefit from the deployment of private, public and consortium blockchain technology. In real estate, private blockchain-based solutions help authenticate the documentation for facilitating the transaction of ownership transfer from a seller to a buyer. Such transactions are carried out without a notary intermediary, thus eliminating the associated costs for their service, which are often expensive (Morkunas et al., 2019). In the finance sector, public blockchain deployment can reduce the costs that firms spend on manual processes, search and the negotiation of deals, which do not add business value to the firm. In total, the innovation of infrastructure in the finance industry is expected to bring up to 20 billion US dollars worth of savings (Morkunas et al., 2019). The consortium blockchain can also transform traditional supply chains to capture value. A supply chain based on the blockchain offers real-time visibility and the tracking of products during the distribution phase, thus reducing potential financial risks (Wu et al., 2017).

Risk: The utilisation of a blockchain may also require *increased investments* to develop and maintain the network, chain and platform through which digital transactions happen. Such likelihood increases when deploying a public blockchain network. There are two main reasons that determine the potential negative effect of a public blockchain on value capture. First, overhead costs increase when a blockchain promotes anonymous participation. Since the entry into the network does not require authorisation (Chen & Bellavitis, 2020; Notheisen et al., 2017), organisations need to invest financial resources and effort to increase the operational complexity associated with the utilisation of proof-of-costs, proof-of-stake and proof-of-space mechanisms (Anderson et al., 2016; Kiayias et al., 2017; Notheisen et al., 2017). These mechanisms make the creation of new blocks of data costly, thus discouraging nodes (i.e. members) from disseminating corrupted information and eliminating the risk of Sybil attacks (cyber-attacks through the creation of a large number of anonymous and deceiving identities) (Dinger & Hartenstein, 2006). Second, given the standardisation challenge, different blockchain architectures require investment to increase the interoperability and standardisation of systems to ensure seamless integration and operation (Morkunas et al., 2019).

5. Implications for business model innovation

The analysis of the literature has made it possible to identify five groups of benefits and risks of the public, consortium and private blockchain conducive to value creation, delivery and capture functions in business models operating as value chains, value networks and value shops. To enable the benefits, the deployment of the technology in the firm's infrastructure should be implemented in such a way as to mitigate contingent negative implications. Blockchain benefits represent opportunities for firms to achieve better performance by transforming their practices. As far as value creation is concerned, the blockchain can facilitate a trustable collaboration. This benefit can be realised by adopting the public and consortium blockchain in the value shop, value network and value chain contexts by taking into consideration the possibility of flexibility in transactions, which a high degree of data accessibility and some extent of decentralisation entail. The second benefit in the value creation process is the possibility to control value offerings that is inherent to value chains and value networks. This benefit can be enabled by private or consortium blockchains, which have centralised or partially decentralised control and a higher possibility to trace data. Value delivery is rooted in the efficiency of managing transactions and the wider reach of the audience. The efficiency of service delivery is likely in value chains and value networks. Efficiency is contingent on trust-free disintermediation conducive to all types of blockchain networks. However, the utilisation of the public blockchain may incur the risk of service disruption due to a more complex data validation mechanism and permission-less access to the network increasing its operational complexity. The second benefit facilitating value delivery is rooted in the public blockchain infrastructure creating network effects irrespective of firms' value configurations. Such effects are realised through the decentralised control of transactions and permission-less access to data. When it comes to value capture, the adoption of a blockchain impacts firms' cost-revenue schemes. The deployment of a private, public and consortium blockchain redefines transactional cost structures by introducing a disintermediated data validation mechanism in value chains and networks. As far as value shops are concerned, the cost efficiency resulting from value co-production is conducive to public and consortium blockchains. From a business model innovation perspective, the benefits of trustable collaborations, value control, service delivery, network effects and cost efficiency reflect the introduction of new company activities, a change in the sequence or the structure of existing activities or new governance of activities.

The introduction of new activities is common for value chains and value shops. For such organisations, public and consortium blockchains can bring the benefit of trustable collaborations. In value chains, trust-free collaboration makes it possible for the parties to create solutions innovating and improving existing organisational processes or products (e.g. rice traceability systems, cryptocurrency) (Chen & Bellavitis, 2020;

Chong et al., 2019; O'Leary, 2017). In value shops, such as ChainArchitect, http://Blockchain.info and Sensorica, trustable interactions between stakeholders facilitate the co-development of products and services on blockchain platforms (Chong et al., 2019; Kazan et al., 2015; Pazaitis, 2020). Service delivery and cost efficiency can be improved when adopting private, public and consortium blockchain networks for businesses modelled as value chains. The adoption of the technology replaces traditional practices with new sets of activities. This strategy can be manifested as the launch of a new service creating a lock-in effect or the innovation of manufacturing practices and delivery methods reducing the cost of a final product (Worley & Skjellum, 2018; Zhang et al., 2018). Also, new activities can take the form of the introduction of a holistic tracking system providing real-time accurate data about product delivery, which is a result of the collaborative efforts of logistics partners. Such activities offer complementary benefits for their customers and service efficiency (Behnke & Janssen, 2020; Tiscini et al., 2020). Public and consortium blockchain systems can realise the benefit of cost efficiency of transactions in value shops too. A decentralised or partially decentralised blockchain creates the conditions for establishing trustable disintermediated relationships between all parties, fostering the exchange of ideas and the co-development of novel or complementary offerings. Such relationships between stakeholders can also be favourable for increasing the scale of the diffusion of products and services (Chong et al., 2019). The benefit of network effects can be made possible when business models operating as value chains and value shops adopt the public blockchain. For example, in value shops, open-access participation scales up the network of co-developers by increasing the growth of participants on the supply and demand sides. Knowledge shared between multiple stakeholders makes the development of solutions faster (Kazan et al., 2015; Wu & Tsai, 2022). In value chains, the high accessibility and traceability of networks increases the visibility of transactions carried out in the chain, which can drive membership (Gong et al., 2022; Worley & Skjellum, 2018).

The innovation of business models by restructuring existing activities happens when the adoption of the blockchain results in the removal of an intermediary and the consequent accessibility and traceability of data by customers (Bauer et al., 2019; Caro et al., 2018; Chong et al., 2019; Maull et al., 2017). Therefore, such a form of business model is prevalent for firms operating as value networks (Chong et al., 2019). Trustable collaborations become possible when adopting the public and consortium blockchain, offering strong data validation and accessibility to the network. Trustable collaborations improve the efficiency of data exchange between stakeholders. For example, in the finance sector, the democratisation of access to financial resources reduces uncertainty for customers and the confidentiality of transactions without third-party trustable guarantors (Sydow, Sunny, & Coffman, 2020). Such relations also create complementary services for customers by offering transparency in transaction data (Caro et al., 2018; Sydow et al., 2020; Zavolokina et al., 2020). When purchasing products, the traceability boosts confidence about the quality of the sources and the standards of production (Caro et al., 2018). The benefit of service delivery is conducive to all types of blockchain networks. Service delivery through digitally intermediated networks with strong data validation mechanisms has three implications. It improves the efficiency of transactions between stakeholders freely exchanging resources and data in the blockchain-enabled ecosystem and locks participants into the network, thus reducing switching costs (Gerth & Heim, 2020; Li et al., 2018; Morkunas et al., 2019; Schneider et al., 2020). The mediation of parties through a blockchain-based peer-to-peer platform creates new services, such as online learning and on-demand services (Sun et al., 2018). The benefit of cost efficiency is possible due to reduced transaction costs, the minimisation of security and financial fraud and reduced energy consumption resulting from the adoption of blockchain systems (Brilliantova & Thurner, 2019; Zhang et al., 2021; Zhang & Wen, 2017). Network effects are created when business models are enabled by a public blockchain. Such technology stimulates decentralised relations between the parties. Network effects can improve efficiency by extending stakeholders' scope and catalysing sales (Fu et al., 2017; Kundu, 2019).

New governance of existing activities results from the deployment of a private and consortium blockchain in firms operating as value chains and value networks. New governance enables the benefit of controlled value. While overseeing data exchange, companies can take the role of a controller of value for customising and improving their offerings. Such activities make it possible to design value-added complementary services, which can create a lock-in effect (the motivation to participate in repeated transactions) (Amit & Zott, 2001; Direction, 2017; Hänninen et al., 2018). For example, for Car Dossier, blockchains create opportunities to adjust products and services to customer preferences. Opportunities include tailoring packages based on car specifications, identifying pricing strategies, offering discounts dynamically based on the history of records about purchases (Bauer et al., 2019).

Table 2 summarises the BMI design elements and value drivers associated with the private, consortium and public blockchain and different value configurations.

6. Conclusion

6.1. Conclusion

This paper aimed to address the gap in the literature on business model innovation, concerning the lack of understanding about the benefits and risks created by the utilisation of blockchains in business processes. The gap set out two objectives for the study. First, we analysed the literature and identified the characteristics of the technology inherent to the public, consortium and private blockchain. The three types of blockchain differ by the varying degree of accessibility to data, decentralised control and operational complexity. The findings of such an analysis contribute to the literature by identifying and assessing the advantages and limitations of the technology. Drawing on the prior literature in the domain of business model innovation, we analysed the benefits and risks inherent to different blockchain networks for business model functioning as value chains, value networks and value shops. Secondly, the paper provides an understanding of the conditions for successful business model innovation and discusses the design elements of business model innovation rooted in blockchain benefits. The analysis contributes to the current body of knowledge, which lacks insight into the potential value destructive consequences of blockchain adoption (Chong et al., 2019; Morkunas et al., 2019; Tiscini et al., 2020).

The study has a number of managerial implications. First, the study can inform managers about the strategic changes in business models that the introduction of different blockchain types may entail in terms of the new activities and processes, the change of the structure or the governance of existing activities and processes. It is important to adapt and align the existing capabilities and resources of the firm prior to adopting blockchain technologies to transform their business models. Second, the mapping of blockchain benefits and risks against BM functions provides insight into the routes through which companies can improve their value creation, value delivery and value capture mechanisms. Finally, the paper informs practitioners about the potential implications of the transformation of value creation, delivery and capture logic of the firm in terms of creating value-added services, improving the efficiency of business processes or introducing new value offerings.

6.2. Limitations and avenues for future research

The paper uses a conceptual approach to examining the relationships between blockchain technologies, business model innovation and its implications. As such, the lack of a systematic approach to analysing the literature could be a limitation, hindering the methodological validation of the findings. Since the research on the role of blockchain technologies in the business models of firms operating as value chains, value shops

Table 2
Mapping blockchain-enabled BMI design elements in relation to value chains, value networks and value shops.

BMI design	Value configuration	Blockchain benefit	Blockchain type	Value drivers	Examples
New activities	Value chain	Trustable collaborations	Public, consortium	Novelty, efficiency	Cooperation in the production of digital assets and innovative blockchain solutions
		Service delivery	Public, consortium, private	Novelty, lock-in, complementarity, efficiency	Tracking systems enabling faster production and delivery of products and services
		Network effects	Public	Novelty, efficiency	Increased membership in the publicly accessed systems
		Cost efficiency	Public, consortium, private	Novelty, efficiency	Innovation of manufacturing practices and delivery methods, reducing the cost of the final product
	Value shop	Trustable collaborations	Public, consortium	Novelty, efficiency	Facilitating co-development of applications
		Network effects	Public	Novelty, efficiency	Scaling up the network of co-developers on open-access platforms
		Cost efficiency	Public, consortium	Novelty, efficiency	Faster development and deployment of customised solutions
New structure	Value network	Trustable collaborations	Public, consortium	Novelty, efficiency, complementarity	New forms of collaboration between organisations and trade systems
		Service delivery	Public, consortium, private	Novelty, lock-in, efficiency	On-demand online services
		Network effects	Public	Novelty, efficiency	Extending stakeholders' scope due to decentralised governance
		Cost efficiency	Public, consortium, private	Novelty, efficiency	Trust-free disintermediation, reducing transaction costs, minimising security and financial fraud
New governance	Value network	Controlled value	Private, consortium	Novelty, lock-in	Transaction validation and security makes stakeholders locked-in to the network
	Value chain	Controlled value	Private, consortium	Novelty, complementarity	Traceability of agri-food products offering complementary services

and value networks is growing, this limitation can be addressed by future research. Also, considering the dearth of literature on the implications of business model innovation enabled by blockchains for companies with discrepancies in value configurations, we discuss the potential value drivers of BMI design elements. Therefore, future studies can draw upon this limitation to examine empirically the value drivers of blockchain-enabled BMI, such as the lock-in effect, complementarity, efficiency and novelty.

To broaden the current body of knowledge and bring clarity to the impact of blockchains on organisational performance, future research should take two stances. First, since the current literature is more focused on the technical characteristics of the technologies, it offers little explanation as to how they are used by firms apart from cryptocurrency transactions (Valtanen et al., 2018; Yang et al., 2019; Zhang & Wen, 2017). Therefore, scholars need to develop a framework summarising the application of blockchains in different industries. The framework should cover the type of blockchain (permissioned/permissionless), the name of the blockchain technologies developed to date, the attributes, advantages and disadvantages and the outcome of their utilisation for firms in diverse sectors. The second direction for research concerns the empirical validation of the findings of the present study. Scholars need to use methodologies to draw primary insights into the role of the different types of blockchain and their technical characteristics in the company value configurations, as suggested below.

To examine the degree to which permissioned and permission-less blockchains facilitate or hinder the value creation process through efficient collaborations between parties, future research should take qualitative and quantitative approaches. First, scholars could use a case study approach using a sample of organisations who have already adopted a blockchain. The qualitative insight gleaned from the interviews with IT specialists and managers can help understand the impact of the technology on the efficiency of collaborations. It can also explain the outcome of collaborations by taking into consideration usability patterns and technical characteristics. Both managerial and IT specialists' perspectives are important to avoid inaccurate conclusions, as the value of the technology in removing the barriers to digital data exchange may be explained not only by the robustness of the technical performance. Although, technically, the blockchain is a trust-free system, poor knowledge of the technology may slow down its usage and adoption by different organisations' stakeholders. Second, to confirm the benefit of the control over transactions for improving and customising value offerings, future research needs to use a quantitative approach. While it may be obvious that the possibility of tracking customers' preferences is beneficial for the company, the examination of its quantitative impact on company profit over time before and after blockchain utilisation needs to be made to validate the assumptions. Third, to forecast the potential adoption of blockchains by firms' stakeholders, future studies need to understand stakeholders' preferences and the beliefs that may hinder adoption and shape their biased attitude to technology benefits. By utilising a survey approach, organisations will be able to build an understanding of the degree to which the control and traceability of transactions through blockchains raises privacy concerns. The perception of risks could potentially destroy the value for customers and other company stakeholders. Also, by correlating their perceived risks and intention, it will be possible to predict the rate of technology adoption.

The efficiency and the scalability of blockchain technology remains a debatable area, since the delivery of services and operational efficiency vary across permissioned and permission-less blockchain infrastructures (Chen & Bellavitis, 2020; Chong et al., 2019; Janssen et al., 2020; Morkunas et al., 2019). The findings of this conceptual study provide a number of avenues for future research development in the fields of business management and computer science. Specifically, scholars in the business management discipline need to explore the use cases of both permissioned and permission-less blockchain systems for the efficient delivery of services. As a first step, scholars could explore the application of the technology across different sectors, drawing on secondary data. Once the conceptual framework of potential use cases is developed, scholars should empirically examine the impact of each type of blockchain (and their characteristics) on value delivery. In the information systems domain, future research needs to address the negative implications of the technology for firms' performance. One of the primary focuses of research should be directed at eliminating the compromise between scalability and network efficiency, which are deep-rooted in the systemic characteristics of blockchains. Computer scientists and system developers need to look into opportunities to decrease the latency of transactions in large permission-less networks, keeping the robustness of the security mechanisms. The second area for future research in the IS concerns negative implications that both permissionless and permissioned blockchain architectures have for ensuring inter-organisational interoperability (Behnke & Janssen, 2020; Wang et al., 2017). Therefore, future research needs to explore how to address the limitations to create an efficient business ecosystem.

Although, from the technical perspective, the utilisation of a blockchain results in cost-reduction, empirical validation of the returns on investment is needed. Specifically, future research in the business management field needs to analyse the profile and the profitability of companies which have been using blockchain technology. It is important to examine the degree to which the use of technology helps reduce transactional costs and increase revenues. Another direction for research is to provide an industry-wide insight into the benefits of blockchains in reducing the possibility of fraudulent transactions. To address this need, scholars could conduct a survey to collect information from managers about their experience of utilising the system. Finally, more research is needed for developing systems addressing the standardisation, security and interoperability challenges that negatively affect firms' revenues (Dinger & Hartenstein, 2006; Morkunas et al., 2019).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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