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Organizing for value creation in blockchain information systems

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ABSTRACT

Many blockchain consortia have been established to build blockchain information systems. While the developed blockchain information systems were promising, few have reached market entry. Indeed, blockchain consortia often lost development focus due to high system complexity and a lack of understanding of how to create a system that will serve the needs and bring value to all stakeholders. Thus, stakeholders struggled to leverage blockchain information systems' full value. Prior studies demonstrated that blockchain systems pose not only technical but also organizational challenges. Analysing six blockchain consortia, we identify their value mechanisms, organizational problems, and organizational solutions that successful blockchain consortia experience while organizing themselves for value. As a result, we propose a new organizational form, i.e., a layered organization, for blockchain consortia to achieve better value creation.

1. Introduction

Since 2014, many blockchain consortia have been established in various business sectors, reaching more than 400 by 2020 (ESG Intelligence, 2021). In these blockchain consortia – defined as associations of multiple organizations with joint objectives, activities, and/or goals (Zavolokina, Ziolkowski, Bauer, & Schwabe, 2020) – multiple businesses join forces and aim to build blockchain information systems (BC IS) in the hope of utilizing the technology for their respective businesses (Bauer, Zavolokina, Leisibach, & Schwabe, 2020). The general value potentials (e.g., operational efficiencies, product innovations, or customization of products or services) brought by decentralized collaboration through blockchain technology are well-defined for various businesses acting in diverse industry domains (Upadhyay, 2020). However, few of these promises have been realized (Behnke & Janssen, 2020). In fact, many consortia are behind expectations.

The problem lies in the power and the high complexity of BC IS (Zavolokina et al., 2020), making the technology interesting, yet difficult to apply, especially to contexts less known than cryptocurrencies (Nakamoto, 2008). Given their architectural versatility (Notheisen, Hawlitschek, & Weinhardt, 2017), BC IS promise various benefits for stakeholders, like more transparency, trust, and efficiency in interorganizational relationships (Fridgen, Lockl, Radszuwill, & Rieger, 2018). However, blockchain consortia often lose

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development focus and do not meet the expectations set. Instead, they struggle with ever-increasing development costs, rising system complexity, and the diverging interests of the involved stakeholders. These issues can hamper the collaborative spirit within blockchain consortia, prevent the growth of the consortia, and hinder the advancement of BC IS.

While increasing apace, current research on blockchain has not produced insights into what mechanisms help create value in BC IS (Frizzo-Barker et al., 2020) and how organizations in blockchain consortia organize themselves for successful value creation. Information systems researchers recognize the strategic opportunities for businesses but also the lack of widespread adoption and assimilation of blockchain in business strategy (Kohli & Liang, 2021). Kohli and Liang (2021) call for future research along the research themes (among others in their research framework) of organizational integration of blockchain and value creation.

The objective of this article is to address this gap by raising the following research questions:

***RQ1:** What are the mechanisms of value creation in BC IS?*

***RQ2**: What organizational problems do consortia face in implementing those mechanisms?*

***RQ3**: How are these organizational problems dealt with in practice?*

We analyze one focal and five additional blockchain consortia from various domains to understand the mechanisms of creating value (i.e., what helps a business create value and how) in BC IS. We focus our analysis on a subclass of consortia that address business problems, not technology consortia such as Corda. In addition, we describe organizational problems in creating value and their organizational solutions.

This study contributes the identified value mechanisms, organizational problems, and their solutions to create value in BC IS (Rossi, Mueller-Bloch, Thatcher, Bennett, & Beck, 2019). Further, by investigating successful real-world cases, we address prior calls for practically grounded insights into the value of BC IS (Frizzo-Barker et al., 2020) and the approaches of different organizations to addressing digital innovation (Hinings, Gegenhuber, & Greenwood, 2018). From a practical perspective, our findings can help various stakeholders involved in blockchain consortia better understand the sources of value creation and organize their BC IS development beyond single-organizational innovations. Finally, the ability to point out the value mechanisms and their organizational implementation supports budget requests for businesses to continue their engagement in blockchain consortia.

The remainder of this paper is structured as follows: first, we review prior work on blockchain information systems and consortia, and identify the research gap concerning value mechanisms and organizational problems in BC IS. Next, we describe how the data was collected and analysed; then, we present our case description and the study's results and discuss our results in light of prior academic work; finally, we conclude the paper by pointing out limitations and directions for future research.

2. Related work

This study builds upon and contributes to three streams of literature: blockchain information systems and consortia, value creation in blockchain, and organizational aspects of BC IS. Fig. 1 illustrates this intersection and refers to the exemplary literature in these research streams.

2.1. Blockchain information systems and consortia

Blockchain is characterized as a distributed and decentralized database of append-only transactions with high tamper resistance (Beck, Avital, Rossi, & Thatcher, 2017). For business applications, blockchain technology is often used as tamper-proof record management, shared and operated by a network of businesses (Lacity, 2018). By time-stamping and broadcasting each new transaction

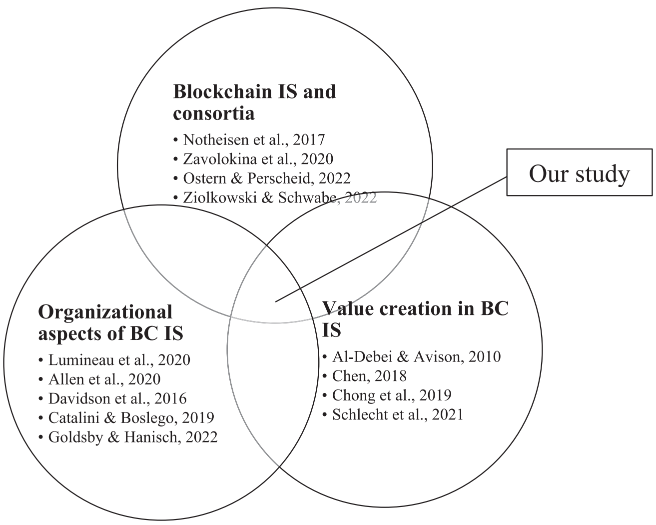

Fig. 1. Research streams our study builds upon and contributes to, and their exemplary references.

approved by the network, blockchain enables greater trust and transparency in the interactions between actors (Hinings et al., 2018). Further, smart contracts that can be built into, or run on top of the underlying blockchain protocol, are 'self-executing digital contracts' that automate the execution of transactions and thus lead to increased efficiency (Zachariadis, Hileman, & Scott, 2019). Research often differentiates between permissioned and permissionless blockchains and accordingly suggests different approaches to their adoption (Toufaily, Zalan, & Dhaou, 2021). Blockchain is expected to transform not only individual business areas but entire industries, offering both challenges and potential for businesses (Kimani et al., 2020). On the one hand, the reason for this is the reduction of transaction costs that blockchain offers (Tapscott & Tapscott, 2017). On the other hand, creating a 'trustless system' threatens to disintermediate current well-established businesses (Mazzei et al., 2020). BC IS can essentially be broken down into three layers: the infrastructure layer, which is sometimes even further split into the hardware layer (i.e., computers as nodes), and the protocol layer (i.e., distributed database, decentralized consensus mechanism, cryptographic protocols); the platform layer (i.e., an environment that enables implementation of platforms or markets); and the decentralized application layer (i.e., individual decentralized applications or other applications) (Bauer-Hänsel, Liu, Tessone, & Schwabe, 2024; Glaser, 2017; Notheisen, Hawlitschek, & Weinhardt, 2017). Each layer in this structure is interdependent. The infrastructure layer forms the foundation upon which the platform layer is built, and in turn, the platform layer enables the creation and functioning of the decentralized application layer. A change or malfunction at any level can impact others, highlighting the integral interconnectedness of these layers within the BC IS (Glaser, 2017; Notheisen et al., 2017). While decentralization is key to blockchain information systems at each layer, it has to be viewed not only from a technical but also a political and business view, necessitating an interdisciplinary viewpoint (Sunyaev et al., 2021). Also, frameworks developed as guides for creating tokens as an inherent part of blockchain information systems emphasize the need to integrate to address technical, legal, and operational challenges (Sunyaev et al., 2021).

BC IS for business purposes are developed jointly by multiple stakeholders within blockchain consortia (Bauer, Ziolkowski, Hacker, & Schwabe, 2023; Zavolokina, Ziolkowski, Bauer, & Schwabe, 2020). A consortium is not a novel form of organizing in the IT field. For example, prior research examined consortia, built with the purpose of the creation of ICT standards (Nelson, Shaw, & Qualls, 2005; Xu & Boh, 2014), and derived certain characteristics for a consortium: the need for interoperability, voluntary participation, consensus-driven decision-making based on voting rights, management, and work groups adhering to their charter, by-laws and group. Blockchain consortia became a new emerging form of consortia focusing on implementing systems, solutions, or platforms based on blockchain technology. The goals of the businesses involved in these consortia are creating innovative products and services in collaboration with multiple businesses; reducing costs through streamlining and sharing processes across organizations, and/or increasing the fit of products and services to customers' needs by granting them control over their data (Bauer et al., 2020).

While many blockchain consortia have been established, research on blockchain consortia is still quite scarce. Most studies focus on technical implementation (Alketbi, Talib, & Nasir, 2021; Subramanian & Thampy, 2021, 2022) and report on the design and development of 'consortium blockchains' (i.e., private blockchains) and not on organizational problems and solutions in building a 'blockchain consortium' (i.e., an organization with the goal to use blockchain technology for their purpose). More recently, Goldsby and Hanisch (2022) studied the organizational challenges of BC IS. The authors discuss the complexities of coordination and control in BC IS and introduce four fundamental blockchain governance modes to tackle these challenges: chief, clan, custodian, and consortium. Further, this study offers a framework that suggests four strategic actions (connecting, isolating, loosening, and tightening) to effectively navigate the intricacies of blockchain governance. Adopting a governance perspective, Liu, Lu, Yu, Paik, and Zhu (2022) systematically map blockchain stakeholders to governance dimensions and stress legal compliance and ethical responsibilities in blockchain governance. Adding to that, Lumineau, Wang, and Schilke (2020) highlight the importance of the social implications of BC IS and their associated challenges.

Other studies consider the organizational perspective of blockchain consortia in particular. For example, Zavolokina et al. (2020) take a single case study approach and provide insight into tensions around management, governance, and business value in a blockchain consortium along its lifecycle. Du, Pan, Leidner, and Ying (2018) acknowledge the importance of the organizational perspective in blockchain implementations and identify blockchain affordances and their actualization in the organizational context of FinTech. Further studies investigate governance (like principle-agent and regulatory conflicts) (Ziolkowski & Schwabe, 2022) and managerial conflicts in blockchain consortia (Ostern & Perscheid, 2022). These studies conclude the importance of the organizational view over the solely technical view on BC IS. To the best of our knowledge, only Schwabe (2019) examines the role of a single actor, i.e., public agencies, in blockchain consortia: as an actor in organizational processes, supplier of data, source of trust, a guarantor of data quality, and a user of data. However, no further studies examine how different participants in a consortium (like a business, academic, technology, or legal partner) collaborate to create value for them.

Only a few studies look at the different stages of blockchain consortia development. In this regard, understanding the different stages of a consortium's lifecycle and the related value creation and governance challenges can help develop dedicated strategies to address them more effectively. Several studies focus on the temporal perspective (Hacker, Miscione, Felder, & Schwabe, 2023; Putz & Pernul, 2022). For example, Putz and Pernul (2022) analysed ten blockchain consortia and derived four phases in a blockchain consortium's phases: formation, pilot, launch, and expansion. We provide a short description of these phases since we will use them as a template to analyze the development of our studied consortia over time in the empirical part of this paper.

- Formation: This phase involves developing ideas and creating initial software prototype concepts—the initiator searches for consortium and implementation partners to collaborate on the project. If necessary, a legal entity is formed to represent the consortium unless a pre-existing partner network is already in place.

- Pilot: In this phase, the requirements and initial scope for the business case are established, taking into account compliance and security needs. The consortium institution and/or software provider develops the prototype software, which is then used in a real-world business process for testing purposes.
- Launch: The first product is released for production use during the launch phase. A revenue model is developed, and the consortium institution begins earning revenue (applicable only to for-profit consortia). Participants start to see the initial benefits of adopting the product.
- Expansion: In the expansion phase, more peripheral organizations in the supply chain join the platform, often as users rather than operators. Additional business cases or products within the consortium are developed and launched, further extending the platform's reach and capabilities.

While technical implementations of BC IS are possible, given the right skills, tools, and financial resources, most related challenges emerge within the social interactions of such collaborations (Behnke & Janssen, 2020). So, to better understand value creation–which is not solely a technical but very much an organizational concept–for our study, we separate the purely technical view and focus on the organizational view of blockchain consortia, implementing BC IS.

2.2. Value creation in blockchain information systems

The notion of 'value' has been extensively researched in disciplines ranging from psychology, marketing, and management to human-computer interactions (Amit & Zott, 2017; Kühne & Böhmann, 2019; Kujala & Väänänen-Vainio-Mattila, 2009). 'Value' is typically understood as an expected or perceived benefit for a company. In information systems, 'value' is seen as a benefit delivered by or through an information system. Previous studies in management science and information systems study concepts such as 'value creation' and 'value capture' in different business contexts and for various information systems or digital environments (Chong, Lim, Hua, Zheng, & Tan, 2019). These concepts have become essential to (digital) business models and, thus, a business's success (Al-Debei & Avison, 2010; Amit & Zott, 2017). 'Value creation' can be described as activities aiming to deliver a product or service that satisfies the customer's needs and benefits all stakeholders. As for 'value capture,' it can be described as how businesses extract revenue (or benefit) from delivering a product or a service. In our study, in particular, we focus on the mechanisms (i.e., the 'how') for value creation, which becomes more complex and challenging for organizations that involve multiple organizations.

Several studies have already described the value potential of blockchain technology for different industries (Chen, 2018; Ølnes, Ubacht, & Janssen, 2017). Such studies are important to develop an initial understanding of the possibilities of the technology in various fields. Few studies have analysed the value drivers of blockchain technology (Amit & Zott, 2017; Schlecht, Schneider, & Buchwald, 2021), and those have either neglected the organizational aspects involved in creating and using the technology or focused on a specific context. For example, Angelis and Ribeiro da Silva (2019) focus solely on the value drivers of technical aspects such as decentralization or smart contracts. While granting equal relevance to technical and organizational aspects, Zheng and Boh (2021) focus their analysis on using blockchain technology in online communities.

As BC IS development progresses, a deeper understanding of how businesses can effectively create and capture value is needed (Chong et al., 2019). For business value creation, this involves explicitly understanding the interrelation of the technical and organizational aspects (Kohli & Liang, 2021; Sarker, Chatterjee, Xiao, & Elbanna, 2019). Further, no studies have offered insight into potential organizational problems in creating value and approaches to addressing these. However, a lack of knowledge on how to deal with potential problems that arise through novel cross-organizational collaboration can lead to the failure of consortia, as already observed in some cases (Melis, 2019).

2.3. New organizational form brings new problems in value creation

The emergence of blockchain technology with its unique combination of characteristics –decentralization, 'distributedness,' no formal central authority, and automated governance – brought up the question of whether the technology has the potential to influence organization science (Catalini & Boslego, 2019) and to become a critical turning point for organizing collaborations (Lumineau et al., 2020). In the recent research discourse, researchers agree that blockchains enable a new organizational form (Allen, Berg, Markey-Towler, Novak, & Potts, 2020; Catalini & Boslego, 2019; Miscione, Ziolkowski, Zavolokina, & Schwabe, 2018) when contrasted to existing ones like markets and hierarchies (Williamson, 1975), networks (Powell, 1990) or commons (Ostrom, 1990). For example, Miscione et al. (2018) call blockchain 'tribal governance,' which can be characterized by some peculiar characteristics: it has rivalry created in a digital space, the majority of decisions are enforced, built-in reward schemes influence participants' behaviours, and it has organizational togetherness (where participants rely on each other). Another study argues that blockchains 'offer a way to enforce agreements and achieve cooperation and coordination that is distinct from both traditional contractual and relational governance as well as from other information technology solutions' (Lumineau et al., 2020).

A blockchain organization may resemble and be compared to a hybrid organization (Catalini & Boslego, 2019). A hybrid organization combines multiple organizational structures (Battilana & Lee, 2014). Different organizational structure elements are not always compatible (Greenwood, Raynard, Kodeih, Micelotta, & Lounsbury, 2011). When a hybrid organization must combine mutually conflicting processes or practices demanded by various organizational forms in the hybrid work context, such incompatibility can lead to tensions within the hybrid organization (Tracey, Phillips, & Jarvis, 2011). Recent research suggests that combining organizational forms is critical to organizational innovation, particularly the creation of new forms (Tracey et al., 2011), such as blockchain organizations that combine different organizations. Hybrid organizations follow one (or more) of the four organizing approaches (Battilana & Lee, 2014): (1) *Dismissing* means explicitly rejecting elements or demands of at least one organizational form; (2) *Separating* means compartmentalizing elements or claims from different organizational forms; (3) *Cumulating* means retaining and connecting disparate elements of different organizational forms; and (4) *Creative* means creating a new distinctive institutional order. Our study looks at the approaches the examined blockchain consortia follow to address the organizational problems related to value creation.

Several researchers consider blockchain technology a more efficient form of organizing (Allen et al., 2020; Davidson, De Filippi, & Potts, 2016; Lumineau et al., 2020). However, in practice, many blockchain organizations struggle to go beyond the initial idea or prototyping stage. For instance, organizational governance facilitated through a blockchain may reduce searching, monitoring, and enforcement costs but tends to imply higher design costs (Lumineau et al., 2020). Along this line, Catalini and Boslego (2019) discuss the evolution of a blockchain organization throughout time: from the 'new blockchain' phase to the 'transition period' and a 'mature system.' They conclude that one of the challenging aspects is governance in blockchain organizations when transitioning from one phase to another needs to be done. The authors formulate it as a 'decentralization paradox': in blockchain organizations, founders must give up control for the network to develop and realize its full potential, yet doing so comes at a cost for them, early users, and stakeholders. This tension between short-run and long-run incentives can only be resolved if founders are patient and ready to own a smaller portion of a bigger ecosystem or if the transition is integrated into the 'constitution' of the blockchain organization. When a blockchain organization fails to make such a transition and instead remains in a state with too much influence from its early stakeholders, it collapses back to an organizational shape that did not require the technology in the first place. In their study of 14 blockchain systems from four application domains, Ziolkowski, Miscione, and Schwabe (2020) went deeper and empirically derived decision-making problems that combine well-known governance problems from the information systems domain (like data or demand management) with new governance problems that emerge in blockchain systems (like transaction reversal or ownership disputes). While prior research focuses primarily on governance aspects, the organizational problems related to realizing (business) value are hardly covered, and the question of how a blockchain consortium can organize for value creation remains open.

Finally, it is important to note that while our research examines decentralized structures within blockchain consortia, it does not specifically focus on Decentralized Autonomous Organizations (DAOs). Instead, we explore a broader spectrum of value-creation mechanisms within different types of business blockchain consortia. While both DAOs and blockchain consortia use blockchain technology, they differ fundamentally. DAOs are fully automated and decentralized entities with governance rules encoded into and executed by smart contracts (Hassan & De Filippi, 2021). Blockchain consortia are groups of organizations collaborating on a shared blockchain network, typically with a human- or organization-involved governance model and a specific industry focus.

3. Methodology

This study is part of a multi-year research project exploring blockchain consortia, the value of blockchain for businesses, and blockchain-based ecosystems in a multiple-case study. In addition, building up a blockchain consortium (Zavolokina, Ziolkowski, Bauer and Schwabe, 2020), i.e., the CarBlock[1] consortium, allowed members of the author team to gain practical and in-depth experience in one case in particular. Therefore, the CarBlock consortium serves as the main case in this article, given the unique and comprehensive data that the authors could access as initiators and participants in this project over more than 2.5 years. Besides the main case, this article draws on data from five other cases, which we term 'additional' cases, collected in an interview-based study on blockchain consortia. For both the main and the additional cases, we were able to collect data from multiple sources of evidence, including primary data (e.g., interviews) and secondary data (e.g., archival data like press releases) (cf. Table 1). Combining the in-depth main case study and the additional cases in a multiple-case study design allowed us to gain comprehensive insights into the value mechanisms of BC IS and the approaches needed to realize them (Yin, 2009).

Regarding the main case study, we adopted an exploratory and interpretative research approach (Eisenhardt & Graebner, 2007; Stebbins, 2001) while drawing on the layers of BC IS by Notheisen et al. (2017) and the consortia's phases by Putz and Pernul (2022) to structure our findings. Other than the layers and the consortia's phases, a specific theory did not drive our analysis since we intended to inductively derive a set of mechanisms to achieve value in BC IS, the organizational problems they face to achieve it, and the solutions they find. Through an in-depth analysis of our main case study, we identified several key value mechanisms. To ensure the reliability of our findings, we cross-validated them using interview materials and secondary data from the additional cases. Given that some of the authors were also involved in the initiation of the CarBlock consortium, the collection and analysis of data for the additional cases was led by another member of the author team to facilitate an external perspective. Organizing the data collection in this manner and triangulating the findings from the CarBlock with findings from the additional cases were deliberate measures to avoid researchers' bias. Following this procedure, except for *decentralized data markets*, we found confirmation of the value mechanisms identified in the CarBlock consortium in the additional cases.

Overall, this approach allowed us to gain in-depth insights from the main case and increase the validity and generalizability of our exploratory findings using data from the additional cases (Eisenhardt, 1989; Yin, 2009). This was important to our study as we aimed to explore general rather than domain-specific value mechanisms in BC IS and generalizable organizational problems and their solutions. The presented findings report on the value creation and their organizing approaches that we could observe at least two times in the studied blockchain consortia (in the main case and at least one additional case) but with less variety. In the subsequent sections, we

[1] Name of the consortium has been changed to ensure confidentiality.

Table 1
Summary of the collected data for both the main and additional cases.

Data type / Case type	Primary data	Secondary data (other documents, grey literature)

Main case: CarBlock	• 25 interviews (conducted between 2017 and 2019) with all relevant project stakeholders (see Appendix)
	• Participating observation in 3-weekly 'Live-Sessions,' weekly sprint meetings, and 3-monthly steering committees over 2,5 years
		• Comprehensive software documentation of the CarBlock platform (requirements, modelling, architecture)
		• Project documentation (appr. 170 meetings with more than 250 pages of meeting minutes):
		  • Weekly sprint meetings: ca. 130 minutes
		  • Live Sessions: more than 40 minutes
		  • Steering Committees: 10 minutes
		• 11 documents (e.g., press releases, see Appendix)

Additional cases: LandBlock DrugTransBlock FoodBlock FraudBlock TradeChain	• 13 interviews with key individuals involved in the five consortia, among them representatives of the business partners and technology companies (conducted in 2019; see Appendix)	• 38 documents (e.g., press releases, annual reports, presentations; see Appendix)

provide more details on the data collection and analysis.

3.1. Data collection

Data collection included two types of empirical data: semi-structured interviews (primary data and the main source of our findings) and grey literature (secondary data).

3.1.1. Sampling strategy

The selection of the additional cases aimed at maximizing our knowledge about business blockchain consortia regardless of their industry (Dubé & Paré, 2003). As for the search for the consortia, we collected a list of 107 organizations that resembled blockchain consortia. This list was assessed based on the following selection criteria: fit the definition of a consortium, maturity, industries, size, and the presence of a formal agreement or contract. For the 'fit to the definition of a consortium,' we used the following definition (Venugopal, 2016): '*A consortium is an association of two or more individuals, companies, organizations or governments (or any combination of these entities) with the objective of participating in a common activity or pooling their resources for achieving a common goal. Each participant retains its separate legal status, and the consortium's control over each participant is generally limited to activities involving the joint endeavour, particularly the division of profits. A consortium is formed by contract, which delineates the rights and obligations of each member*.' For the criteria 'maturity,' 'industries,' and 'size,' we aimed to maximize the variety in our selection. In addition, we focused on consortia aiming to build blockchain solutions to address business problems (as opposed to consortia developing technological infrastructure only). This selection resulted in the list of 33 consortia iteratively contacted to participate in the study. Initially, we intended to conduct interviews with ten blockchain consortia; however, we noticed that they provided further findings. So, we continued to search for additional consortia to be interviewed and ended up with interviews with nine other consortia and 19 in total. Out of these consortia, in addition to our main case, we selected the five successful cases in their value creation. 'Successful' here means that these consortia had managed the first two consortia's phases (formation, pilot) and entered the third phase (launch). Specifically, the selected consortia had entered the production stage by the time the interviews took place or did so shortly after. Table 1 outlines the primary and secondary data collected for the main case study (CarBlock) and additional case studies (LandBlock, DrugTransBlock, FoodBlock, FraudBlock, and TradeChain).[2] Our approach highlights the breadth and depth of data collected to comprehensively understand the main and additional cases, providing a robust foundation for our analysis.

3.1.2. Main case

Primary data. This study includes semi-structured interviews with individuals involved (e.g., Hopf, 2012, p. 350) and participatory observations in the CarBlock consortium.

In total, we conducted 25 semi-structured interviews. In the phases from Initiation to Expansion, 21 interviews were conducted with all relevant project stakeholders (business, technology, legal, and academic partners and a public agency) between 2017 and 2019. These interviews provided first-hand accounts and direct observations about different aspects such as business value, governance, and design during the consortium's formation, pilot, and launch phases. Participatory observation also occurred during weekly sprint meetings, 3-weekly 'Live-Sessions' where the team reported their progress to the stakeholders, and 3-monthly steering committees over 2.5 years. Right before the expansion phase, the last round of four interviews was conducted with one academic partner, one business partner, the technology partner, and the public agency from the consortium. Following up on previous interviews, these interviews included questions about a consortium's value creation approach, technical aspects of the blockchain solution,

[2] Names of the consortia have been changed to ensure confidentiality.

collaboration, consortium governance, and legal and regulatory issues. The interview guide can be found in the Appendix. The interviews were held in German and conducted face-to-face. All interviews were recorded and transcribed verbatim.

Secondary data. Secondary data was sourced from various documents, including extensive software documentation for the CarBlock platform. This consisted of requirements, modelling, and similar technical specifications. Project documentation also played a crucial role and comprised meeting notes and minutes from various team interactions. Specifically, we analysed approximately 130 minutes from weekly sprint meetings, over 40 minutes from 'Live Sessions', and ten minutes from steering committees, resulting in over 250 pages of meeting minutes. Additionally, 11 documents, such as press releases, were included in the analysis (see Appendix).

3.1.3. Additional cases

Primary data. For the additional case studies - LandBlock, DrugTransBlock, FoodBlock, FraudBlock, and TradeChain - primary data was collected via 13 interviews with key individuals involved in these consortia in 2019. To ensure that we cover the perspectives of various stakeholders, we conducted at least two interviews with various roles (e.g., a business partner, academic partner, technology firm) per consortium. The interviewees belonged to different member firms of a consortium and had different competencies in the consortium, e.g., consortium management or blockchain system implementation. Conducting interviews with several interviewees per consortium allowed us to cross-validate and contrast individual statements within a case. Table A in the Appendix provides an overview of all consortia, their goals, funding sources, foundation dates, the status of their projects, and the interviewees' roles. The interviews were held in German or English and conducted face-to-face or via video-conferencing between February and September 2019. All interviews were recorded and transcribed verbatim.

Secondary data. Given the hype around blockchain, blockchain consortia received extraordinary attention in the professional press and the media. Hence, while not necessarily academic references are available concerning our additional cases, there is a lot of grey literature (news articles, professional and consulting reports, and projects' websites). As a result, our empirical study relied on publicly available whitepapers, press releases, and newspaper articles from the cases searched for in Google and Google Scholar, as well as the official websites of each project (if available). We also included specialized press sources such as Forbes and Medium. The latter has frequently been used as a channel by representatives of these projects to announce the news on, for example, the state of their development, changes in their roadmaps, or educational purposes. We used these statements, among others, as credible inputs in their project descriptions to carve out their development's state and identify deviations from set targets. Reliance on various sources reporting about these projects was critical to ensure a plausible depiction of these cases. The collection of the grey literature spanned from February 2019 until the summer of 2020 and included 38 documents for the additional cases (see Appendix).

3.2. Data analysis

The interview material was analysed, i.e., iteratively coded, using qualitative data analysis software (MAXQDA). At the beginning of the coding process, we started with seven top-level codes (*interviewee_background, consortium_overview, business_model_value_creation, platform_data, governance, working_together, legal_regulatory)* that reflected the themes from the interview guide. We applied the architectural lens proposed by Notheisen et al. (2017), which breaks down a BC IS into three key subsystems: infrastructure, platform, and application. This served as our guide to identify *where*, i.e., in what subsystem, and *how*, i.e., what technical components are involved, value is created in a BC IS. We then integrated this perspective with the consortium phases (Putz & Pernul, 2022) and searcher bottom-up (Saldaña, 2021) for the types of stakeholders involved in the blockchain consortia. Having identified the stakeholders involved in each subsystem (infrastructure, platform, and application) within BC IS, we again analysed our data with a particular focus on the value mechanisms across the individual subsystems and the consortia's phases, when they were achieved. Analysis of the value mechanisms and possible organizational problems the organizations faced on the way to realizing the value mechanisms, and the organizational solutions to these problems. Each value mechanism is demonstrated by its description within the CarBlock context and by showing one or two additional cases where it was found. However, it is important to note that if we did not spot a specific value mechanism in our data for a certain additional case, it does not necessarily mean it is absent in the blockchain consortium.

The resulting coded segments were mainly phrases and (groups of) sentences (Weber, 1990). Table B in the Appendix provides an overview of the value mechanisms, their descriptions, and further examples of the coded segments. The results were discussed and refined iteratively within the research team. Further, to include external feedback, we conducted a workshop with collaborators of the study team to discuss and review preliminary results. The secondary literature informed researchers during the interview preparation and served for data triangulation in the analysis stage.

4. Case description

4.1. Main case: CarBlock

The CarBlock consortium is a multi-stakeholder initiative within the mobility sector in Western Europe. The consortium aimed to create a reliable and secure "single source of truth" for car-related data to tackle the challenges arising from inconsistent and unreliable data saved by different organizations in local databases, costly and cumbersome business processes for companies and state organizations, and the lack of transparency and trust between individuals and organizations. To achieve this, they developed a blockchain-based permissioned platform to increase transparency and trust in the car-related ecosystem by securely and reliably storing and exchanging all relevant information about a car's history. The blockchain solution also empowered data owners to control their data and receive fees for providing it, enhancing stakeholder trust and cooperation.

4.1.1. Consortium's phases

Formation (2016–2017). Initially, the CarBlock project focused on creating a concept, recognizing the used-car market as a suitable application for blockchain technology, and aiming for trust and transparency as the main benefits. The project was initiated by a software company in collaboration with a university (the authors of this paper were among the consortium's initiators). To form the consortium, various car-related organizations were invited, and founding members such as a car importer, an insurance company, and a road traffic agency joined. The project received research funding from a national funding institution, which lowered participation barriers, encouraged more organizations to join, and showed government support, leading to the successful formation of the consortium.

Pilot (2017–2019). During the second phase, the project centred on system design and pinpointing its business value for consortium members. They used the Scrum software development method to create a permissioned blockchain for a minimal viable product (MVP). The prototype CarBlock frontend, a user-facing app, was developed as part of the MVP, offering basic car data, history, assessment, and other information gathered from consortium data providers. The backend was implemented using Corda, a permissioned distributed ledger technology typically used for blockchain in the business context. A permissioned system allowed the consortium to establish and store data rights and meet complex rights management requirements.

Launch (2019–2020). The MVP was put into use to support used car sales, encouraging stakeholders to provide data for a car's entire lifecycle. In return, stakeholders would benefit from the jointly created data market. As the CarBlock project approached market entry, governance and business value, challenges became more critical. The consortium assessed the business value for each stakeholder involved in every problem area and decided to concentrate on used car sales to benefit all stakeholders equally.

Expansion (from 2020). The long-term vision includes having multiple (ideally all) companies from car-related industries join the consortium and contribute their data. This would allow the system to open to private users and cover the entire used-car market. Although the initial focus was on the used-car market, future expansion could address other issues within the car-related ecosystem, like inefficiencies in document management during car importation or streamlining repair and service processes. As of June 2023, the CarBlock consortium includes 35 members and partner organizations.

4.1.2. CarBlock's BC IS subsystems

Fig. 2 visualizes CarBlock's subsystems, their technical components, and the organizations involved, as described further. The *infrastructure subsystem* (i.e., the hardware and protocol components) is characterized by a collaboration between a variety of

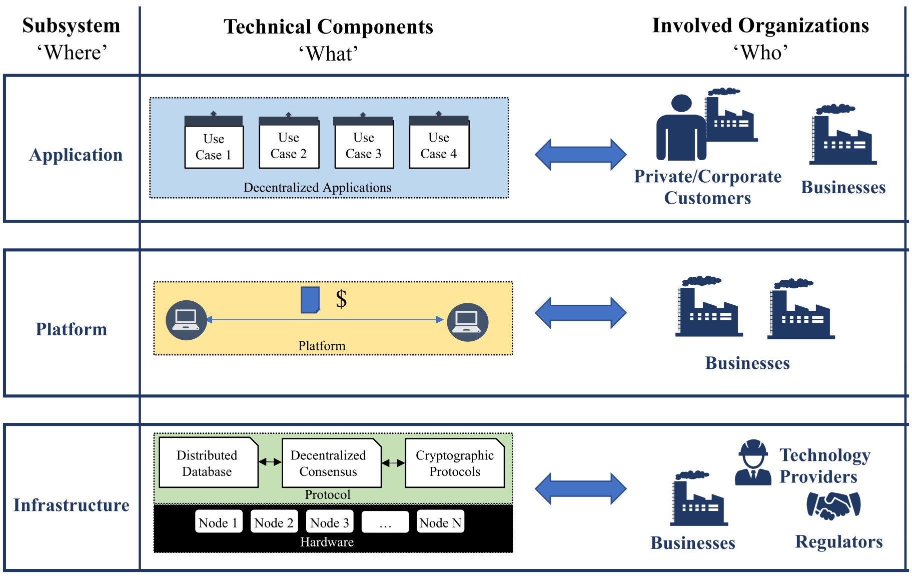

Fig. 2. Subsystems, Technical Components, and Involved Organizations.

stakeholders (e.g., different businesses, regulators, and sometimes technology providers) utilizing the key mechanisms of blockchain – a distributed database architecture, a decentralized consensus mechanism, and tamper-resistant transactions – in the aim of addressing issues in a particular ecosystem. In the case of CarBlock, the consortium includes a variety of stakeholders from the automotive ecosystem, including car importers, used-car dealers, car insurers, and mobility service providers, who are experiencing rising competitive pressures from digital giants. While big companies like BMW or General Motors establish monopolistic platforms for the increasing amount of data generated by car usage (*BMW* Open Data Platform, 2023; *GM Digital Platform Enables Future Technologies | General Motors*, 2023), CarBlock's opted for a decentralized system as the basis for their infrastructure.

The *platform subsystem* (i.e., an environment that enables the implementation of platforms or markets) is characterized by the interaction of multiple businesses via a platform built upon and drawing on the underlying infrastructure. The individual business actors in the CarBlock consortium were struggling with data and process fragmentation problems. They quickly saw the opportunity to monetize the ever-increasing availability of car-related data by developing a data market on top of the interoperable infrastructure that allows them to exchange car-related data across organizations efficiently. The data market served as an incentive model for data exchange. The data providers got a monetary reward for providing their data, while the data consumers had to pay for the data they wanted to access. They hoped to increase efficiencies or create novel data-driven products or services.

Finally, the *application subsystem* (i.e., individual decentralized applications or other applications) is characterized by the interaction of businesses with customers (i.e., end-users) through applications. These end-users can be artificial (e.g., robots or smart cars) or human users, and private and corporate users from a firm or public agency. For example, businesses involved in the CarBlock consortium (e.g., car importers and retailers) mentioned the aim of addressing information asymmetries between buyers and sellers of

Table 2
Summary of the main and additional cases, their addressed problems, and blockchain use cases.

No.	Pseudonym *Sector* Description	Addressed problem(s)	Blockchain solution
C01	**CarBlock (main case)** *Mobility* Documentation of all relevant events that occur during the life cycle of a car.	• Inconsistent and unreliable data saved by different organizations in local databases • Costly and cumbersome business processes for companies and state organizations • No transparency and trust between individuals and organizations • No single source of truth for car information	• Blockchain-based permissioned platform aims to increase transparency and trust in the car-related ecosystem by storing and exchanging all relevant information about a car's history in a secure and reliable manner • Consortium members can benefit from process optimization and create new business value due to the (emerging) car-related data market • Blockchain enables data owners to have control over their data and receive fees for providing data
C02	**LandBlock** *E-government* Documentation and management of land titles.	• Buying and selling land in the consortium's country was a long process, involved a fee, and was prone to bribery • The country's government wanted to fight corruption and modernise public services	Use of blockchain technology to manage land titles to: • achieve security (as data cannot be corrupted) • enable public auditors to make real-time audits • reduce friction in the system and costs of property rights registration (use blockchain as notary service)
C03	**DrugTransBlock** *Pharmaceutical* Track and trace the temperatures of medicines during transportation.	• As temperature-sensitive pharmaceutical products travel to the patient, external conditions, specifically temperatures, can reduce their efficacy and quality. • Temperature-controlled packaging can maintain the desired temperature ranges. However, a monitoring solution is required to fulfil the standards and regulatory requirements	• Tracking drugs' temperature and offering data integrity in combination with the Internet of Things (IoT) • Process automation for the ecosystem's participants • Compliance with the standards and regulatory requirements
C04	**FoodBlock** *Food supply chain* Track and trace food.	• Lack of transparency in the seafood supply chains • Difficult to verify the authenticity of products • As a result, no consumer's confidence in the product's quality	Blockchain technology provides: • instant information about the fish-to-market journey, including the size of the catch, point of capture, and the fishing community that caught it • a way to verify authenticity, freshness, safety, fair trade fishing certification, and sustainability.
C05	**FraudBlock** *Trade finance* Reduce inefficiencies and fraud in trade finance.	• The commodities exchange is managed across borders and jurisdictions using an ineffective, issue-prone, antiquated paper-based record tracking system • Miscommunication and fraud, security vulnerabilities, manual, repetitive tasks, long verification times, and losses due to transaction fees, invoice factoring, and delayed payment methods	• Blockchain-based platform for the commodity trade ecosystem • A shared ledger to improve access to accurate information across the ecosystem, and private data exchange based on permissions
C06	**TradeChain** *Trade finance* Digitalization and simplification of trade finance processes.	• Trade finance is a step-by-step transactional process. As a result, the many involved parties significantly slow down the process. • The process is paper-heavy and not very automated, which increases costs. • The value chain is complex because many parties involved cannot "trust" each other per se.	• A digital platform to execute, secure and finance trade transactions digitally • Traders, particularly SMEs, who did not have access to bank guarantees, invoice financing, and credit insurance, use the platform to enhance their cash flow and digitise their existing paper-based processes.

used cars by providing trusted car life cycle certificates for all cars in their regional market. They aim to offer such certificates by providing a decentralized application (dApp) that draws on the underlying data market and aggregates traceable data events from different stakeholders.

4.2. Additional cases

Table 2 summarizes the addressed problems and the blockchain solutions of the CarBlock as the main case and five additional successful blockchain consortia from our sample (additional information is available in Table A in the Appendix).

5. Results

This section presents the identified value mechanisms structured along two dimensions: Interoperability and Decentralization. Finally, we describe the organizational problems and solutions in value creation.

5.1. Mechanisms for value creation in blockchain information systems

Table 3 gives an overview of the value mechanisms along the subsystems (the 'Where,' which reflects on which layer of a BC IS value is created) based on the previously introduced layers of a BC IS (Glaser, 2017; Notheisen et al., 2017) and the phases (Putz & Pernul, 2022) of the CarBlock consortium when they were implemented.

Following the growth of the CarBlock consortium from 2016 to the present, we focused on how two main value dimensions, Interoperability and Decentralization, have developed over time. From 2016 to 2017, during the initial Formation phase of CarBlock, value mechanisms and value creation, in general, were not yet apparent. The project participants brought various potential ideas about how they may create value, initially motivating their involvement. However, due to the project's early stage, these ideas and, consequently, tangible value had not been realized yet. Nevertheless, as CarBlock moved into the Pilot phase between 2017 and 2019, interoperability became visible through the development of an *interoperable infrastructure* (interoperability dimension) and the decentralized control emerging under Decentralization. During the Launch phase, from 2019 to 2020, these value dimensions continued to evolve. *Platform innovation* became the key focus under interoperability, and *decentralized data markets* came to the fore under decentralization. Starting in 2020, in the Expansion phase, the emphasis was placed on *tokenization* (interoperability dimension), and decentralization surfaced with the development of *decentralized applications*. At the same time, our analysis showed how these value mechanisms aligned with the particular BC IS subsystems. In the Pilot phase, the value mechanisms were primarily applied to the infrastructure subsystem. During the Launch phase, they were implemented in the platform subsystem. In the Expansion phase, the focus shifted towards the application subsystem.

Next, we describe the value mechanisms along two dimensions – decentralization and interoperability, and their manifestation in our main case, CarBlock, with 1–2 examples (except for the decentralized data market, where no other case was identified) per value mechanism from the additional cases corroborating our findings from the main case. Table 4 summarizes the description of the value mechanisms in the CarBlock consortium and shows the cross-validation result from the additional cases with X indicating the presence of a value mechanism.

5.1.1. Decentralization

Decentralization is a key aspect of blockchain technology that can provide significant benefits in various domains. In the context of blockchain consortia, decentralization entails three key concepts. First, decentralized control gives a consortium's members the power to manage and share their data in a decentralized system with no central authority, enhancing privacy and accountability. Second, decentralized data markets use blockchain to create transparent digital marketplaces, where validated data can be exchanged directly between sellers and buyers. Lastly, decentralized applications (dApps) are programs run on the blockchain, not controlled by any single entity, but overseen by its users or organizations. These elements create a transparent, fair, and user-centric environment, enabling innovation and trust within BC IS.

Decentralized control. Decentralized control means that no single central authority has control over the system. Instead, as inherent to blockchain systems, each consortium member contributes to running and maintaining the system and validating the transactions. Furthermore, data owners maintain possession and management over their data, deciding who can access it, thereby enhancing privacy and reducing dependency on central servers.

Table 3
Value mechanisms along the subsystems and the phases in CarBlock.

Phase / Value mechanism	Formation (2016–2017)	Pilot (2017–2019)	Launch (2019–2020)	Expansion (from 2020)
Interoperability	–	Interoperable infrastructure	Platform innovation	Tokenization
Decentralization	–	Decentralized control	Decentralized data market	Decentralized applications
BC IS Subsystem	–	Infrastructure	Platform	Application

Table 4
Summary value mechanisms, their manifestation in the main case and cross-validation with additional cases.

Value Mechanisms		Definition	CarBlock (Main Case)	Additional Cases				
				LandBlock	DrugTransBlock	FoodBlock	FraudBlock	TradeChain
Decentralization	Decentralized Control	The distribution of control over the system and data over multiple parties	• Each stakeholder in CarBlock's consortium runs a blockchain node and controls the vehicle data they recorded in the blockchain. Each stakeholder maintains their data, eliminating the need for a central authority. • CarBlock's blockchain ensures transparency and accountability among consortium members, as every transaction and data addition can be audited.	yes	yes	yes	yes	yes
	Decentralized data market	Markets (for data) that allow buyers and sellers to meet and deal directly with each other	• CarBlock supports a transparent, peer-to-peer used-car market, where deals can be made based on reliable data. • By providing comprehensive and reliable data about each vehicle and equal rights and access among the consortium's members, CarBlock encourages fair trading practices.	no	no	no	no	no
	Decentralized Applications (dApps)	Applications that are developed on a blockchain network	• CarBlock members can develop DApps for diverse purposes, like insurance claim management or service tracking. • Businesses in CarBlock can leverage shared data to offer services like personalized car maintenance suggestions.	no	yes	yes	no	yes
Interoperability	Interoperable Infrastructure	A network that can interact with different systems	• CarBlock provides a common technical infrastructure for data storage and exchange for various stakeholders like manufacturers, dealerships, insurance companies, and service centres, ensuring comprehensive coverage of the used-car market and a car's lifecycle • Each industry sector can contribute and access car data relevant to them (e.g. road traffic agency – registration data) according to the agreed-upon data model.	yes	yes	yes	no	yes
	Platform Innovation	Novel structures that increase the effectiveness with which a group of activities may be performed and involve coordinating different resources and actors to create a new digital platform	• The modular platform allows the consortium members to create their own services on top of CarBlock, such as personalized insurance offers. • By moving competition to the digital space, CarBlock encourages innovation, enabling businesses to differentiate their offerings through developing dApps.	yes	yes	yes	yes	yes
	Tokenization	Creating unique digital objects of value, i.e., digital assets	• CarBlock tokenizes vehicle data to present a comprehensive digital profile of each vehicle. • Tokenization ensures the car's entire lifecycle data is carried forward, building an uninterrupted vehicle history.	yes	yes	yes	no	no

Main case. CarBlock establishes a platform where each stakeholder in the consortium has control over the vehicle data, they record on the blockchain (Bauer, Zavolokina, Leisibach, & Schwabe, 2020; Zavolokina, Ziolkowski, Bauer, & Schwabe, 2020). CarBlock's infrastructure layer is built on a decentralized network of computers (nodes). This network is the foundational layer where data is stored immutably on the blockchain. Cryptographic protocols ensure that data remains tamper-proof. While only metadata (like timestamps and types of transactions) are stored publicly, most of the data can only be accessed if and when the data owner grants access rights to another party. For instance, '*service centres hold and manage a car's service history, while insurance companies maintain insurance records*' (C01). This structure eliminates the necessity for a central authority by distributing control among multiple participants.

In addition to reinforcing decentralized control, CarBlock's blockchain design also promotes transparency and accountability among consortium members. As each transaction and data addition is recorded on the blockchain, these actions can be audited anytime. This visibility reinforces the credibility of the data and fosters trust within the consortium. This assurance of auditability helps to maintain a high level of accountability within the CarBlock ecosystem.

Additional cases. In the context of the FoodBlock consortium, distributed control means that data governance (the rights and responsibilities for the recorded entries) is spread across all the strategic partners involved in the tuna supply chain. Each data entry's ownership is recorded on the blockchain, eliminating the need for centralized authority and ensuring equal control among participants. The blockchain's inherent characteristics contribute to heightened transparency and accountability among consortium members in FoodBlock. Every '*data entry, tracing each fish's journey from capture to consumer, is visible to all parties and cannot be altered*' (C04) once added to the blockchain. This openness ensures that every participant's actions are transparent, promoting accountability for their part in the supply chain.

Decentralized data market. Blockchain consortia create decentralized data markets that are digital markets for data validated and authenticated by blockchain. In decentralized data markets, data buyers get direct access to validated authentic data from data sellers and explicit consent to use it for transparent, market-based transactions. Such data markets involve three roles: (1) data sellers, i.e., individuals and organizations who sell their data in a trusted and transparent market-based environment; (2) data buyers, i.e., individuals and organizations, who want to buy authentic and validated data directly from data sellers, and (3) notaries, i.e., organizations that confirm and validate the authenticity and accuracy of traded data and resolve disputes.

Main case. The CarBlock project aims to create a decentralized market for the entire used-car market in one country. A transparent peer-to-peer market can be facilitated by having comprehensive and trustworthy data available for each car on the blockchain. In this market, a car owner, for example, can demonstrate the good maintenance history of their vehicle to a potential buyer, backed by immutable data recorded on the blockchain. This transparent and data-driven approach encourages honest trading practices, enhancing the confidence of all parties involved in the transaction.

In the case of CarBlock, the data market also serves as an incentive for data exchange. If an organization wants to get access to the data of others, it will have to pay for it. In turn, if an organization provides its data to the blockchain, it will be remunerated for this data. This approach fosters a fair data market, incentivizing the sharing and utilization of data. For the data market to be fair, it is also important for CarBlock to ensure that any organization within the consortium has equal access and rights.

Additional cases. We could not identify a comparable case for cross-validation of the decentralized data markets. Despite the lack of similar instances for comparison, we believe that the insights from CarBlock demonstrate the potential and the importance of decentralized data markets as a value mechanism in blockchain consortia.

Decentralized applications (dApps). A 'dApp' is a computer program that exists and runs on the blockchain. DApps are very similar in basic structure to the apps one knows (web apps or mobile apps), except for a few key differences. All web apps have two components – a frontend (on the local computer) and a backend (on the servers). The difference between a traditional app and a dApp is that the backend component of a dApp resides on a blockchain. Because dApps are tied to blockchain networks like Ethereum or Hyperledger, a copy of the data is stored on all computers on a blockchain network. This means that, by definition, no single individual or group controls a dApp. Compared to traditional apps, dApps are also overseen and funded by their users or organizations, in the case of consortia.

Main case. The CarBlock consortium has designed an ecosystem that promotes innovation and competition by implementing a store dedicated to dApps. Consortium members can develop their dApps within the CarBlock platform, utilizing shared data for diverse and personalized services. For example, an insurance company within the consortium could create a dApp designed to adjust insurance premiums automatically, drawing on information from a car's digital token. This dynamic adaptation provided a more accurate and personalized service to car owners, demonstrating the inherent innovation and competitive advantages derived from the decentralized nature of the platform.

Moreover, the development and use of dApps enhanced the accessibility of the blockchain. An example is a dApp by a road traffic agency to streamline car repair processes. In this scenario, '*the agency communicates directly with the authorized repair shop. As a result, car owners are no longer required to come to the road traffic agency; they only need to verify on the blockchain that the repair workshop is authorized*' (C01). This approach provides new legal safeguards, empowering the road traffic agency to control repair processes via a dApp.

CarBlock's approach provided a real-world example of how dApps could enhance and streamline various processes across the car's lifecycle. By fostering dApp development, CarBlock encouraged a lively ecosystem where businesses can leverage shared data for various services, such as personalized car maintenance suggestions, leading to better and more efficient use of blockchain technology.

All members of the CarBlock consortium, whether new or long-standing, are encouraged to contribute not just financially but also to developmental activities. This active participation fosters a culture of collaborative innovation and enriches the platform's offerings.

Additional cases. In the TradeChain consortium, the value mechanism of decentralized applications is primarily demonstrated through the development and use of their TradeChain dApps. The consortium employs the TradeChain application, built on a blockchain framework, Hyperledger. This application specifically caters to the trade finance industry. It is cloud-based, and each bank in the consortium has its own cloud instance, a feature that mirrors the private blockchain concept. This allows banks to '*interact, conduct business, and process transactions on a platform built specifically for the needs and requirements of the trade finance industry*' (C06). TradeChain also allows for personalized services by using and exchanging data between different dApps on the platform. Banks can access and use this shared data to tailor their services to specific customer needs or improve operational efficiency.

5.1.2. Interoperability

Interoperability in blockchain technology is about ensuring that different systems can communicate and exchange data efficiently. This includes building a unified infrastructure that connects different parties and facilitates seamless information exchange. It also involves tokenization, where real-world assets are digitized into tokens on the blockchain, creating a comprehensive digital representation of these assets. Lastly, interoperability includes platform innovation, providing a common, decentralized platform for data exchange and application development. This fosters an environment encouraging competition and innovation, allowing parties to create unique digital services based on shared data.

Interoperable infrastructure. Creating an *interoperable infrastructure* was mentioned as another value mechanism on which the stakeholders involved in the infrastructure subsystem were working. In the context of blockchain technology, interoperability also describes the transfer of tangible assets and ensuring consistency between different systems. Consequently, blockchain, which offers the 'single source of truth' for data about the exchanged assets (physical or digital), becomes a value mechanism for consortia's members.

Main case. CarBlock serves as a unifying technical infrastructure, facilitating data storage and exchange across various stakeholders, ranging from manufacturers, dealerships, and insurance companies to service centres, road traffic authorities and car owners. This broad participation ensures comprehensive coverage of the used-car market and encompasses an entire car's lifecycle.

This interoperable infrastructure allows each industry sector to contribute and access data relevant to their specific operations. The seamless data exchange eliminates traditional barriers between industries, making collaboration and data-driven decision-making more efficient. For example, an insurance company can obtain an accurate history of a car directly from its digital token. This allows the company to offer an accurate insurance quote without contacting multiple parties for information. A technology provider involved with CarBlock highlighted the '*significant advantage of this system in enabling diverse stakeholders to interact and share valuable data in a secure, controlled and efficient manner*' (C01).

Additional cases. A business associate from the FoodBlock consortium, which focuses on tracking food from production to delivery, emphasized the importance of a '*shared interoperable infrastructure that would allow capturing and authenticating data from various strategic partners*' (C04). The aim is to ensure consistency and accuracy throughout the supply chain, a critical area where blockchain technology is particularly suitable. Such infrastructure allows tangible assets to be tracked consistently across different systems. Thus, the blockchain's ability to act as a 'single source of truth' for data about exchanged assets becomes a valuable mechanism for consortium members.

Platform innovation. Digital platform innovation refers to the novel structures that increase the effectiveness of a group of activities on a platform (Yablonsky, 2020) and involves coordinating different resources and actors to create a new digital platform (Klein, Sørensen, de Freitas, Pedron, & Elaluf-Calderwood, 2020). Blockchain consortia strive for platform innovation by building a decentralized platform that acts as a coordinator between the platforms of other consortium members.

Main case. A prominent aspect of CarBlock's platform innovation lies in the empowerment of consortium members to create and develop unique, innovative digital services using the data stored by CarBlock. For example, insurance companies can use the vehicle data available on the platform to create personalized insurance offers. Such offers can integrate various data points like vehicle maintenance history, accident records, and mileage to provide highly tailored and accurate insurance premiums.

Furthermore, CarBlock has shifted the traditional business competition into the digital by providing a common, decentralized platform for data exchange and dApps development. Organizations can differentiate themselves and gain a competitive advantage by creating dApps that leverage the shared data to offer new services to their customer. This model fosters an environment of healthy competition, leading to increased innovation across the CarBlock ecosystem.

However, for the platform to function, it is essential to standardize the data model. Thus, CarBlock tried harmonizing data by creating a 'meta-model.' The primary challenge faced by CarBlock was deciding whether the consortium should agree on a rigid, standardized data model, requiring all participants to adapt their data to match, or adopting a more flexible approach. The flexible approach would standardize the minimum necessary data while providing a 'translation service' to accommodate different data formats from different stakeholders. This would enable new participants to integrate their data with CarBlock's data model easily and could make the model more scalable.

Additional cases. All of our additional cases strive for platform innovation. It is well-exemplified by the FoodBlock and TradeChain consortia. TradeChain seeks to '*transform itself into an integrative platform—a one-stop shop for organizations in their business area*' (C06). This approach not only enables firms to perform a range of activities efficiently but also provides access to other platforms, fostering a dynamic and interconnected digital environment. FoodBlock articulates a similar vision of '*innovation through its ambition to serve as a* *bridge between various platforms, embodying the principle of interoperability'* (C04). The consortia's goal of becoming a 'platform between platforms' aligns with the concept of platform innovation as it aims to coordinate resources and actors across different platforms effectively.'

Tokenization. Tokenization is the creation of a digital image of a tangible asset (e.g., property, equipment) or an intangible asset (e.g., software programs, licenses). This means the specific asset is securitized using blockchain technology and represented by a token as a digital asset. A digital representation is created on the blockchain for a real asset: objects or values in the "real" world are linked to tokens on the blockchain. In other words, this is a digital replica of classic and well-known financial instruments such as shares or bonds. In nearly every blockchain consortium in our dataset, the interviewees emphasized the importance of tokenization for creating digital authenticity and uniqueness. Tokens are a part of the application subsystem since, in the consortia, their value is associated with data or property as an asset, and this value is only realized in use cases.

Main case. CarBlock showcases 'tokenisation' as a key interoperability value driver. It tokenises vehicle data to create a comprehensive digital representation of each vehicle, encapsulating details from manufacturing to service history. This tokenised data fosters exchange between various parties, including insurers, manufacturers, and dealers. Each party can access and contribute to the tokenised vehicle data, ensuring up-to-date and comprehensive data availability.

Furthermore, tokenisation aids in maintaining data continuity. Digital tokens ensure the ownership of the vehicle's complete lifecycle data, forming an uninterrupted, vehicle history that remains associated with the car, regardless of ownership changes or geographic relocations.

Additional cases. Tokenisation played a significant role in other blockchain consortia, as tokens can represent various types of assets - from digital commodities such as pharmaceutical data to tangible assets like property ownership. For instance, within LandBlock, 'the verification of property ownership is stored on the blockchain, enabling only the legitimate owner to confirm their property rights. This security is ensured by unique hashes containing precise details about the property and its owner, which are immutable.

While tokens are sensitive for some consortia due to their associations with cryptocurrencies such as Bitcoin, their importance in blockchain systems is universally acknowledged. DrugTransBlock, a consortium that leverages blockchain technology to enhance the transparency and efficiency of the pharmaceutical supply chain, utilized an Initial Coin Offering (ICO) to raise funds for the development and growth of the company. The tokens issued during this ICO '*represent not ownership but dividend rights, giving holders a share of the company's profits and voting rights in decision-making processes*' (C03). DrugTransBlock has an ongoing discussion about tokenizing physical assets in the supply chain, potentially allowing for more precise and secure tracking of shipments or logistics data.

Table 5
Organizational problems and solutions for achieving the value in BC IS.

Subsystem	Targeted value mechanism	Organizational problems	Organizing approaches	Organizational solutions
Application	Decentralization	**Loss of competitive advantage:** fear of competitors and new contributors entering a created ecosystem	**Separating** competitors by letting them create their own decentralized applications and manage their digital assets as a 'private good'	**Market** Foster competition between businesses by establishing a market: • a common understanding of the value of an open ecosystem, and • fair rules for the dApp market and digital assets
Platform	Decentralization Interoperability	**System bootstrapping**: reluctant stakeholders who do not dare to make larger investments to bootstrap the platform	**Cumulating** different organizational structures of stakeholders on a platform allows for fulfilling both private and public needs	**Market and Commons** Manage the balance between collaboration on the platform and competition in the data market by: • working on a joint denominator use case, and • creating formal governance structures
Infrastructure	Interoperability	**Loss of power**: technology providers have gained too much power, causing trust breaches with other stakeholders in the consortium	**Dismissing** the needs of individual organizations to create an infrastructure as a 'common good'	**Commons** Apply a 'commons' approach with respect to the collaboration in implementing the infrastructure by: • financial burden sharing, and • operational collaboration over infrastructure

5.2. Organizational problems and solutions for value creation

By analysing the value mechanisms, we identified the organizational problems the consortia faced in trying to achieve these value mechanisms. These problems hindered the progress of the consortia. In the following, we describe the most common organizational problems we observed in value creation in each subsystem. Further, based on the analysis of the main case and five additional successful consortia, the solutions how they achieved value creation with the value mechanisms. Table 5 below summarizes the identified organizational problems, implemented organizing approaches, and organizational solutions for each subsystem. Here, we do not differentiate between main and additional cases for better readability. Instead, we describe the consortia where the problem was more prominent.

5.2.1. Infrastructure subsystem

Problems. The willingness to achieve *interoperability* leads to the problem of power imbalances. Organizations striving for an interoperable platform require collective participation and contribution. In some cases, technology providers, integral to the development, may gain excessive power in the consortium. In most consortia, the technology providers took over a special role while creating value in the infrastructure subsystem, driven both by their knowledge and competencies in such fundamental development work and their business acumen. With their technical expertise in blockchain, they often steered the consortium. Technology providers understood early that their business case in blockchain projects lies in developing the consortium's technical infrastructure, setting up the necessary components (i.e., nodes) for the individual stakeholders, and educating them.

Although the initiative and competencies of technology providers are essential for development progress, it poses the risk of an imbalance in the consortium that causes a sense of distrust among the other stakeholders towards the technology provider. For example, in the TradeChain consortium, this issue was evident when the project could not sustain itself financially. Tension arose because, while the business stakeholders were not making any money yet, their technical partner was already earning from the development contract and consulting service. This led to a sense of imbalance and unease. They were trying to build a value proposition for their customer jointly. Nevertheless, it seemed that the technology provider needed to take a different approach and invest more into the project, or in other words, 'put more skin in the game'.

In cases where the technology provider was part of the consortium from the beginning, like in CarBlock, they were primarily viewed as partners at eye level during the early project stages. However, we observed that over time, the role of the technology provider changed from a partner role, which implies balanced contributions and benefits, to a supplier role, in which the technology provider generates revenue. Specifically, in the case of blockchain consortia, given their ecosystem approach (i.e., bringing whole supply chains onto the blockchain), technology providers start benefitting before any other partner can benefit, e.g., from the data market or own process efficiencies. In the long run, it changes the balance in the relationship between the ecosystem's stakeholders.

Solutions. A successful organizing approach to avoid a breach of trust between the technology provider and the other partners was to *dismiss* the needs of individual organizations to create an infrastructure as a 'common good' for an ecosystem's stakeholders. This approach was internalized on two levels: financially and operationally. This strategy was well exemplified by a technology provider in the CarBlock consortium. They understood that their primary value was in providing the technology, which led them to be willing to make early investments and contribute more than required. Hence, they contributed equally to the infrastructure development and even made advanced payments by providing substantially larger resources in terms of time and workforce. For the technology provider, the willingness to invest in the infrastructure was explained by the opportunity of possible gains through future software development and integration contracts from the involved stakeholders in the case the ecosystem is successfully growing. Their partners perceived this approach well, and it enabled them to move forward jointly.

This included a financial investment and an investment in time, resources, and knowledge. Such strong operational collaboration supported understanding and applying the potential of this complex technology to the respective business domains. CarBlock set up dedicated working groups and committees with representatives from all participating organizations to ensure operational collaboration. These groups were responsible for various infrastructure development facets, from technological underpinnings to legal and regulatory compliance. Thus, the organizational solution for participating stakeholders involved in the infrastructure subsystem was to build the infrastructure subsystem as a '*commons*' through:

- *Sharing financial burdens, either equally or by having them pre-finance parts of the development to justify their premature business advantage.*
- *Operational collaboration over infrastructure to leverage interdisciplinary knowledge for making the technology applicable to the ecosystems.*

5.2.2. Platform subsystem

Problems. In the pursuit of achieving *interoperability* and *decentralization*, organizations encounter the problem of system bootstrapping. In particular, developing decentralized (data) markets and/or platform innovations within the platform subsystem seemed to bring the most significant potential and organizational problems for the businesses involved in blockchain consortia. On the one hand, business stakeholders must work together to create a decentralized market or platform. On the other hand, however, they will be direct competitors on the foreseen market or platform.

While the vision of a common platform or market in early-stage consortia sounds very promising, and all partners seem to be motivated to build it, the realization brings many difficulties. Consortia in the prototype stage reported the problem of reluctant stakeholders. This problem had several reasons: insufficient understanding of the complex technology (and its variations) among non-technical stakeholders, lacking clarity about the legal basis for data sharing and data protection, and missing business cases that would motivate a business organization to push the development.

To launch a joint platform or market, the stakeholders have to dare to take a big step, either through increased investment to scale their prototypes to production or by giving up previously created advantages (e.g., in the form of resources). For example, in CarBlock, business stakeholders hesitated when considering whether the development investment would yield future profits. They expressed concerns about the readiness to take risks in anticipation of future returns, noting the 'chicken and egg' nature of the problem.

Besides the risk of insufficient capital, reluctance to share resources emerged as another form, causing bootstrapping issues for the value mechanisms on the application layer. Commonly, platforms live from network effects. So, not getting enough participation on a platform and in the data market (which, in turn, needs data contributors) makes it useless. On the one hand, cooperation is required to develop and establish the core concepts and mechanisms for the platform or market to function. On the other hand, competition arises as businesses realize that by adding their share to the joint platform or market, other stakeholders will have an equal possibility to take advantage.

Solutions. The successful organizing approach was *cumulating* different organizational structures of stakeholders on a platform, allowing them to fulfil both private and public (within the ecosystem) needs. Successful consortia managed coopetition by creating a joint denominator use case that focuses on problems that affect all business stakeholders equally on a more general level. In the case of CarBlock, it was an application that aimed at improving trust and transparency in the used car market by providing a blockchain-based history of a car to used car buyers and sellers. On the one side, this use case did not serve the interests of any stakeholder in the consortium but rather the whole market. On the other side, its implementation requires data collection throughout a car's lifecycle in a tamperproof way (i.e., immutable and authenticated). The complete history benefitted all stakeholders since they were interested in individual 'events,' i.e., data, from this history.

An alternate approach complements others and involves establishing formal governance structures. These structures cultivate stakeholders' trust, propelling them to make progressive decisions and move forward. This perspective is supported by a business stakeholder from TradeChain, who believes that a successful cooperation model requires effective collaboration, valuable contributions from all partners, sensible decision-making structures, and a common goal. Many consortia set up separate legal entities to materialise this cooperation model. For example, TradeChain is an independent legal entity, owned by twelve shareholder banks. It initially began as a consortium but has since evolved into something distinct. This transition was motivated by the founding banks' collective desire to produce and bring an application to market expediently. Therefore, effective governance structures for successful blockchain consortia often involve establishing a legal entity like an association. These structures define the governing bodies, including a board of directors, data protection officer, working streams, and decision-making procedures within the consortium. Thus, the solution for business stakeholders to successfully create value in the platform subsystem was through managing the balance between collaboration on the platform (i.e., as a 'commons') and competition in the data market by:

- *Establishing and working on a joint denominator use-case (*i.e.*, a use-case that will benefit all business stakeholders fairly).*
- *Creating formal governance structures will allow stakeholders fairly distribute the created value.*

5.2.3. Application subsystem

Problems. The willingness to achieve *decentralization*, specifically through dApps, leads to the potential loss of competitive advantage. Organizations feared that by aiming for a decentralized ecosystem where competitors and new contributors could freely participate, they might inadvertently surrender their competitive edge. This fear emerges because, in a decentralized setting, competitors can create, manage, use and even make money with their dApps independently.

Though creating competition through dApps sounded promising, businesses were stuck in old thought patterns and afraid of opening up to potential contributors. What makes blockchain consortia unique in this case is that from the organizational standpoint, the competitors need to combine the collaboration (on the infrastructure subsystem where no strong business interests are present except for technology providers) and can compete (on the application subsystem, where their individual use cases are realized). From the technical standpoint, it remains a question of what part of the collaboration and decision-making rules can be placed on-chain (on blockchain), i.e., be automated. At the same time, some are still executed off-chain (outside of blockchain).

The value and the potential application areas of dApps increase with the number of participants joining the consortium and contributing to them. However, in many consortia, we observed a restrained attitude from stakeholders towards new entrants. For example, in CarBlock, the members feared letting in competitors (like a second car importer) since engaging early in the consortium would destroy the first-mover advantages they had built up. However, they also recognized the value they would gain by opening up through the competitive environment that could motivate the ecosystem to grow and prosper. The competition would increase the value of dApps and their quality since each organization would be willing to create the best dApp for themselves or their customers.

Solutions. A successful organizing approach was *separating* competitors by letting them create their own decentralized applications and manage their digital assets as a 'private good.' Businesses in successful consortia embraced these problems on the one hand by establishing a common understanding of the necessity to cover the whole ecosystem and foster competition and, on the other hand, by implementing fair rules on how businesses can offer and develop dApps. The fair rules included open participation in developing dApps (any stakeholder who wanted could develop a dApp) instead of lock-in to the specific technology provider. CarBlock recognized blockchain's value for creating a network. They realized that this network should be capable of including both competitors and trading partners within its organizational structure.

Consequently, the consortium placed great importance on creating appropriate privacy structures. While they initially opted for non-competing partners, from the beginning, they emphasized ecosystem thinking in the consortium. In each meeting, the consortium manager mentioned to the stakeholders that they needed to be prepared for their competitors to join. Some of CarBlock's stakeholders understood this open ecosystem approach early and were led by a good example of actively assisting the consortium in engaging with their direct competitors. These stakeholders presented the overarching value of the project to their competitors, downplaying their competitive roles as insurers. Other participants in the ecosystem greatly appreciated this open approach.

Further, we observed that a successful strategy was implementing fair rules on how dApps can be developed and offered. For example, concerning dApps development, the CarBlock consortium established 'workstream' structures. Different businesses could join smaller groups in such workstreams to develop dApps. These workstreams were free for any organization to initiate and lead, and the consortium did not organize them. Hence, the development costs also had to be borne by the individual businesses, not the consortium. However, businesses (and other consortium stakeholders) could also develop a dApp independently. So, in such a case, there might be several dApps with similar functionalities, and they would compete to win customers for them (as they would do in a traditional market). Such structures were created to foster competition and motivate businesses to use the underlying infrastructure and platform.

The solution for business stakeholders aiming to realize the value mechanisms in the application subsystem was to create a *market* and foster competition in the consortium, as it will increase the value created by:

- *Establishing a common understanding of the value of an open ecosystem among the consortium stakeholders, and*
- *Establishing fair rules for dApps development. This will increase the value and quality of the same.*

6. Discussion: From hybrid towards layered organizations

Businesses involved in blockchain consortia have struggled with high system complexity and little oversight regarding what drives value creation in BC IS and how these value mechanisms can be achieved (Behnke & Janssen, 2020). At first sight, blockchain technology seems to offer promising business opportunities. However, a thorough understanding of the complexities of BC IS is necessary to realize their potential for the involved stakeholders. Furthermore, it is recognized that building a BC IS requires creating a new organizational form, which brings new challenges. Our study makes a two-fold *theoretical contribution*. First, we propose a 'layered organization' concept as a new way of successfully organizing blockchain consortia to create value. Second, we derive specific value mechanisms for value creation in blockchain consortia. Further, we describe them in more detail. Altogether, our study brings new insights into the growing knowledge about blockchain consortia. As for *practical implications*, our insights would bring value to managers of blockchain consortia in the early stages of finding a way to cope with a blockchain consortium's organizational complexity.

6.1. 'Layered organization' to organize for value

Extending prior research that mainly examined governance in this new organizational form and provided strategic moves to manage the governance challenges in different organizational settings (Goldsby & Hanisch, 2022), our study focuses on value creation, organizing for value, and associated organizational problems and solutions blockchain consortia apply to move from the early prototyping phase to actual market entry. While blockchain organizations have similarities to hybrid organizations (Battilana & Lee, 2014; Greenwood et al., 2011; Tracey et al., 2011) in the sense that they combine different organizational structures and elements that are not necessarily compatible with each other, there are also specific differences. In alignment with (Goldsby & Hanisch, 2022), the major difference we see is BC IS's 'layered' nature, reflected in how blockchain consortia approach value creation. Thus, we argue that this new type of organization can be called a 'layered organization.' This structure provides several advantages, like clear separation of concerns and clearly defined interfaces, akin to features seen in modular organizations and layered architectures in computer science. The layered structure allows for a clear division of tasks and responsibilities, allowing organizations to reduce complexity for themselves and focus on their area of specialization, thereby increasing efficiency and quality of outcomes. Furthermore, it facilitates parallel development processes (like dApps development), with different layers being able to innovate and evolve independently if they maintain interface compatibility. This can lead to faster overall progress and the creation of various applications and services. Finally, it supports the system's organizational resilience by isolating potential problems or failures to individual layers.

Such a 'layered organization' utilizes different organizing approaches (such as separating, cumulating, and dismissing) from hybrid organizations (Battilana & Lee, 2014). However, their use and effectiveness depend on the layer on which they are implemented. A 'layered organization' that implements a BC IS has 'commons' (Ostrom, 1990) and 'markets' (Williamson, 1975) placed on different layers. This implies that while this combination of organizing approaches facilitates value creation by harmonizing or separating the interests of organizational stakeholders, it may also introduce challenges that are inherently associated with these approaches on individual layers. We conclude that the organizational (i.e., how blockchain consortia organize themselves) reflects the technical structure (i.e., the systems' architectures they are implementing) in BC IS and the other way around. However, such an outcome could not be envisioned in the prototyping phase of blockchain consortia but rather the result of an evolution of blockchain consortia, their iterative development cycles, and ecosystems' expansion. With this, we empirically demonstrate, in line with the prior literature (Catalini & Boslego, 2019; Lumineau et al., 2020; Ziolkowski et al., 2020), that different stages of blockchain consortia pose different organizational challenges but also the working solutions that successful consortia implemented.

6.2. Value mechanisms in blockchain consortia

We contribute to prior works on value creation in blockchain consortia (Angelis & Ribeiro da Silva, 2019; Hacker et al., 2023; Putz & Pernul, 2022; Zavolokina et al., 2020; Ziolkowski & Schwabe, 2022). Research on blockchain consortia is scarce. Even though blockchain technology has reached a certain level of maturity, organizations still experience challenges in collaboratively using it for their purposes (e.g., to enhance interoperability in their fields). However, while blockchain consortia have similarities to consortia that have been established to define and promote standardization (like the need for interoperability, voluntary participation, and consensus-driven decision-making based on voting rights) (Nelson et al., 2005; Xu & Boh, 2014), they also have differences to them. For example, organizations in blockchain consortia need to find a way to create private value for themselves but separate between their private and public goals while implementing a blockchain solution. This can be a challenging task within a consortium since, per definition, a consortium unites organizations through a common goal but also because of possible governance and managerial conflicts (Ostern & Perscheid, 2022; Ziolkowski & Schwabe, 2022). So, blockchain consortia need to plan value creation, both for private and public (i.e., common) value, in advance, since once established, changing the rules of how a consortium operates may be very hard or even impossible (both on technical and organizational levels). On one side, it leaves the question of who among the consortium members should take responsibility for creating public value within the ecosystem. At the same time, businesses primarily care about their private value. On the other side, the public value (i.e., the 'commons' in the infrastructure subsystem) is a prerequisite for the private value to be realized at all. To better address this challenge, our study illustrates three subsystems we observed in BC IS and discloses the value mechanisms for each subsystem.

Furthermore, our study demonstrates what roles within a blockchain consortium are involved in value creation. This extends prior scarce research (such as Schwabe (2019)) on the various perspectives of stakeholders within blockchain consortia. This helps different stakeholders better understand where (i.e., on which subsystem) and how (i.e., what value mechanisms to use) they need to engage in a blockchain consortium to use and optimize their resources in more efficient ways (e.g., involving regulators only for the aspects related to the infrastructure subsystem). However, as many blockchain consortia have surpassed the experimentation and prototyping phases (Putz & Pernul, 2022), an in-depth understanding of what drives value creation if the system is applied in business contexts, is still necessary for individual stakeholders.

Further, we abstract from a specific domain (e.g., online communities) (Zheng & Boh, 2021) and describe the case-independent value mechanisms of BC IS by drawing on a rich empirical dataset. These insights can help blockchain consortia from various domains move forward and build value-creating BC IS by allowing them to understand what will directly affect the success of novel business models (Amit & Zott, 2017). While focusing on a specific case helps us understand and identify value mechanisms for domain-specific requirements, cross-validation with additional cases in various application fields allows us to make more confident generalizations and identify interrelationships.

Such interrelationship that emerges from our study is one of the subsystems and value mechanisms. We purposefully disassembled BC IS in this study, following Glaser (2017) and Notheisen et al. (2017), for our analysis. However, it became apparent that the value mechanisms of each subsystem – that the different stakeholder groups aim to achieve by utilizing various technical components – are yet dependent on each other. Such dependencies of the value mechanisms are not surprising in a layered architecture, which BC IS also comes with (Rossi et al., 2019). Nevertheless, many blockchain consortia, driven by fast business gains, neglect these and end up with scattered, unfinished components rather than a holistically functioning system (Upadhyay, 2020). In particular, business stakeholders in blockchain consortia are often primarily interested in offering 'end-products' or 'end-services' to their customers. Therefore, they focus on developing the value mechanisms in the application subsystem (i.e., decentralized applications or the use of tokens). Hence, they neglect the importance of the other subsystems of BC IS (i.e., infrastructure or platform development) that are necessary enablers of their targeted applications. This might result in significant investment on customer-facing ends, which can never be realized as the technical backbone is missing. However, there are also, at least as often, blockchain consortia that get stuck in one of the other subsystems out of infatuation with technology (infrastructure subsystem) and an inability to cooperate (platform subsystem).

The temporal perspective on the emergence of blockchain consortia also offers valuable insights and contributes to the ongoing discourse on the dynamics of blockchain consortia (Hacker et al., 2023; Putz & Pernul, 2022). Our results show the dynamic and evolving nature of value creation in such consortia, from potential value-creating ideas (but not necessarily clarity) to tangible value mechanisms. A consortium identifies possible ways to generate value early, but these ideas are not immediately implemented. As the consortium matures, it moves from more complex to less complex value mechanisms along two main value dimensions: decentralization and interoperability. This complexity relates to both technical implementations as well as organizational readiness of the consortium. For example, independently developing an individual dApp is less complex than establishing a shared infrastructure within the consortium. As the consortium grows, it starts with the interoperable infrastructure, that can work with different internal and external systems, as the foundation for further platform and application development. Hence, the temporal perspective shows that creating value in a blockchain consortium is closely linked to its technological and organizational growth, and the ability to apply these value-creating mechanisms varies according to the maturity of the consortium. Further, following Sunyaev et al. (2021), we argue that an interdisciplinary perspective on decentralization and tokenisation is indispensable for building successful BC IS.

Overall, we conclude that to build successful BC IS, reducing the complexity of blockchain information systems in blockchain consortia as a layered organization is paramount; at the same time, the relationships between the subsystems and the temporal perspective should not be ignored, as ignoring them may lead to partial or even complete failure (Melis, 2019). Instead, in line with prior works (Bauer, Parra-Moyano, Schmedders, & Schwabe, 2022; Notheisen et al., 2017; Sarker et al., 2019), we argue that the stakeholders involved in blockchain consortia should carefully consider the interrelatedness of the subsystems of a blockchain information system and responsibly assume their roles in all relationships. A way to achieve this and organize for successful value creation in BC IS would be for blockchain consortia to go beyond multi-layer governance mechanisms (Ziolkowski et al., 2020) and look at value creation in the established organization from the perspective of individual layers.

7. Conclusion

The hype around Bitcoin has mostly vanished, yet the interest in building BC IS remains strong, given its wide-reaching promises for various businesses. However, creating and leveraging value from BC IS is prone to many problems due to its complexity, the interrelatedness of its subsystems, and the diverging interests of involved stakeholders. By having engaged in and building one blockchain consortia and analysing five further successful ones, we opened the BC IS black box for stakeholders involved in blockchain consortia. We explicated the subsystems in BC IS and their respective value mechanisms. Further, we described organizational problems that consortia face in creating value from each subsystem and the solutions used to address these problems successfully.

Thus, this study contributes to the growing body of knowledge on value creation from blockchain information systems (Chen, 2018; Frizzo-Barker et al., 2020; Schlecht et al., 2021) and the approaches of different organizations to address organizational problems faced in an attempt to create value (Hinings et al., 2018; Ostern & Perscheid, 2022; Zavolokina et al., 2020). By doing so, we provide grounds for more substantial BC IS research. Other researchers, for example, can use this approach of the subsystems to indicate the focus of their research and describe the stakeholders that interact with specific technology components. Further, these insights are aimed at helping stakeholders of blockchain consortia to move forward by explicitly understanding the value mechanisms of BC IS and the approaches that can allow them to achieve the same. Finally, by supporting the development of BC IS through disclosing organizational problems and their solutions, this study helps BC consortia move on and contribute to creating public value in society.

Yet, our study is not without limitations that open avenues for future research. First, as the objective of our study was to understand value creation in BC IS, we disassembled them and made the subsystems that exist in BC IS and its value mechanisms explicit. Although our study suggests that these subsystems are not independent of each other, further studies are needed to investigate the interrelationships between them explicitly. Second, in many cases in our study, we observed collaborations between blockchain consortia and public agencies. However, much more engagement and research on their different yet important role are still needed. Third, at the time of data collection, the consortia in our study had already successfully gone live but were still in a relatively early production stage. We acknowledge that the sustainable viability of these BC IS still needs to be proven. Follow-up studies could consider the further development of the consortia and possibly investigate further cases. Findings from these studies might also require us to sharpen our recommendations and insights on successfully and sustainably managing the value mechanisms in BC IS. Fourth, the conducted data collection per case was limited to a small number of interviews and documents. While this offers breadth, it limits the depth of the analysis, and the findings, and the findings may suffer from biases because of the subjective perspectives of individual interview partners. Fifth, regarding the 'Decentralized data market' value mechanism, it is important to acknowledge as a limitation that our evidence primarily stems from our main case study, with additional cases not providing supplementary evidence for this value mechanism. Blockchain-based data markets are still rare and require further investigation to fully understand their complexities and potential. Sixth, compared to the main case, our analysis for the additional cases relies more heavily on evidence from secondary sources such as news articles, consulting reports, and project websites. This may introduce biases due to marketing and hype. However, for each additional case, we also gathered primary interview data that aided in mitigating this bias, enhancing the reliability of our conclusions. Finally, many open questions around regulatory and legal aspects still exist, which we have neglected in our study. These need to be understood and appropriately addressed before BC IS can come to life.

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Authors' contributions

Liudmila Zavolokina (LZ): led the research team of the CarBlock consortium (main case); contributed to the design and conception of the study, data collection and analysis for the CarBlock's data, and data analysis for the additional cases; reviewed the first version of the manuscript. After the first revision round, LZ substantially rewrote the manuscript and took over the first authorship. Ingrid Bauer-Hänsel (IBH): participated in the CarBlock consortium and the "BC consortium study" (a collaborative project with Deloitte Switzerland focusing on the additional cases); contributed to the design and conception of the study, data collection and analysis for all cases. The first version of the manuscript was written by IBH as first author. Janine Hacker (JH): led the research team of the "BC consortium study"; contributed to the design and conception of the study, data collection and analysis for all cases; wrote the "Methodology" section of the first version, and reviewed the first version of the manuscript. Gerhard Schwabe (GS): led the research team of the CarBlock consortium and the "BC consortium study"; contributed to the conception and design of the study, reviewed the first version of the manuscript. All authors have contributed to the subsequent revisions.

CRediT authorship contribution statement

Liudmila Zavolokina: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Validation, Writing – review & editing, Visualization, Writing – original draft. **Ingrid Bauer-Hänsel:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing, Visualization. **Janine Hacker:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – review & editing. **Gerhard Schwabe:** Conceptualization, Funding acquisition, Resources, Validation, Writing – review & editing.

Declaration of competing interest

None.

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Appendix A

Interview guide

0. INTRODUCTION

0.1 I will start with giving you some background information on and instructions for the interview.

0.2 Could you please tell me a bit about your personal background and your current role in your organization?

1. SETTING THE SCENE: Let's talk about your consortium [NAME].

1.1 Could you please give me a brief overview of how this / your consortium was formed? Which other options besides forming a consortium did you consider? Why did you rule out those other options and decide to cooperate in a consortium?

1.2 What is the legal form of your consortium? Under which jurisdiction was your consortium formed? Why did you choose that legal form and jurisdiction?

1.3 Why would the consortium deploy blockchain? When did you decide to use blockchain?

1.4 If interviewee is founding member: How were the members of the consortium selected? What is each partner's role and which role does your company have / expect to have in this consortium? If interviewee joined later: When and why did you join the consortium? What is each partner's role and which role does your company have / expect to have in this consortium?

2. HOW DOES THE CONSORTIUM OPERATE?

2.1 BUSINESS MODEL:

I would now like to focus on the consortium's business model.

2.1.1 How would you describe the initial business idea of the consortium? Is this idea still the current focus of the consortium?

2.1.2 What is the consortium's envisioned business model? Why would the consortium decide for that specific business model?

2.1.3 Please characterise the customers / business segments targeted by the consortium. Why would specifically those customers / business segments be interested in your solution?

2.1.4 Which problem does your system solve in a superior way? How is blockchain technology helping you to create superior value and achieve your business goals? (Why?) On the other hand, how does the use of blockchain create challenges in terms of value generation? (Why?)

2.1.5 How does the fact that you are organized as a consortium facilitate creating superior value and achieving your business goals? (Why?) On the other hand, how does this organizational form create challenges in terms of value generation? (Why?)

2.1.6 We have now talked about the business model of the consortium as a whole. Besides that, what was the business case of your company to join the consortium? And how / where is the consortium helping you to improve your performance?

2.1.7 Finally, we would like to know whether your consortium has an own token / is planning to implement a token-system?

2.2 PLATFORM AND HANDLING OF DATA:

Let's talk about the solution / system that your consortium has implemented / is planning to implement.

2.2.1 Who implemented the initial system and how was it implemented? Have you considered alternative platforms / types of blockchain? Why did you decide for this platform / type of blockchain?

2.2.2 How do you deal with new technical requirements to the system? Can you / how can you change the system's architecture?

2.2.3 Which (personal) data does the consortium use within the project and how are these data used?

2.2.4 Who is allowed to enter data into the system and why? How do you make sure that entries are correct?

2.2.5 Regarding the example data entry that you just mentioned: Who has access to the data employed by the consortium and why? How do you protect (personal) data?

2.2.6 Besides what you have already told me, are there any global privacy policies for the treatment of data that all consortium members have to follow? How does blockchain technology enable privacy?

2.2.7 Which challenges regarding your platform and data handling arise due to your blockchain implementation? How do you address these challenges?

2.2.8 Imagine there was a hack or fraud – how would the consortium deal with that?

2.3 COLLABORATION AND GOVERNANCE:

In this part of our interview, I would like to learn more about how members of the consortium make decisions and work together.

2.3.1 Please think of a recent stage in your project and recall a major decision made in this stage. Please tell me about this decision and how you came to (or did not come) to an agreement in the consortium.

2.3.2 Regarding the stage you were referring you, please describe the responsibilities and tasks that different members of the consortium had in this stage. How did you allocate different responsibilities and tasks? (Why?)

2.3.3 In the stage you were talking about, how did the different consortium members communicate with each other, e.g. to inform each other about the current status of their work or to discuss a new requirement?

2.3.4 It seems that each partner has some tasks that they do individually. There are also many tasks that are done together by all members or a team of several members. How do you organize collaborative work in the consortium?

2.3.5 Compared to other consortia / working groups that you might be involved in or your company, do you feel that the use of blockchain technology in the consortium influences how members work together and make decisions? How does your blockchain implementation influence the way you work together? How does blockchain technology enable / constrain your work?

2.3.6 How does the fact that you are organized as a consortium influence how members work together and make decisions? How does this structure enable / constrain your work?

3. CLOSING: We're now close to the end of the interview.

3.1 What was your most remarkable moment as a member of this consortium so far (and why)?

3.2 What do you personally consider as the consortium's biggest achievement / success so far? How did you celebrate this achievement?

3.3 In your opinion, what are the biggest challenges currently faced by the consortium?

3.4 Looking at the overall story of your consortium: With your current knowledge, what would you do differently if you could turn back time? What would you in the same way?

3.5 As a final question, I would like to know which aspects do you perceive crucial for the success of blockchain consortia? Which specific challenges / threats can you recognize for blockchain consortia?

3.6 Are there any documents (e.g., a description of the consortium, information about the blockchain project, a whitepaper) that you could provide as further background information about the consortium? Would you be willing to answer an e-mail with follow-up questions to clarify any aspects that are not clear to us later?

3.7 Is there anything else that you would like to add? Do you have any questions or comments about the interview?

Case overview

Table A
Overview of participating blockchain consortia and interviewees.

No.	Pseudonym	Sector	Description	Status (Beginning 2020)	Funding	Founded	Interviewees (# of interviews)	Grey literature documents
C01	CarBlock	Mobility	Documentation of all relevant events that occur during the life cycle of a car.	Production	Public	2017	Academic partner (1) Legal partner (1) Business partners (16) Public agency (5) Technology firm (2)	11
C02	LandBlock	E-government	Documentation and management of land titles.	Production	Public/ Private	2016	Business partner (1) Legal consultancy (1) Technology firm (1)	14

(continued on next page)

Table A (*continued*)

No.	Pseudonym	Sector	Description	Status (Beginning 2020)	Funding	Founded	Interviewees (# of interviews)	Grey literature documents
C03	DrugTransBlock	Pharmaceutical	Track and trace the temperatures of medicines during transportation.	Production	Private	2016	Legal consultancy (1) Technology firm (1) Technology firm (1)	2
C04	FoodBlock	Food supply chain	Track and trace food.	Production	Private	2018	Technology firm (1) Business partner (1)	5
C05	FraudBlock	Trade finance	Reduce inefficiencies and fraud in trade finance.	Production	Private	2018	Blockchain platform (1) Business partner (1) Business partner (1)	8
C06	TradeChain	Trade finance	Digitalization and simplification of trade finance processes.	Production	Private	2017	Blockchain platform (1) Business partner (1)	9
						Total	38	49

Coding

Table B
Value mechanisms, their descriptions, and exemplary coded segments.

Value Mechanisms		Description	Exemplary coded segments
Decentralization	Decentralized Control	• The distribution of the control over the system and data over multiple parties	• I think outside of government obviously a lot of private businesses are very interested in blockchain too. A lot of the reason for that I think is because it's a technology that returns control of people's data to them. It gives individuals greater control and access to their own personal data. We're working with a company called (anonymized), they're one of our closest partners—and this is separate from (anonymized). We've worked with them on several different ways, several different programs and services that give individuals better control over the whole personal medical data, allows them to transport that data, allows them to use that data in ways that hospitals and other medical services previously had nothing to do. • There will be a kind of role concept, so who is allowed to see what data, and then everyone is allowed to see only the data relevant to him or her, for example, the tax-relevant.
	Decentralized Data Market	• Markets (for data) that allow buyers and sellers to meet and deal directly with each other	• Basically, how I see this: we bring this car-related market now from physical world to the digital world. • Much more important is that the data market should work, i.e. that simply nothing is paid for bad data. So if my data supplier does not deliver good data, complete, in good quality, then he gets nothing for it or certainly not in the longer term.
	Decentralized Applications (dApps)	• Applications that are developed on a blockchain network	• The other one is that really to use the application as a explore and make money based on providing an infrastructure in which for parties but also yourself can really implement distributed applications. • We want to be data- and party-neutral. I can see you created a dApp but I can't see anything else than that. Asking for a service fee, for example, monthly payment or asking for distributed model for each sale you made via our platform I get a certain percentage. I need to set up an invoicing system and a customer management system. I need to know who you are and that kind of

(*continued on next page*)

Table B (*continued*)

Value Mechanisms		Description	Exemplary coded segments
			stuff. We specifically do not want it. Plus, if it's a distributed model maybe you provide the service for 10% and somebody else—10% for each sales and somebody else will create it for 8% of each sales, I'm not neutral anymore because I have probably preference over the one paying me 10% than the one of 8%. We don't want that. The most fair and easiest way is then via transaction fee, cause the only thing we can see is that there is a transaction between you, between user of the dApp and a party who uses your services. That is very neutral way. Preferably with tokenised system. By doing so we don't have to set up a whole accounting scheme, hiring people, makings systems, etc.
	Interoperable Infrastructure	• A network that can interact with different systems	• The goal is to create that interoperability in trade, to bring those 30–35 parties together and share the knowledge they have and create visibility to optimize supply chains. For that we think currently that the best way to do it is to create an infrastructure where all parties can link to with a very, very strict core concept is that we as a consortium hopefully a new company as well in 2020, have the basis that it should be: one, data neutral from our point of view and party-neutral. • I'm saying that the main goal of (anonymized) is create this new decentralized model to interconnect, to let institution to get access to data that today is difficult or impossible to access to it in a easy way, friendly way, secure manner too and with a reasonable price.
Interoperability	Platform Innovation	• Novel structures that increase the effectiveness with which a group of activities may be performed and involves coordinating different resources and actors to create a new digital platform	• That's exactly the direction, so the basic idea is, if you have the platform, as a trading platform, at the beginning we called it a trade finance platform, now we're going more in the direction of a trading platform, where simply everything that is needed in trade and everything that supports trade should be found there, that starts with very simple banking products, can also mean other banking products, but also all other products related to trade that are not relevant to banking should be there, ultimately in the direction of Marketplace, direction I don't know, Amazon for Corporates, whatever. • So the business idea is to make a platform available, as comprehensively as possible of course, so that data can be taken from this platform and individual business cases or use cases can be processed. We have created a so-called ecosystem, and of course they all have different interests. • On top of that there's a layer of see this kind of app store, so additional layer with room for producers or companies to provide additional services on the platform.
	Tokenization	• Creating unique digital objects of value, i.e., digital assets	• The fact that you can now also capture not only data but also behaviour related to assets. An asset can be a bill of lading and it can also transfer assets with the behaviour index. That is something which is very important for a document like the Bill of Lading, where you have transfer of a ownership, where you can create multiple copies, and you want to be sure that somebody plays according to the rules and then you both need to agree on behaviour to make that behaviour transferable. • The idea is that you're able to—I think you probably know this—but you're able to transfer an asset of value from one person to another in a way that is secure and immutable, that's why cryptocurrency is such an obvious application of blockchain because it's a technology that allows you to send money and to convey the value of that money.

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