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RESEARCH PAPER

To sell, to donate, or to barter? Value creation and capture through business model types in decentralized data ecosystems

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Abstract
Decentralized data ecosystems, enabled by data spaces, are transforming how organizations create and capture value from interorganizational data sharing. However, the implications of such data ecosystems on the business models of data-sharing participants remain underexplored. Based on 26 qualitative interviews with experts from two cases, we delineate and compare two generic business model types for data sharing: *bartering*, where participants share data reciprocally without direct monetary compensation, and *marketplace*, where data providers either sell or donate data. By comparing the two cases and their business model types, we find that while decentralization of technical infrastructure and governance enhances value creation, it simultaneously constrains value capture by increasing complexity and costs. Moreover, we demonstrate that the emergence of business model types is determined by the ecosystem's contextual factors. By contextualizing business models and investigating the influence of decentralization on value creation and capture, our study advances the discourse on the business dimension of data ecosystems. These insights inform both scholars and practitioners navigating the complexities of data ecosystems.

Keywords Data spaces · Decentralized data ecosystems · Data sharing · Business models · Value creation and capture

JEL classification M15 · O3

Introduction

The diffusion of digital technologies has exponentially increased the volume of data available to organizations (Azkan et al., 2020; Chen et al., 2012), transforming data from a mere byproduct into a strategic resource (Legner et al., 2020). Simultaneously, organizations are increasingly collaborating within ecosystems to create value collectively (Beverungen et al., 2022). Building on these developments, data ecosystems have emerged as a promising concept that fosters collaborative value creation through interorganizational data sharing (Oliveira & Lóscio, 2018; Oliveira et al., 2019).

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In general, digital ecosystems rely on digital infrastructure, such as platforms, around which they can evolve (Hein et al., 2020; Möller et al., 2024). Hereby, digital platforms enable the interaction of multiple market sides, such as supply and demand (de Reuver et al., 2018; Gawer, 2014). These platform ecosystems are often governed by a central platform owner, or "keystone" (de Reuver et al., 2018; Gawer, 2022). However, due to the sensitivity and strategic value of data, organizations frequently hesitate to share it outside their organization, as this requires relinquishing control to centralized platform owners (Azkan et al., 2020). To address these concerns, ecosystems building on a decentralized form of digital platforms, referred to as data spaces, increasingly emerge in practice. Data spaces provide a secure infrastructure for interorganizational data sharing without requiring centralized integration. Instead, ecosystem participants maintain data sovereignty, i.e., retain control over their data (Otto, 2022). Moreover, unlike traditional platform ecosystems, data spaces and their surrounding ecosystems are governed collaboratively by multiple actors (Otto & Jarke, 2019).

The rise of decentralized data ecosystems has been accelerated by the data strategy of the European Union (European

Commission, 2022), which led to initiatives such as Gaia-X and institutions like the International Data Spaces Association (IDSA) (Gaia-X, 2024a; IDSA, 2024). Gaia-X, launched in 2019, aims to establish a federated and decentralized infrastructure to address challenges such as data sovereignty, interoperability, and trust in the face of dominant non-European cloud providers. By fostering secure, standardized, and self-determined data sharing, Gaia-X guides the development of data ecosystems built on data spaces (Gaia-X, 2024a; Heinbach et al., 2024; Tardieu, 2022). Consequently, numerous data spaces are emerging across various domains, adopting the overarching decentralized framework of Gaia-X (Möller et al., 2024).

Despite the growing prominence of decentralized data ecosystems, their adoption is hindered by unclear economic benefits and organizational reluctance (Gelhaar & Otto, 2020; Oliveira et al., 2019). Scholars argue that these ecosystems have the potential to create new and improved avenues for data-based value creation (Beverungen et al., 2022), but their success depends on active participation from organizations (Fassnacht et al., 2023a). Participation, in turn, requires sustainable business model opportunities that offer mutual and equitable distribution of benefits for all stakeholders (Heinz et al., 2022; Oliveira et al., 2019). In that regard, existing research assumes decentralized data ecosystems distribute profits more fairly among participants (Otto, 2022), unlike centralized ecosystems, where the platform owner captures most of the created value due to its powerful position (Gawer, 2022; Ofe & Sandberg, 2023).

Since data significantly influences how organizations create and capture value (Teece, 2010; Wiener et al., 2020), research has studied data-driven or data-infused business models (Hartmann et al., 2016; Schüritz & Satzger, 2016), exploring how individual firms leverage (big) data or data-driven services for value creation and capture (Hunke et al., 2022; Lange et al., 2021; Schüritz et al., 2017). Recently, scholars have expanded this focus by examining data-driven business models within ecosystems (Schweihoff et al., 2022), thereby addressing an important research gap (Wiener et al., 2020). This shift underscores the growing recognition that organizations create less value in isolation and increasingly rely on collaborative ecosystems (Hein et al., 2019). Building on this ecosystem perspective, researchers such as Jussen et al. (2024b) and Azkan et al. (2022) have modeled the value flows for data sharing, respectively, data ecosystems using the e^3-value notation.

Since data sharing forms the foundation of data ecosystems (Jussen et al., 2024b; Oliveira & Lóscio, 2018), recent studies have examined incentives for interorganizational data sharing (Gelhaar et al., 2021b, 2023) and design options for data-sharing business models (Schweihoff et al., 2023). For example, Fassnacht et al. (2024) identified four archetypes of data-sharing practices, illustrating that organizations share data to achieve objectives such as compliance, efficiency, direct revenue generation, or societal and environmental benefits. Similarly, Jussen et al. (2024a) analyzed remuneration mechanisms for data providers, including monetary payments, data exchanges, service access, or data donations without compensation.

These pioneering studies often provide broad overviews of data-sharing incentives or business model options, frequently presented as taxonomies. Other research focuses on the business models of key ecosystem roles beyond data providers and consumers, such as data intermediaries (Lipovetskaja et al., 2024; Schweihoff et al., 2024). Therefore, the business models of data providers and consumers in real-world contexts remain insufficiently studied (Ammann, 2025; Guggenberger et al., 2025). To bridge this gap, we follow the research call from Jussen et al. (2024b) to contextualize data-sharing value scenarios in the form of business models utilizing a case study. In essence, we investigate how the context of decentralized data ecosystems shapes the business logic for data providers and consumers.

This raises the following research question: *How do data providers and data consumers (i.e., data-sharing participants) create and capture value through business models in decentralized data ecosystems?*

Being a novel phenomenon in research and practice, decentralized data ecosystems lack empirical scrutiny (Schurig et al., 2024). To address this shortcoming, we adopt a comparative case study of two advanced Gaia-X-based decentralized data ecosystems: the Mobility Data Space (MDS)[1] and Catena-X.[2] Drawing on 26 qualitative interviews with experts, we identify two predominant business model types—*bartering* and *marketplace*—and analyze how contextual factors shape these models. We then compare the cases' characteristics in value creation and capture. Our findings contribute to the literature by explaining (Gregor, 2006) that, first, the context determines the types of business models, and second, decentralization of data ecosystems benefits value creation but poses challenges for value capture.

The remainder of the paper is organized as follows: the next section outlines the conceptual foundations, followed by a detailed description of the methodology. We then present the findings from our comparative case study, including both within-case and cross-case analyses. Subsequently, we derive two theoretical arguments and discuss these findings in the context of existing literature. Finally, we address the limitations of the study, outline directions for future research, and conclude with a summary of our key insights.

1 https://mobility-dataspace.eu/

2 https://catena-x.net/en/

Conceptual background

In this section, we first summarize the literature on decentralized data ecosystems and contrast their socio-technical characteristics with those of centralized data ecosystems. Second, we define the concept of business models, emphasizing the critical elements of value creation and value capture.

Decentralized data ecosystems

Ecosystems comprise a multilateral set of organizations that interact to co-create value (Adner, 2017). When data serves as the pivotal resource for joint value creation, these ecosystems are referred to as data ecosystems. At their core, data ecosystems rely on interorganizational data sharing, which entails granting third-parties access to data sets (Jussen et al., 2023a, 2024b; Oliveira & Lóscio, 2018). This process requires at least two roles: a data provider and a data consumer (Jussen et al., 2024a), which we collectively refer to as data-sharing participants in this study. While data sharing can occur directly on a peer-to-peer basis, it is frequently facilitated by digital platforms—technical artifacts that connect the supply side (data providers) with the demand side (data consumers) (de Reuver et al., 2018; Gawer, 2014).

In addition to participants, data ecosystems often include intermediaries, which facilitate and organize data-sharing activities (Jussen et al., 2024b). Intermediaries can take on various forms and provide services such as transaction, governance, sovereignty, technology, data, and support services (Schweihoff et al., 2024). As in this study we focus on the data-sharing participants and not on the intermediaries, we subsume these intermediation services under the two broad categories of governance and technical intermediation. On the one hand, the governance intermediary—or multiple entities providing governance intermediation services—establishes the steering framework of the ecosystem. On the other hand, the technical intermediary—or multiple technical intermediaries—operates the technical infrastructure required for data sharing. Notably, data ecosystems may also include additional roles, such as third-party service providers, which contribute to specific ecosystem functions beyond providing data, receiving data, or mitigating data sharing as intermediaries (Jussen et al., 2024a, b).

For the purpose of this study, we differentiate between *centralized* and *decentralized* data ecosystems. While granular classifications of data ecosystem archetypes exist (e.g., Kernstock et al., 2024), we adopt the dimensions of centralization versus decentralization as the primary lens for comparison. Table 1 summarizes the socio-technical characteristics of these two types. Thereby, we build on Hein et al.'s (2020) distinction between the social and technical dimensions, defining digital platforms as the technical infrastructure and their surrounding ecosystems as the social environment.

First, from a **technical perspective**, data ecosystems rely on varying digital data infrastructure concepts (Möller et al., 2024), which can be centralized or distributed (i.e., decentralized) (Gelhaar et al., 2021a). *Centralized* data ecosystems are characterized by central data integration, for instance, by using data consolidation hubs (Otto, 2022). In contrast, *decentralized* infrastructures, such as data spaces, retain data at its source without requiring physical integration. That means, technical intermediaries manage the data space infrastructure to facilitate data sharing but do not access or control the data itself—only the metadata (Otto, 2022), as illustrated in Fig. 1. While data is shared bilaterally between a data provider and a consumer, the data space simultaneously allows its participants to search for and access data multilaterally (Möller et al., 2024).

Ecosystem participants share data via connectors, which function as standardized interfaces. These connectors enable participants to define usage policies (Gieß et al., 2024), allowing ecosystem participants to maintain sovereignty over their data and its usage conditions (Otto & Jarke, 2019).

Table 1 Differentiation of centralized and decentralized data ecosystems based on socio-technical characteristics

	Centralized data ecosystem	Decentralized data ecosystem
Technical dimension	Centralized data infrastructure design based on, for instance, a central data storage (Otto, 2022)	Decentralized data infrastructure design, built, for instance, on distributed data storage, i.e., data space infrastructure (Gieß et al., 2024; Möller et al., 2024)
Social dimension	Autonomously controlled by the platform owner or keystone organization (de Reuver et al., 2018; Gawer, 2022) as the sole owner (Tiwana et al., 2010)	Participatory (Schurig et al., 2024), alliance-driven (Beverungen et al., 2022; Otto & Jarke, 2019), shared (Tiwana et al., 2010), or networked (Kari et al., 2025) governance
Examples	Data Sentinel[a]	• MDS • Catena-X

[a]https://www.data-sentinel.com/

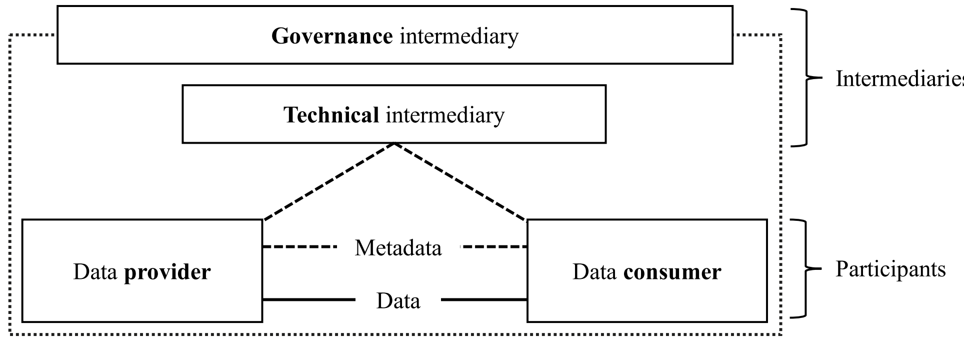


Fig. 1 Roles and data flow in decentralized data ecosystems

Importantly, data spaces represent a decentralized form of digital platforms (Otto & Jarke, 2019), serving as the technical core that connects various market sides and facilitates their interactions. As digital platforms, data spaces adhere to platform economic principles (Otto, 2022).

Second, from a **social perspective**, governance and control over the key resource—data—can be centralized or decentralized (Gelhaar et al., 2021a). In *centralized* ecosystems, a single organization, typically the platform owner, controls the resources as well as both the technical infrastructure and the governance framework (de Reuver et al., 2018; Gawer, 2022). Consequently, this keystone organization consolidates technical and governance intermediation roles, autonomously setting rules and managing resources, which positions it as a powerful actor within the ecosystem (Gawer, 2022). For example, Data Sentinel operates as a centralized platform for storing and sharing sensitive data (Lipovetskaja et al., 2024).

By contrast, *decentralized* data ecosystems are self-managed and participatory, with no single entity autonomously determining governance rules (Guggenberger et al., 2025). Instead, governance is shared among multiple stakeholders (Tiwana et al., 2010), for instance, through alliances (Beverungen et al., 2022; Otto & Jarke, 2019), networks (Kari et al., 2025), or consortia (Flak et al., 2022; Hein et al., 2020). In these ecosystems, technical and governance intermediation roles are separated, with distinct organizations or alliances covering these functions.

In this study, we focus on decentralized data ecosystems, which we consider synonymous with data space–enabled ecosystems. We employ the definition of Möller et al. (2024), defining the phenomenon as "socio-technical systems that emerge around one or multiple (federated) data spaces. They represent the sum of collaborative data-sharing activities built on the secure and trustworthy data-sharing paradigm of data spaces to realize shared goals […] for their members" (p. 8). In particular, we focus on data ecosystems aligned with the architectural framework for decentralized data ecosystems provided by Gaia-X (Gaia-X, 2024a; Heinbach et al., 2024; Tardieu, 2022).

Value creation and capture through business models

Although the literature lacks a unified definition, business models generally describe the logic by which organizations create and capture value (Zott & Amit, 2010; Zott et al., 2011). Various business model conceptualizations exist, including the Business Model Canvas (Osterwalder, 2004) and the V^4 model (Al-Debei & Avison, 2010). For this exploratory study, we adopted a broad perspective on business models, focusing on their two fundamental aspects: value creation and value capture. The first aspect, **value creation**, describes how organizations orchestrate resources to generate value (Schüritz & Satzger, 2016). In the context of data, raw data must undergo transformation through the *data value chain* to become valuable (Badewitz et al., 2020; Curry, 2016).

The data value chain comprises three main activities: data collection, data interpretation, and data exploitation (Badewitz et al., 2020; Gelhaar et al., 2021b). In the data collection phase, organizations generate and gather raw data, for instance, via enterprise information technology (IT) systems or sensors in industrial settings (Chen et al., 2012). During data interpretation, the collected data is analyzed to extract information and, eventually, actionable knowledge. In the data exploitation phase, this knowledge is applied to generate business value (Badewitz et al., 2020; Gelhaar et al., 2021b). Importantly, only the final stage, data exploitation, contributes to business value (Badewitz et al., 2020).

In addition to value creation, **value capture** is pivotal to successful business models (Schüritz et al., 2017), ultimately influencing organizational success. Value capture refers to the logic of profit generation, which considers both revenue streams and cost structures associated with business activities (Teece, 2010). The literature identifies two distinct forms of value capture from data: *direct* and *indirect*. The former refers to direct monetary returns from selling data, while the latter describes the employment of data for optimization, such as improved decision-making or cost savings (Förster et al., 2022; Schüritz et al., 2017). Crucially, mechanisms for value creation influence the potential for value capture, emphasizing

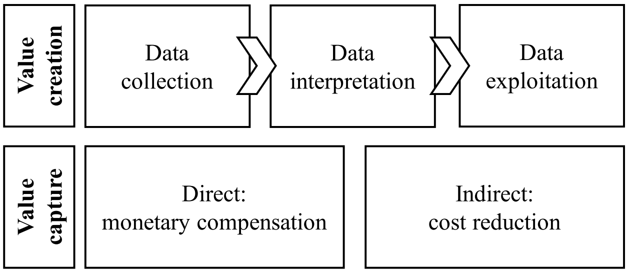


Fig. 2 Value creation and capture from data

the interconnected nature of these two dimensions (Schüritz & Satzger, 2016). Figure 2 illustrates and summarizes the value creation and capture characteristics from data.

Importantly, business models extend beyond the boundaries of the focal organization to include its partners, suppliers, and customers (Zott & Amit, 2010). That means value creation and capture occur within value networks (Al-Debei & Avison, 2010; Shafer et al., 2005), such as ecosystems, rather than in isolation. Increasingly, organizations co-create value collectively with other ecosystem actors by linking complementary resources (Hein et al., 2019), resulting in a value offering surpassing what any organization could achieve alone (Zott et al., 2011). Eventually, the collaboratively created value must be distributed or co-captured among the co-creators within the value network, which requires an acceptable balance of profits (Teece & Linden, 2017). Prior research highlights the typically skewed value distribution in digital platform ecosystems, in which powerful platform owners capture a disproportionate share of the value (Gawer, 2022; Ofe & Sandberg, 2023). Decentralized data ecosystems, by contrast, promise fairer value distribution (Otto, 2022), though scholars question their economic sustainability (Beverungen et al., 2022). In summary, we differentiate between the individual business models of ecosystem participants and the shared business logic of the ecosystem, as shown in Fig. 3. Our study focuses on the business models the ecosystem context enables for its participants.

Since digital technologies have the potential to fundamentally change the way an organization does business (Veit et al., 2014), novel data space technologies for ecosystems have the potential to enable new and adjusted business models for organizations. While prior research has recognized the potential of data for business models (Wiener et al., 2020) and studied business models and value flows within data ecosystems (Azkan et al., 2022; Schweihoff et al., 2022, 2023), it remains unclear how context factors influence the ways participants create and capture value in decentralized data ecosystems (Jussen et al., 2024a).

To address this gap in research, we employ the business models of data-sharing ecosystem participants as the unit of analysis (Dubé & Paré, 2003) to explore the prospects for value creation and capture in decentralized data ecosystems that feature participatory governance and data spaces as their technical core.

Methodology

In this section, we outline the methodology of our study. First, we present the research design and the criteria used for selecting the cases. Next, we describe the data collection process in detail. Finally, we explain the data analysis approach employed.

Research design

To explore and theorize the types of business models for data providers and consumers that emerge from the context of decentralized data ecosystems, we adopted a qualitative, comparative case study approach (Eisenhardt, 1989). An inductive approach was particularly suited to this study,

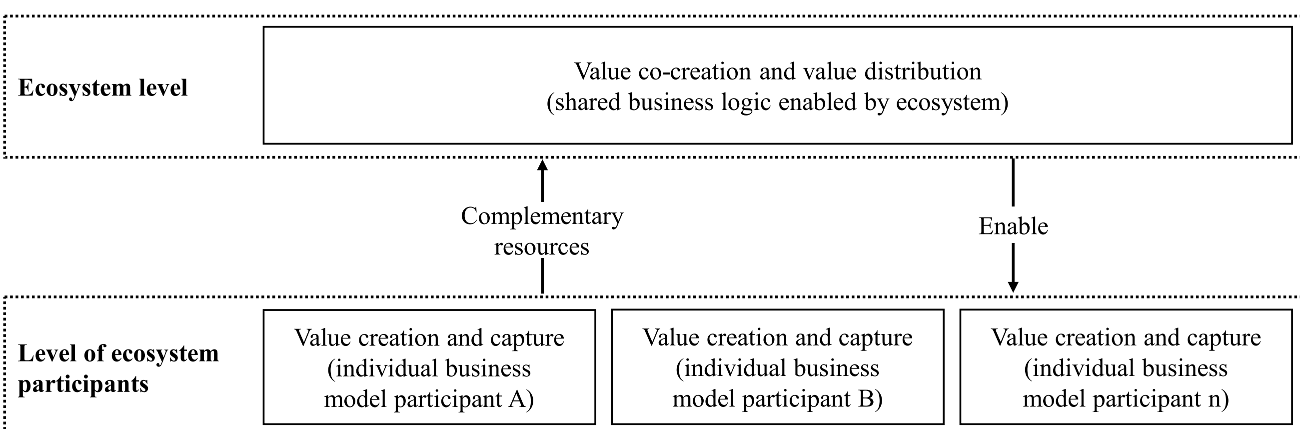


Fig. 3 Interrelation of individual business models and shared business logic of ecosystems

given the limited prior knowledge or theory regarding business models for data-sharing participants in the context of data spaces and decentralized ecosystems. Inductive methods are also well-equipped to address the complexity of the research setting (Dubé & Paré, 2003; Yin, 2018). Furthermore, empirical research on data spaces and their ecosystems remains scarce (Kari et al., 2023). Although public information is available about Gaia-X initiatives such as Catena-X and the MDS, given their status as publicly funded initiatives, the secondary data on their respective business model logic for data sharing lacked the depth required for this study. Hence, qualitative interviews with experts were deemed essential for gaining rich insights.

Decentralized data ecosystems based on Gaia-X have only begun to emerge in practice within the past five years, with most initiatives still under development. However, to observe value creation and capture mechanisms, it was critical to select fully operational ecosystems. To account for that, we adopted a matched pair case design (Eisenhardt, 2021) based on a theoretical sampling strategy (Eisenhardt, 1989). In that vein, we chose the two cases of Catena-X and the MDS, as they are among the few fully established Gaia-X-based data ecosystems referred to as "live data spaces" (Möller et al., 2024, p. 9). Catena-X and the MDS depict rich empirical instances of the phenomenon (Yin, 2018) and are positioned as "lighthouses" within the Gaia-X context (Gaia-X, 2024b; Heinbach et al., 2024). We carefully selected the cases based on the principle of similarities and contrasts to enable meaningful comparative insights. Catena-X and the MDS share similarities in their adherence to the Gaia-X framework, their shared governance and distributed technical design, and financial support from German ministries. Additionally, both ecosystems stem from comparable historical roots, exhibiting the same antecedent features (Eisenhardt, 2021). Despite these similarities, the cases differ in key aspects, including their industry focus and design features, such as the legal form of their governance intermediary and the specifics of their technical frameworks. For instance, the MDS incorporates a data catalog, a feature not present in Catena-X. Studying these two cases allowed us to compare their value creation and value capture characteristics directly.

Data collection

From November 2023 to October 2024, we conducted 26 in-depth expert interviews, both via online meeting applications and in person. We interviewed ten experts per case, and to obtain multiple sources of evidence, we conducted six additional interviews with experts who have insights into both cases, thus naturally applying a comparative lens. These case-spanning experts included three data space consultants from different consultancy firms, one lawyer specialized in data and IT topics, and two experts from the overarching institutions Gaia-X and IDSA. Table 2 provides an overview of the informants selected to display a diverse set of ecosystem participants and case-spanning experts to represent a variety of voices (Myers & Newman, 2007). We acquired the experts via the career network LinkedIn and the authors' personal networks. To maintain anonymity and given that the ecosystems are already referred to by their real names, we refrain from providing further details about individual backgrounds. However, we indicate whether the experts held technical (e.g., system architect), domain expert (e.g., business owner), managerial, or consulting roles and whether their affiliated organizations were members of the respective ecosystems.

We applied a semi-structured interview guide (Myers & Newman, 2007), included in Appendix A, which was continually refined throughout the data collection process. The main areas of inquiry included (1) the informant's background, (2) the organization's role in the ecosystem, (3) the reasons for participating in the ecosystem, (4) the nature and characteristics of value creation and value capture, and (5) the opportunities and challenges of ecosystem participation. The interviews were conducted in either German or English, lasted an average of 48 min, and we took field notes during their conduction. We recorded the interviews and transcribed them verbatim afterward (Myers & Newman, 2007).

To comprehend the cases' historical developments and current structure and to strengthen the validity of our findings, we triangulated the interview data with publicly accessible information, including websites of the initiatives and ecosystem participants, newspaper articles, and whitepapers. Notably, much information about Catena-X and the MDS is publicly available. Additionally, as data spaces and their ecosystems are gaining significant attention in research and practice (Möller et al., 2024), we attended several events to gather further insights into these emerging phenomena. For further triangulation, we used documents such as internal presentations sent to us by the informants. This allowed us to compile a comprehensive database of secondary material, as detailed in Table 3. Ultimately, the secondary material consisted of 56 documents. To ensure the reliability of our findings, we organized all relevant data in a case database (Yin, 2018).

Data analysis

To analyze the extensive data collected, we conducted a two-step process: first, a within-case analysis, followed by cross-case pattern recognition (Eisenhardt, 1989; Gehman et al., 2018). Our data analysis was guided by an a priori specification of business models, focusing on the two core dimensions of value creation and value capture, as informed by foundational literature (e.g., Teece, 2010; Zott et al.,

Table 2 Informants overview

#	Individual role	Affiliated organization		Interview duration (hh:mm)
		Company	Ecosystem membership	
Case 1: Catena-X				
C1	Domain expert	Original equipment manufacturer (OEM) α	Yes	00:38
C2	Technical role	OEM β	Yes	01:01
C3	Managerial role	Supplier* α	Yes	00:58
C4	In-house consultant	Supplier* β	Yes	00:24
C5	Managerial role	Supplier* γ	Yes	00:37
C6	In-house consultant	Supplier* δ	Yes	01:26
C7	Managerial role	Recycling company	Yes	00:41
C8	Technical role	Operating company	Yes	00:54
C9	Domain expert	Software vendor	Yes	00:53
C10	Consultant	Software start-up	Yes	00:23
Case 2: MDS				
M1	Domain expert	OEM	Yes	00:49
M2	Managerial role	Railway company	Yes	00:48
M3	Managerial role	Infrastructure provider	Yes	00:35
M4	Managerial role	Start-up α	Yes	00:40
M5	Technical role and managerial role	Start-up β	Yes	00:37
M6	Domain expert	Government agency α	Yes	00:42
M7	Domain expert	Government agency β	No	00:31
M8	Domain expert and managerial role	Operating company	Yes	00:58
M9	Managerial role	MDS holding company	Yes	00:36
M10	Managerial role	Research foundation	Yes	00:53
Case-spanning				
A1	Consultant	Consultancy α	Yes	00:51
A2	Consultant	Consultancy α	Yes	00:46
A3	Consultant	Consultancy β	Yes	00:48
A4	Board member	IDSA	No	01:29
A5	Lawyer	Legal firm	No	01:17
A6	Scientific advisor	Gaia-X	No	00:45

*Supplier refers specifically to upstream suppliers in the supply chain that provide raw materials, components, or subsystems to manufacturers, including OEMs and higher-tier suppliers

2011). Value creation refers to how participants generate value through data sharing within the ecosystem, while value capture examines the mechanisms by which participants appropriate this value, either directly or indirectly. This specification served as an analytic lens without constraining the inductive nature of the analysis, as it allowed novel themes to emerge inductively from the data.

Figure 4 displays the data analysis process we followed. In the first step, we performed a within-case analysis to explore the characteristics of each case separately (Eisenhardt, 1989). Adopting a replication logic, we analyzed each case as a standalone entity (Eisenhardt, 2021; Yin, 2018). We focused on identifying case characteristics supported by multiple informants and secondary materials. The secondary data was particularly valuable for understanding the development of the cases and their technical and governance-related designs. Additionally, we utilized the secondary material to verify the plausibility of the informants' statements and to assess our line of argumentation critically.

In the second step, while constantly iterating between data collection and analysis, we compared the characteristics across cases (Eisenhardt, 1989) to group them into distinct cross-case themes (displayed as rows in Table 5 depicting the overview of the cross-case analysis). Specifically, we looked for similarities and differences in value creation and value capture characteristics stimulated by the respective ecosystem context to derive more abstract themes inductively. We used the software MAXQDA for coding the data,

Table 3 Secondary material

Case	Sum of secondary material collected	Types and amount of secondary material
Catena-X	23	• Catena-X website (1) • Catena-X LinkedIn profile (1) • Catena-X documents (e.g., Operating Model Whitepaper, Onboarding Guide, Association Statutes) (4) • Websites and internal presentations of ecosystem participants (12) • Newspaper articles (4) • Event participation (1)
MDS	20	• MDS website (1) • MDS LinkedIn profile (1) • Newsletter articles (2) • Websites and internal presentations of ecosystem participants (12) • Newspaper articles (2) • Event participation (2)
Case-spanning	13	• IDSA and Gaia-X websites (2) • Whitepapers and Position Papers (e.g., Gaia-X Architecture Document, Gaia-X Vision & Strategy, IDSA Data Spaces Overview, IDSA New Business Models for Data Spaces Grounded in Data Sovereignty, IDSA Rule Book, IDSA Reference Architecture Model) (7) • Newspaper articles (2) • Event participation (2)

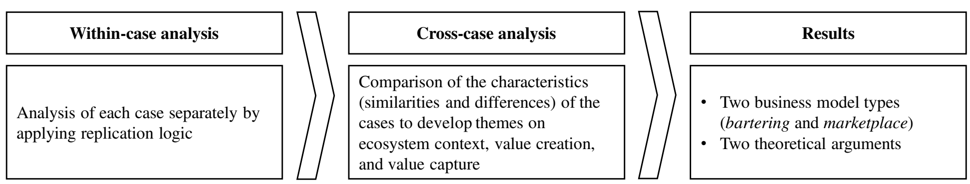


Fig. 4 Data analysis approach

which resulted in the assignment of approximately 300 codes overall. Table 4 exhibits examples of the coding process related to the value capture themes of "nature of value capture" and "value distribution." The former theme exhibits its distinct characteristics, while the latter demonstrates a similar characteristic across both cases.

In addition to tabulating evidence, we also graphically illustrated the emergence of themes and their case-specific characteristics. Figure 5 offers a representative visualization of the two themes: "nature of value capture" and "value distribution." The complete set of graphical visualizations of theme developments from the data is available in Appendix B.

Building on the similarities and differences in value creation and value capture characteristics, we aggregated these findings into two generic business model types: *bartering*

Table 4 Coding examples

Within-case analysis		Cross-case theme	Dimension
Distinct case characteristics:		Nature of value capture	Value capture
Catena-X: indirect	**MDS:** direct		
The Catena-X model is intended to actually exchange data in the supply chain and […] does not aim to monetize the data as such. (A5)	Data that is available can be monetized. (M10)		
Catena-X: intangible	**MDS:** none		
You cannot evaluate the collaboration in Catena-X purely monetarily. (C4)	All the data that is published there is completely openly available under an open license. (M6)		
Similar case characteristic:		Value distribution	
Catena-X and MDS: not primarily centralized toward a single actor			
This reverses the classic model of the platform owner earning all the money so that we can say that the users are the actual beneficiaries. (A4)			

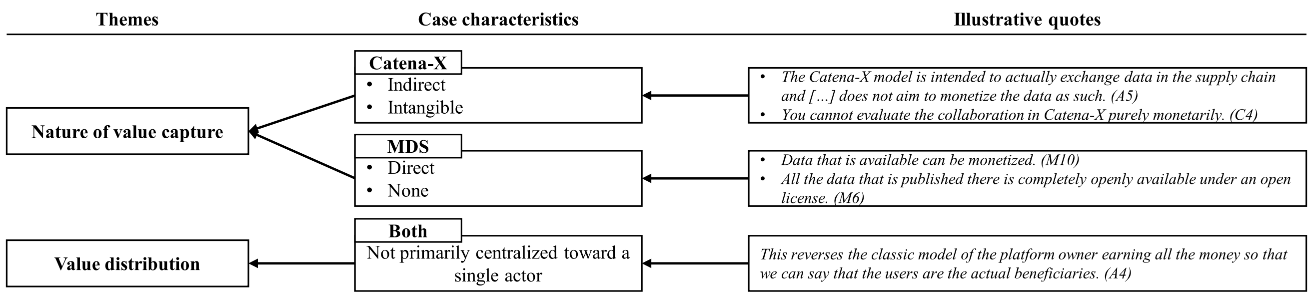


Fig. 5 Visualization of theme development from raw data

and *marketplace*. Finally, we abstracted two theoretical arguments across both cases to build theory (Eisenhardt, 1989, 2021) on context-sensitive business models for data-sharing participants in decentralized data ecosystems.

Within-case analysis

In this section, we detail the characteristics of each case separately, describing their development, context, and the resulting business model type for data-sharing participants in the respective ecosystem.

Catena-X: Bartering model

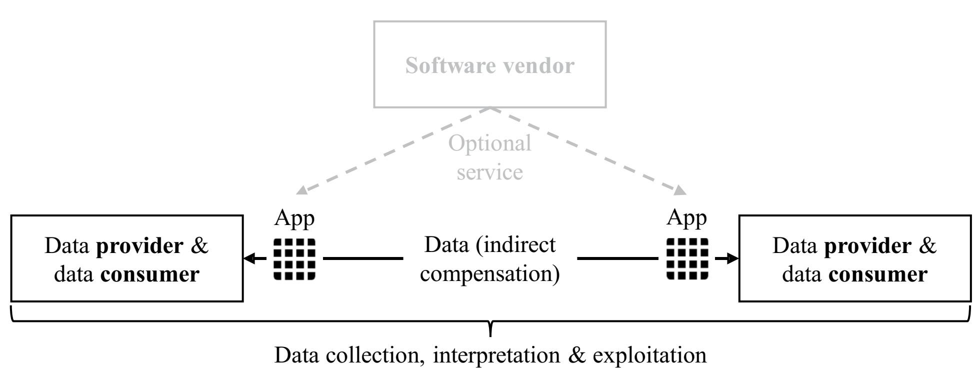
Catena-X is a decentralized data ecosystem reflecting the supply chain of the automotive industry. It originated in 2020 as the *Automotive Alliance*, a private-sector initiative that later secured public funding from the German Ministry for Economic Affairs and Climate Action. Building on this funding, the Catena-X consortium was established in 2021, bringing together 28 primarily private companies, including OEMs, suppliers, software vendors, and other automotive-related organizations. Catena-X was founded in response to significant industry challenges, particularly increasing regulatory requirements. Since the termination of the consortium in July 2024, the *Catena-X e.V.*, a not-for-profit association with 193 members as of November 2024, has taken over ecosystem governance. Participation in the association is voluntary for all Catena-X participants and requires payment of a membership fee to sustain the association. From a technical perspective, the infrastructure for decentralized data sharing is operated by a profit-oriented intermediary.

As depicted in Fig. 6, the business logic for data providers and consumers in Catena-X revolves around reciprocal data sharing. Participants barter data for data without receiving monetary compensation. Accordingly, we categorize it as a *bartering business model*.

In this model, participants act as "prosumers," simultaneously providing and consuming data. Since data providers are supposed to be data consumers simultaneously, each participant covers data collection, interpretation, and exploitation activities to create value. Notably, data sharing is not invariably reciprocal. Although Catena-X advocates for data bartering, there are instances where suppliers share data with OEMs, such as through contractual agreements, without receiving data in return.

A defining feature of Catena-X is that data interpretation is predominantly use case–driven. Data-sharing activities are facilitated through predefined software applications tailored to specific use cases, enabling participants to derive valuable insights from shared data. These use cases are developed collaboratively within the Catena-X association, and participants can join the association to contribute to their formulation. A concrete example is the *demand and capacity management* use case, where participants along the supply

Fig. 6 Bartering model in Catena-X



chain share data about their demands with suppliers while simultaneously receiving data from customers about their respective demands. Applications designed for demand and capacity management assist in matching and interpreting this data, creating actionable insights. While data sharing is primarily application-based, participants also have the option to share data outside of these applications. However, informants emphasized that use-case applications are critical for generating actionable insights and, consequently, business value.

MDS: Marketplace model

The MDS was established in 2019 as part of a political resolution stemming from a German governmental strategy, with funding provided by the Ministry of Digital Affairs and Transport. In 2021, the *DRM Datenraum Mobilität GmbH*, the holding company for the MDS, was founded to establish the organizational framework. Although legally structured as a limited liability company, the holding company has declared itself non-profit-oriented. Its founding partner and principal shareholder, holding 76% of the shares, is a research foundation that is also not profit-driven. The remaining 12 shareholders, each holding 2% of shares, include a mix of private companies, public organizations, and political authorities. While the governance of the MDS is managed by the holding company, a profit-oriented intermediary operates the technical infrastructure required to facilitate data sharing among participants.

As the MDS facilitates matching data providers (supply side) with data consumers (demand side), we refer to this as a *marketplace business model*. Data providers either sell or donate their data to consumers. Figure 7 depicts the value flows in the MDS.

The value creation process in the MDS is distinct in its separation of data value chain activities between data providers and data consumers. Data providers are responsible for collecting data, which they offer in a data catalog maintained by the technical intermediary. Data consumers can then discover the metadata in the catalog and request permission to retrieve the data via the data space connector. To access the data, consumers must first agree to the usage policies established by the providers. Once the data is transferred unidirectionally from the provider to the consumer, the latter can interpret and exploit it to generate value.

Eventually, data consumers utilize the data obtained from data providers via the MDS, for instance, to offer additional value to customers by better service. Furthermore, data sharing might facilitate entirely new value propositions and innovations. This implies that data exploitation generating business value typically occurs on the side of the data consumer only. The data provider, in turn, which covers the data collection and not the data exploitation activities, may demand direct monetary compensation for their contribution to the value creation. Although the MDS supports the inclusion of prices within usage policies, informants noted that data pricing remains rare in practice. Most data shared within the MDS is either donated or offered as open data, resulting in limited financial remuneration for providers.

Cross-case comparison

In this section, we delve into the similarities and differences across cases, as summarized in Table 5. We derived the themes inductively from the data and allocated them to the dimensions of ecosystem context, value creation, or capture, given the definitions we presented in the conceptual background. The value creation and capture characteristics of each case are shaped by their distinct contextual factors; hence, context spans both dimensions of value creation and capture. Before elaborating on the latter dimensions in detail, we first outline these contextual factors.

Ecosystem context

Our analysis revealed that the two ecosystems under study target fundamentally different contexts regarding industry focus, participant composition, industry dynamics, and ecosystem triggers.

First, regarding **industry focus**, Catena-X is focused exclusively on the supply chain of the automotive industry, whereas the MDS spans a broader range of mobility-related industries, creating a more heterogeneous ecosystem. Nonetheless, there is some overlap, as the automotive industry forms one of the many domains included in the MDS. “In

Fig. 7 Marketplace model in the MDS

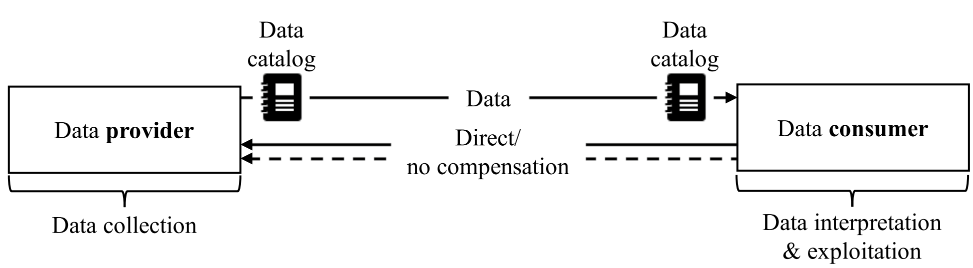


Table 5 Similarities and differences in ecosystem context, value creation and capture characteristics

		Catena-X: bartering	MDS: marketplace
Ecosystem context	Industry focus	Supply chain of the automotive industry	Mobility industries-spanning
	Participant composition	Mainly private sector	Private and public sector
	Industry dynamics	Highly competitive	Moderate competition
	Ecosystem triggers	Significant industry challenges (i.a., high regulatory pressure)	Political resolution
Value creation	Business relationships	Usually already established	Mainly new
	Critical resources	• Data • Software • Infrastructure • Know-how	
	Foundation for value creation	Use cases	Data catalog
	Data value chain activities	Every participant covers the entire data value chain (reciprocal data sharing)	Separation of data collection from data interpretation and exploitation (unidirectional data sharing)
	Primary challenge to value creation	Scaling required to obtain a holistic data chain along the supply chain	Difficulty of data interpretation
	Technical intermediation	• Data sovereignty enables control over value creation • Technical standardization increases efficiency • Decentralization fosters trust	
	Governance intermediation	Participatory governance enables co-shaping the framework of the ecosystem	
Value capture	Nature of value capture	• Indirect • Intangible rewards	• Direct • None (i.e., donation)
	Potential challenge to value capture	Industry power	Data pricing
	Value distribution	Not primarily centralized toward a single actor	
	Costs for participants	At least onboarding costs	Participation currently free of charge
		• Costs inherent to data sharing • Decentralized design produces complexity	

principle, Catena-X represents the automotive supply chain." (C5). "It [the MDS] is not just an automotive data space but a mobility data space. We specifically included other domains so that there is no majorization of mobility sub-sectors, so to speak. That is why public transport has clearly been included. Logistics has been included. Insurance has also been included. That is the exciting story that we are spanning across domains" (M10).

Furthermore, the **participant composition** and **industry dynamics** in the two ecosystems also differ significantly. In Catena-X, the ecosystem primarily consists of private organizations operating in a highly competitive, profit-driven industry. The automotive sector is characterized by intense "competition" (e.g., C3). By contrast, the MDS features a mix of private companies, government agencies, and public organizations. Certain sub-industries within the MDS, such as public transportation and infrastructure, are less profit-driven due to substantial government involvement. This fosters a less competitive environment. "Mobility is not the classic cash cow because it is a common good" (M2). In line with its less competitive context, many MDS participants pursue non-profit objectives. Public organizations, in particular, aim to make "mobility more attractive for society" (M7).

Lastly, the ecosystems were founded for different reasons, driven by distinct **triggers**. The MDS was initiated as a result of a political resolution and was shaped by a governmental strategy (secondary source). In contrast, Catena-X originated from private-sector efforts, with its roots in the "Automotive Alliance" (C5), a network of private companies that later secured public funding. Its origins were driven by significant industry challenges, particularly the need to comply with increasing regulations. "We are well aware of the current legal requirements that are already affecting us and that will become even more heavily regulated in the future […]. that is why Catena-X was initiated" (C2).

These distinct contextual factors, stemming from differences in industry focus and dynamics, participant composition, and origins, influence how value is created and captured within the two ecosystems. The implications of these differences are elaborated in the following.

Value creation mechanisms

From the data analysis, seven themes related to the value creation dimension emerged: business relationships, foundation for value creation, data value chain activities, and primary challenges to value creation revealed differences across the two ecosystems. The themes of critical resources, technical intermediation, and governance intermediation showed notable similarities.

Business relationships In the MDS, value creation often occurs among organizations without prior business relationships. With their active "community management" (M9), the MDS governance intermediary takes on a "networking function" (M10) to set up new collaborations among the diverse set of ecosystem participants. "They say, this might be an exciting use case, you can do this, they [another company] can do that, maybe talk to each other" (M3). Conversely, in Catena-X, value co-creation usually occurs among organizations which have already worked together before the initiation of Catena-X. "We do not share data with a company with which we did not already have a relationship" (C5). Therefore, data sharing can be described as an extension of their already existing business relationship.

Critical resources Both ecosystems rely on four critical resources for creating value: data, infrastructure, software, and know-how. First, complementary data is foundational for value creation in both cases. "The goal is to find one participant who needs specific data and another participant that provides exactly that data. And we bring them together" (M9). "We want to build data chains" (C1). Yet, while both ecosystems aim to leverage a wide variety of data types, their focus differs. Exemplary types of data in the MDS include traffic flow, weather, or parking data, whereas Catena-X leverages, for instance, product carbon footprint and production capacity data. Second, both ecosystems provide decentralized data space core infrastructure, offered by the technical intermediaries. "We make sure that all the basic components are running" (M8). Third, both ecosystems offer software components additional to the core infrastructure, such as connector-as-service solutions or specific applications for data interpretation. "We build software" (C9). Fourth, both ecosystems rely on know-how resources to help participants navigate data sharing and value creation. "We advise the customers" (A3).

Foundation for value creation The foundation for value creation differs significantly between the two ecosystems. In Catena-X, value creation is primarily use case–driven, with use cases being developed within the Catena-X association. Participants can voluntarily join this association to contribute to the formulation of the use cases. Software applications are developed for each predefined use case to turn data into valuable insights. "For a use case, I need a certain application. If I want to do traceability, I need a traceability application" (C1). The applications for use cases can either be "open source," provided free of charge, bought from "commercial application providers," or "locally developed" (C6). However, "all applications are 100 percent interoperable […] so it does not matter which one you buy or use. […] You are not forced to take a certain provider, but you can take whatever you want." (C6). This gives ecosystem participants freedom of choice regarding which application from which software vendor, if any, they want to employ for value creation. However, all applications must be Catena-X certified meaning that if a participant wants to build the app in-house, they must have it certified before it can be employed. Thus, many participants rely on commercial software vendors, which play a pivotal role in supporting data-sharing participants and facilitating value creation within Catena-X. Application-based use cases prove to be beneficial for value creation as the data exploitation is clearly guided. "You have a problem that you want to solve. I just call it the supply chain problem. You know exactly your target image" (C2). Notably, raw data is of little value if it is not interpreted. "The application is decisive, not the data" (C8). Conversely, the MDS relies on a data catalog as its foundation for value creation. "The catalog is fed by data providers. And this catalog offers the possibility for marketplace participants to view, rate, and download the offer on the consuming side" (M9).

Data value chain activities In the MDS, the value creation process is characterized by a separation of data value chain activities between the data provider and consumer. The former is responsible for collecting data and providing its metadata in the data catalog, while the data consumer focuses on interpreting and exploiting the data. "We take this raw data and analyze it" (M5). Essentially, "data from different sources can be mixed" (M8) and obtained via the same standardized interface. Hence, in the MDS, the data exploitation that generates business value is typically on the side of the data consumer only. Data consumers use the data obtained from providers, for instance, to offer additional value to their customers by improving their services. "Data can help us to advance our core business, in other words, making the experience better for our travelers" (M2). Access to data sources via the data space might even facilitate novel value propositions, i.e., "innovative new solutions" (M5). By contrast, Catena-X participants act as data "prosumers," which means all participants are expected to provide and receive data along the automotive supply chain. "What data demands do we have, what kind of data do we generate, what could the sharing look like" (C7). Given this reciprocity, each ecosystem participant covers data collection, interpretation, and exploitation activities, i.e., the entire data value chain, to create value.

Primary challenge to value creation In the MDS, the governance intermediary provides guidance for use case development and data exploitation opportunities. "The community structure is a good thing; it really promotes developing more ideas" (M5). Despite this support, the MDS participants often struggle with interpreting and exploiting data to derive business value. "How can this data then be used to improve mobility? It is often an open question" (M7). As several MDS informants mentioned the difficulty of data interpretation, we identified it as the main challenge to value creation in the MDS. In Catena-X, by contrast, data sharing is tied to use cases that help turn data into valuable insights and give clear guidance for turning raw data into business value. For Catena-X, scaling in terms of increasing adoption emerged as the primary challenge to value creation. While scaling and reaching "a critical mass" (A6) is important to both data ecosystems under study, it is the main challenge for Catena-X because it is specifically focused on the context of the automotive supply chain and, therefore, relies on a holistic data picture along the entire supply chain. Informants highlighted *that* "the effects in terms of cost reductions, etc., will only come when we are really connected in breadth and depth […]. The added value will only come when the First Tier [supplier] has connected all its customers via Catena-X" (C1).

Despite these differences, both ecosystems share commonalities in how their decentralized designs enable value creation, which we elaborate on in the following.

Technical intermediation Both ecosystems build on decentralized technical infrastructures and participatory governance, as well as separate intermediaries for these functions. Turning to the decentralized technical design first, informants from both ecosystems report that value creation benefits from that, as it lies the basis for secure and trustful data sharing. "The big issue is trust. You do not want to centralize data across company boundaries. You do not want that; you want the data to stay where it is, yet you must be able to work with it. Hence, decentralization" (M4). Especially the principle of data sovereignty, which is inherent to the decentralized technical design, enables participants to "control the conditions under which you share data" (C2) to co-create value with others. "Each data provider is free to decide which data is shared to which recipients" (M2). Furthermore, Gaia-X, as "a huge coordination and harmonization initiative" (A6), provides a framework for technical standardization. By standardized data transactions, transaction costs are reduced, which results in greater efficiency for value creation. "Connecting each data recipient individually is costly; we want to do this via a standardized interface" (C3). Lowering transaction costs is especially crucial for the automotive industry, as ever more data sharing is legally obligated. Many Catena-X informants mentioned the inevitable multilateral data sharing for "regulatory compliance" (C4) with the German supply chain law that forces participants to have data about their supply chain origins in place. "We have realized that we are not getting anywhere with bilateral data sharing […]. We see no other option than Catena-X" (C1).

Governance intermediation Lastly, participatory and alliance-driven governance is perceived as very beneficial by the informants of both cases, as it empowers participants to proactively influence the ecosystem's rules for co-creating value. "With a data ecosystem like this, it is not like a proprietary platform owner saying this is exactly how it is. That is the framework, that is it" (A5). Informants appreciate that they have "participation rights" (M2) and that they can "get involved in some way to help shape the rules" (C4). Participants typically perceive it as "democratic" (A2) and "fairer" (M4). Notably, the governance in Catena-X is highly participatory, as every participant can become a member of the association responsible for governance. As an association member, participants can join working groups and expert committees to contribute to shaping the ecosystem. "I am also part of a working group in the association" (C7). The MDS is built upon a shareholder structure, so not every participant can join the governance intermediary as easily as in Catena-X. Yet, the MDS holding company explicitly pays attention to including the interests of the participants, for instance, by organizing working groups and community events. "We have working groups in the community that deal with use cases and requirements" (M10).

Value capture mechanisms

From the data analysis, four themes related to the value capture dimension emerged: nature of value capture, potential challenge to value capture, value distribution, and costs for participants. While the nature of value capture and its associated challenges differ across the ecosystems, similarities exist in terms of value distribution. Mixed characteristics were observed regarding costs for participants. Across both ecosystems, informants consistently emphasized that capturing value from these decentralized data ecosystems remains a complex endeavor. "How do you make money with it? Spoiler alert: this is a difficult topic" (A6).

Nature of value capture To capture value from received data, data consumers in the MDS monetize the generated value outside the ecosystem by offering improved or new products and services to end customers. Data providers, by contrast, focus on data collection rather than its exploitation and may seek direct monetary compensation for their contribution to value creation. "The data provider monetizes the data" (M4). Yet, most data is donated or "open data […], which is completely openly available under an open license" (M6). In that case, data providers do not capture any compensation with direct financial impact. Government agencies, which are part of the MDS, are often even legally obliged to provide data free of charge or at cost price. "The data of the German Weather Service must be open data" (M5). Also, government agencies might engage in data donation to achieve charitable objectives such as "improving mobility services for the population" (M7) or "climate goals" (M6). For profit-oriented organizations, donating data can serve as a visibility strategy. It might be in private companies' economic interest that other organizations provide services with their data so "that it can appear in any developed application" (M6).

In Catena-X, data is reciprocally exchanged so that data providers are simultaneously data consumers. That means data bartering instead of monetary compensation or data donation takes place. "The Catena-X model is basically intended to actually exchange data in the supply chain and […] does not aim to monetize the data as such" (A5). Being data consumers, all participants are supposed to be able to realize cost benefits from data exploitation based on applications that target specific use cases. Value can be captured indirectly by realizing "efficiency advantages" (C5). For instance, efficiency can be increased by reducing costs stemming from "data-based decisions" (C7), leading to "process optimization" (C5). Moreover, the previously mentioned reduction of transaction costs not only facilitates value creation but can also be seen as indirect value capture. "You have standardized interfaces […]. What we have today is that our customers have their own interfaces and they are super maintenance-intensive and therefore cost-intensive. That is the case for us. Cost reduction" (C3).

Besides cost reduction as an indirect value capture mechanism, the mention of intangible rewards or "soft benefits" (C3) by Catena-X informants is striking. "You cannot try to evaluate the collaboration in Catena-X in purely monetary terms" (C4). Many organizations actively participate in Catena-X to increase their reputation and signal that they are "an innovative partner, what can be the deciding factor in tenders. It is not necessarily only decisive whether we are the cheapest […]. Instead, we are also digitally fit" (C3). Also, participation in the data ecosystem can help participants improve their strategic position and differentiate themselves from competitors by better fulfilling customers' needs. "You would not get any more orders if you did not adhere to this standard" (C4). Another intangible reward mentioned by informants is that participation in the ecosystem can enhance the participants' own digital transformation. "If you participate in Catena-X, you can use it as a vehicle to build up an internal infrastructure that allows you to exchange data much better internally" (C4). "Of course, this is also an opportunity to drive your own digital transformation forward" (A3). Informants even argued that the ecosystem is vital for the digital competitiveness of the automotive industry as a whole. "To some extent, Catena-X is actually essential for the competitiveness of the entire automotive industry" (C4). However, such intangible rewards are challenging to quantify. "The problem is that the things that are important are difficult to measure. And the things that are easy to measure are not necessarily the most important" (C4).

Looking beyond the data providers and consumers from the automotive supply chain, we observed that third-party software vendors play an important role in the Catena-X ecosystem. While the former actors capture value indirectly or realize intangible rewards, in contrast, the software vendors directly monetize their value propositions. "We have an interest in selling software" (C9). However, these third-party service providers are not the focus of this study.

Potential challenge to value capture Remarkably, Catena-X's target context—the automotive industry—is characterized by a "clear concentration of power among the big players," so "the pressure to join [Catena-X] is high" (A2). Power dynamics emerged as the primary challenge to equitable value capture within Catena-X, as more powerful participants might pressure other organizations to join the data ecosystem despite unclear economic value. For instance, "a car manufacturer can issue a tender requiring that you must be Catena-X-ready" (C8). Also, informants mentioned that the fairness of value distribution created by the use cases is questionable. Some perceive that the use cases are built to mainly serve the interests of the more powerful participants in the ecosystem instead of bringing the same level of value to all participants, i.e., some "get a bigger piece of the cake" (A2). "I do not know any small or mid-sized company that says I join because the advantages outweigh the disadvantages […], but because otherwise I would be kicked out as a supplier" (A1). However, the participatory governance and technical "open-source environment" (C2) of Catena-X explicitly allow for the development of new use cases so that participants who perceive the use cases as not reflecting their needs could take action. Also, due to the decentralized technical design, data is distributed and not controlled by a single organization. "The threat scenario is that one large player owns virtually all the data," therefore, decentralization "balances power structures" (C4). Notably, informants of the MDS did not mention such pronounced power asymmetries, as the industry-spanning context of the MDS does not favor such structures. MDS informants highlight that the research foundation, which holds most shares of the MDS holding company, effectively functions as a "neutrality anchor" (M10).

While in Catena-X, the automotive industry's power dynamics are the primary obstacle to adequate value capture, the MDS faces the challenge of difficult data pricing. From a technical perspective, the data space connectors allow prices to be set utilizing usage policies. Hence, data providers can realize additional revenue by directly monetizing their data, yet they struggle with adequate data pricing. "It is really difficult to put a price on it" (M5). Pricing data is complex, as "data only has a value if it is in a certain context" (A4). Informants emphasize that data valuation approaches are crucial within the MDS because "without being able to price data properly, you will not get the MDS to fly because data has special properties, and that is why it is not oil or gold" (A2).

Value distribution Although in Catena-X, inherent power imbalances might unevenly distribute the created value toward more influential players in the data-sharing relationship, we find that value capture in both ecosystems is not directed toward any central actor, such as the technical or governance intermediaries. No organization in the ecosystem is intended to have a "monopoly position" (C2). "Away from the 'ego-system' towards the ecosystem. We do not want such dominant players as Meta, Google, but we want to solve everything in a decentralized way" (M8). Both decentralized data ecosystems have separated intermediaries for technical operation and governance, and none of these intermediaries disproportionately captures value for itself. While the technical intermediaries in both ecosystems are profit-oriented, the governance intermediaries purely operate at self-preservation and consist of an alliance of organizations. "We wrote the non-profit approach down in our constitution. The shareholders do not take any profits […]. We only have to refinance ourselves and not make a profit" (M10), which prevents monopolistic value capture. With this decentralization of platform ownership, informants even speak of a paradigm shift where the owner of a platform no longer appropriates the majority of value but "those who exchange data on this platform should be the actual beneficiaries […]. This reverses the classic model of the platform owner earning all the money" (A4).

Costs for participants Regarding the costs incurred by the ecosystem participants, informants stressed that the decentralized design inherent to both ecosystems we analyzed "produces huge organizational overhead" (A2), is technically complex, and therefore costly. "A decentralized infrastructure is almost always more expensive than a centralized one" (A1). Besides the costly complexity of decentralized data ecosystems, informants of both cases highlighted the internal costs emerging from data sharing. Data providers face operating costs for collecting and "keeping all the data ready, making it available. Of course, this always incurs costs" (C1). Moreover, "the IT infrastructure will probably also have to be adapted" (C7) or "contracts […] and framework agreements" (C6) must be checked, which produces additional internal costs stemming from the participation in decentralized data ecosystems.

Importantly, participation in the MDS was, at the time of the interviews, entirely gratuitous due to public funding. So, participants did not have to pay the intermediaries, but the services could be used without costs. "The MDS does not yet cost anything. It is a free offer" (M9). Notably, starting from January 2025, the MDS charges a membership fee depending on participants' annual revenue. Catena-X participants incur various costs depending on the participant's role and preferences. Besides "the onboarding fee" (C6), which is mandatory for all Catena-X participants, costs can include, for instance, membership fees for voluntary membership in the association and certification costs for software vendors. Nevertheless, Catena-X seeks low costs for participants to "keep the entry hurdle low" (C2), for example, by providing applications required for use cases as open-source software. Despite the onboarding costs to compensate the technical intermediary for using its services, most of the value is distributed among the participants.

Discussion

Employing a comparative case study, we identified two generic types of business models for data providers and consumers, i.e., data-sharing participants, shaped by their respective decentralized ecosystem contexts. For Catena-X, we conclude that the business logic follows a *bartering* model, where value is created through reciprocal data sharing and captured indirectly. In contrast, the MDS adopts a *marketplace* logic, allowing data providers to sell or donate data while consumers exploit this data to generate business value. While these types are not exhaustive—other business models exist within the two ecosystems, such as various revenue models for software vendors—the findings provide a foundation for further research. Our study addresses the calls for empirical research on decentralized data ecosystems based on data spaces (Kari et al., 2023) and is among the first to connect these ecosystems with business model literature (Ammann, 2025). By contextualizing value creation and capture through specific cases, responding to Jussen et al.'s (2024b) call to investigate real-world data-sharing value scenarios, our study addresses the lack of research on the business dimension of data spaces and their ecosystems (Guggenberger et al., 2025). From our analysis, we propose two theoretical arguments that are consistent across the cases, which we elaborate on in the following.

> ***Argument 1:*** *The specific context factors shape the types of business models ecosystem participants can realize, i.e., the context determines how data providers and consumers create and capture value from data sharing.*

While Catena-X and the MDS share critical similarities—such as their adherence to Gaia-X standards, funding from German ministries, and similar histories—they differ significantly in their value creation and capture mechanisms. These differences are rooted in context-specific factors, such as industry focus and dynamics, as well as participants' motivations for data sharing. The context determines how participants of decentralized data ecosystems create value and whether they can sell, donate, or barter their data. This underlines the importance of considering the context in which an organization is embedded, as business models go beyond an organization's boundaries (Zott & Amit, 2010).

In Catena-X, data sharing extends the existing business relationships among actors in the automotive supply chain. The bartering model aligns with the context of a predefined network of actors who are already interdependent. Data sharing primarily serves to enhance operational efficiency and meet regulatory requirements, which are paramount in this highly competitive and profit-driven industry. By contrast, the MDS emphasizes collaborations among organizations without prior business relationships. Its broader, multi-industry scope fosters novel value propositions through the innovative combination of complementary data. In the context of the MDS, regulatory pressure is not the key motive for data sharing as is in Catena-X. Hence, in the MDS, other mechanisms for value capture than indirect or intangible are required. The marketplace model reflects the participants' diverse needs, from public agencies seeking societal benefits to private firms pursuing direct revenue.

Our findings align with Jussen et al. (2024a), who emphasize that ecosystems can take various forms depending on the context and the unique stakeholder requirements. Despite overarching standards like the Gaia-X reference architecture, decentralized data ecosystems allow for significant flexibility in implementation (de Reuver et al., 2024; Kernstock et al., 2024). We show empirically, through illustrative quotes and concrete examples, how this flexibility manifests in distinct business models.

> ***Argument 2:*** *The benefits of decentralized data ecosystem designs are more evident for value creation than for value capture. The sustainability of such ecosystems depends on whether they enable business models in which the benefits of decentralization outweigh its complexity costs and equitable value distribution mechanisms emerge.*

Decentralized data ecosystems differ fundamentally from centralized ones in terms of their socio-technical features. Particularly, no single platform owner dictates the value creation and capture mechanisms. Instead, these mechanisms are negotiated among ecosystem participants, leading to increased complexity and coordination costs that shorten value capture potential (de Reuver et al., 2024; Flak et al., 2022; Guggenberger et al., 2025). Thus, the value creation potential in decentralized data ecosystems must be substantial enough to outweigh the increased costs associated with decentralization to be sustainable. In the following, we elaborate on how our findings suggest that while decentralization enhances value creation by promoting efficiency, sovereignty, and trust, capturing value remains a significant challenge.

Implications of decentralization for value creation

Our analysis highlights clear advantages of decentralization of both the technical design and governance for value creation in both cases.

Technical intermediation In line with the literature, our case analysis shows that a decentralized and distributed technical design motivates data sharing and value co-creation due to primarily three reasons. First, technically enforced data sovereignty empowers participants to control their data and its usage conditions (Fassnacht et al., 2023a; Hutterer & Krumay, 2024). Second, technical standardization and interoperability further reduce transaction costs and vendor lock-in, enhancing the efficiency of interorganizational data sharing (Fassnacht et al., 2023a). Third, decentralization fosters trust, stimulating data sharing for value co-creation (Möller et al., 2024).

Governance intermediation From a governance perspective, the two cases we studied are characterized by participatory governance as opposed to control by a single platform owner (Schurig et al., 2024). Platform governance generally determines both the mechanisms and effectiveness of value creation within ecosystems (Flak et al., 2022; Tiwana et al., 2010). In the decentralized setting of our cases, participants are empowered to influence the framework for value creation actively (Schurig et al., 2024). Mechanisms such as expert committees and working groups empower participants to co-design standards, use cases, and rules, which are collectively negotiated (de Reuver et al., 2024). These governance-related mechanisms enhance value creation within decentralized data ecosystems, as suggested by the experts from both cases under study.

Despite these advantages of technical and organizational decentralization for value creation, decentralization also introduces challenges, including difficulty of data interpretation and scaling.

Difficulty of data interpretation While decentralized designs stimulate data sharing, it is imperative yet difficult to turn data into valuable insights. Also, systematic approaches for use case identification are scarce (Fassnacht et al., 2023b). In the MDS, value creation is based on discovering data offerings in the form of a data catalog. Fassnacht et al. (2023a) found that transparency over the data landscape, such as in the form of a data catalog, motivates data sharing. However, we observe that in the MDS, guidance is often lacking on how to interpret and exploit the data to obtain business value.

Scaling By contrast, Catena-X ties data sharing to predefined use cases, providing clear pathways for data exploitation. However, as data spaces—being decentralized digital platforms—adhere to platform economic principles (Otto, 2022; Otto & Jarke, 2019), value creation requires scaling, and a critical mass must first be reached to create value (Zhang et al., 2015). Optimally, both market sides, data providers and data consumers, must adopt in large numbers. However, like every other new platform, also data space–enabled data ecosystems, being in their early stages, face the prominent "chicken-and-egg problem" (Hein et al., 2020; Rochet & Tirole, 2003). While the MDS also struggles with growing the number of participants, scaling is especially pivotal for value creation in Catena-X due to the need for a comprehensive data picture along the supply chain. Notably, both ecosystems emphasize the development of standards and interoperable technical solutions, which are expected to facilitate value co-creation and leverage network effects (Hein et al., 2019; Hutterer & Krumay, 2024). However, jointly negotiating and developing these standards within decentralized settings increases complexity, making it more difficult to reach consensus (Guggenberger et al., 2025; Otto & Jarke, 2019). This presents an additional hurdle to scaling efforts in decentralized data ecosystems compared to other digital platform ecosystems, where a central keystone actor offers take-it-or-leave-it conditions to participants.

To summarize the discussion on value creation, we conclude that despite the two challenges we identified, the majority of case study informants perceive that the benefits of decentralization of data ecosystems for value creation outweigh the hindrances.

Implications of decentralization for value capture

Creating value does not necessarily ensure the ability to capture it, and capturing value from data sharing is particularly challenging (Badewitz et al., 2020; Wiener et al., 2020). This challenge is further compounded by the decentralized structure of data ecosystems, which introduces greater complexity compared to centralized settings. To ensure the economic sustainability of participants, it is pivotal that all costs are compensated by the value captured (Azkan et al., 2020; Jussen et al., 2024a). In decentralized ecosystems, the potential for value creation must, therefore, exceed that of centralized settings to account for increased complexity costs. Additionally, costs inherent to data sharing and other expenses, such as onboarding costs in Catena-X or costs for ensuring data quality (Batini et al., 2009), further constrain the value that participants can ultimately capture (Gelhaar et al., 2021b). Given that the economic rationale is pivotal for organizations to participate in data ecosystems (Gelhaar & Otto, 2020), it is surprising that research appears to overlook the fundamental logic of profit generation when considering platform-based business models (Perscheid et al., 2020) and focused strongly on value creation from data at the expense of value capture so far (Wiener et al., 2020). In the following, we discuss our findings on value capture mechanisms and relate them to prior research.

Direct value capture While the MDS generally emphasizes direct data monetization by enabling participants to sovereignly set prices within the usage policies through data space connectors (Gieß et al., 2024), data providers face significant challenges in pricing their data due to its context-dependent value and the lack of structured valuation frameworks (Parvinen et al., 2020). As a result, much of the shared data is donated without direct financial compensation (Jussen et al., 2024a). Consequently, the anticipated data monetization approach falls short in practice, resulting in participants generating less monetary value than expected. This shortfall could jeopardize the long-term sustainability of the MDS.

Indirect value capture In Catena-X, data bartering eliminates the need for pricing but introduces its own challenges. Literature categorizes bartering as a form of indirect value capture that can entail receiving data or services in exchange for data provision (Gelhaar et al., 2023). When data is exchanged for data, it must hold an equivalent value for all participants involved (Jussen et al., 2023b). For instance, comparable data quality must be ensured when sharing data across organizations (Batini et al., 2009). This *quid pro quo principle* fosters perceived fairness (Jussen et al., 2024a). However, our data shows that fair data bartering is not always given, for instance due to power asymmetries or contractual agreements.

Intangible value capture Besides indirect value capture, Catena-X relies on intangible value capture mechanisms. In line with our empirical study, researchers acknowledge a variety of intangible rewards—such as differentiation from competitors, fulfilment of customer demands, and increased reputation—as motivators for sharing data beyond cost savings and monetary remuneration (Fassnacht et al., 2023a; Gelhaar et al., 2023). Such rewards are valuable yet manifest in ways that are challenging to quantify, complicating the ability of (potential) participants to weigh benefits against participation costs, therefore creating uncertainty for participants. Also, such intangible rewards go beyond the focus of most business model literature, which primarily emphasizes monetary value capture (Teece & Linden, 2017).

Value distribution To develop sustainable data ecosystems, researchers emphasize the importance of fair value distribution (Badewitz et al., 2020; Gelhaar et al., 2021b). Unlike centralized platforms, where the platform owner often captures disproportionate value (Gawer, 2022; Ofe & Sandberg, 2023), decentralized platforms are expected to facilitate a fairer distribution of value (Otto, 2022; Perscheid et al., 2020). Our case study suggests that due to technical and governance-related decentralization, value capture is not exclusively designed to serve the interests of a single organization but is distributed among participants. Our informants appreciated this and even called it a paradigm shift. However, our findings also reveal that power imbalances persist, particularly in Catena-X, where larger players can shape use cases to align with their interests. In that vein, Zott and Amit (2010) acknowledge that organizational power correlates with increased value capture in general. While the decentralized design mitigates some of these imbalances, achieving truly equitable value distribution remains a challenge.

To summarize, both value capture approaches—direct monetization or data donation in the MDS and indirect value capture in Catena-X—face challenges. It is still unclear, how the increased costs stemming from decentralization can be covered by these value capture mechanisms. Nonetheless, value is not concentrated in a single actor but is instead distributed across the decentralized data ecosystems under study.

Contributions

Our work contributes to three literature streams. First, we advance the emerging literature on data ecosystems (Möller et al., 2024; Oliveira et al., 2019) by contextualizing business models in decentralized data ecosystems—a perspective that has been largely overlooked (Jussen et al., 2024b). Through our empirical analysis, we extend this research field by adding two predominant business model types for data-sharing participants shaped by their ecosystem contexts. Each type presents unique challenges and opportunities, and we consider neither inherently superior. While prior research has developed general business models (Schweihoff et al., 2023) or value constellations (Jussen et al., 2024b) in decentralized data ecosystems, we show what and how context factors determine participants' value creation and capture in these settings. Context dependency suggests that while similarities arise across cases from shared elements like the common Gaia-X framework, notable differences emerge due to factors such as industry scope, power dynamics, and motivations for data sharing. This suggests that as more decentralized data ecosystems following the Gaia-X framework emerge, a variety of business models will likely evolve in response to their unique settings.

Second, we contribute to the platform literature, which predominantly explores value creation and capture in centralized digital platform ecosystems so far (e.g., de Reuver et al., 2018; Gawer, 2022; Hein et al., 2019). Due to their distinct socio-technical characteristics, these insights are not fully transferable to decentralized platform ecosystems, such as data space–enabled ecosystems. Given the novelty of the phenomenon and the lack of established frameworks specific to decentralized data ecosystems, our study expands the body of knowledge by investigating value creation and capture in this setting. Our findings underscore the benefits of technical decentralization and participatory governance for value creation. As data becomes an increasingly strategic asset for organizations (Legner et al., 2020), participants value the ability to share it externally while retaining sovereignty and contributing to the governance frameworks under which it is shared. Furthermore, we highlight significant challenges in value capture, as decentralization increases complexity, creating trade-offs that impact economic sustainability. Furthermore, we conclude that decentralized platform ecosystems have only partially dissolved the value capture asymmetries common in centrally dominated ecosystems (Gawer, 2022). Participants continue to prioritize individual interests, and the inherent characteristics of data further constrain value capture opportunities.

Third, we contribute to the business model literature by moving beyond firm-centric models and emphasizing the collaborative generation, sharing, and use of data within ecosystems. We argue that business models extend beyond an individual organization's value creation and capture mechanisms to encompass value co-creation and distribution within the organization's ecosystem (Zott & Amit, 2010). Importantly, the context set by the design of the ecosystem determines how data-sharing participants can create and capture value. Specifically, we highlight the role of decentralized features in shaping a shared business logic within an ecosystem, offering a new perspective on decentralized value network structures (Al-Debei & Avison, 2010; Shafer et al., 2005).

Regarding practical implications, our findings encourage practitioners to develop value capture principles for ecosystem participants that fairly distribute the created value among them. Importantly, practitioners should be aware that value capture must not always be monetary. Instead, indirect value capture mechanisms and intangible rewards should not be underestimated when deciding about participating in an ecosystem for data sharing. Furthermore, our findings help practitioners understand how context factors influence business models at the ecosystem level. This serves as a guide for intermediaries in designing the organizational and technical framework for decentralized data ecosystems so that all participants can realize economic benefits and, therefore, have a motive to participate.

Limitations and outlook

The limitations of our study provide avenues for future research. First, our findings are limited to the contexts of the mobility domain and automotive industry and focus only on B2B relationships. As more data spaces with their particular context factors go live in practice, future research should investigate decentralized data ecosystems pertinent to other domains as well as end customer-facing business models in depth. This includes studying fair remuneration for individuals who share personal data in a B2C setting.

Second, even though the MDS and Catena-X are fully established ecosystems, they remain nascent initiatives and are still developing. For instance, while the MDS was free of charge at the time of the interviews, they started charging membership fees in January 2025, which influences data-sharing participants' value capture. Actors' business models in ecosystems are dynamic and interdependent, evolving in response to contextual changes. This interdependence calls for a dynamic perspective on business models within value networks (Al-Debei & Avison, 2010). Therefore, we encourage future research to examine how business models transform over time and which types remain sustainable, for instance through longitudinal process perspectives.

Third, we present simplified and idealized business model types based on our empirical investigation. However, data sharing in practice is complex and multifaceted (Jussen et al., 2024b). While our analysis identified the two business model types of bartering and marketplace as the predominant logics within their respective ecosystems, we recognize that additional business models may exist beyond the generic types we derived. For instance, in the MDS, a marketplace model could potentially support data bartering in addition to direct data sales and donations. Similarly, while data bartering emerged as the primary logic for data-sharing participants in Catena-X, other models, such as data sales, are conceivable.

Fourth, this study is based on only two cases, which limits the generalizability of our findings to Gaia-X-based decentralized data ecosystems as a whole, especially since these ecosystems can vary significantly in structure and context (Kernstock et al., 2024). Given the novelty of decentralized data ecosystems building on Gaia-X in practice, our cases were purposefully selected as advanced and operationalized examples. Moreover, Eisenhardt (2021) acknowledges matched pair designs with two cases as valuable study designs. Nevertheless, as more decentralized data ecosystems progress in practice, they are likely to support further types of business models. Future research should investigate a broader range of decentralized data ecosystems to validate and extend our findings.

Fifth, we focused only on the roles of data-sharing participants, including data providers and consumers, to reduce complexity. However, it would also be interesting to research and contextualize the business models of other roles, such as ecosystem intermediaries (Schweihoff et al., 2024) and software vendors within the ecosystem. As outlined above, software vendors play an important role, especially in Catena-X. While participants always have the option to employ an open-source, free solution to interpret data, they can alternatively purchase an application from a third-party software vendor that realizes direct value capture by receiving a fee or applying other revenue models. Thus, future research could outline a holistic overview of possible business model types for each ecosystem role.

Finally, as we found that value capture is particularly challenging in decentralized data ecosystems, we want to urge researchers to develop systematic approaches for adequate data pricing that consider fairness in value distribution.

Conclusion

We conducted a comparative case study relying on 26 qualitative interviews with experts on the MDS and Catena-X to delineate two business model types for data providers and consumers in decentralized data ecosystems. While *bartering* involves reciprocal data sharing, a *marketplace* logic fosters the sale or donation of data from providers to consumers. Both generic business models for data sharing are shaped by their particular contexts, bringing both challenges and opportunities. Hence, neither type is considered superior. Furthermore, we show that the decentralized design of Catena-X and the MDS is generally beneficial for value creation between participants, mainly due to technically enabled data sovereignty and participatory governance. Simultaneously, decentralized data ecosystem designs increase complexity and costs, thereby hindering value capture potential, which should be addressed by practitioners and academics alike.

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