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Introduction of Data Spaces for Data Sovereignty – Status and Recommendations for Action

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ABSTRACT

Data sovereignty is paramount in the digital era, and data spaces are often viewed as a means for organizations to cultivate this essential digital competency. However, the adoption of data spaces by organizations remains limited. Furthermore, current perspectives on data spaces tend to emphasize technical aspects while overlooking their socio-technical complexity. What's lacking are recommendations for establishing federated data spaces. To bridge this gap, the study advocates the development of recommendations through expert interviews. Targeting both academia and industry, this research employs coding techniques akin to grounded theory to offer insights and propose four key categories of recommendations: Community, Infrastructure, Interoperability, and Governance. Leveraging data spaces for data sovereignty can provide organizations with a competitive edge.

Keywords: Data spaces, Data sovereignty, Recommendations for action.

INTRODUCTION

In recent years, the importance of national sovereignty in technology and Internet governance has increased significantly (Lewis, 2023). "Sovereignty is the freedom of all actors in the market to make self-determined, independent decisions and to operate in fair competition" (Plattform Industrie 4.0, 2023, p. 18). In Europe, there has been a greater focus on digital sovereignty and its importance in the use of digital platforms (Fischer et al., 2023; Kagermann et al., 2021). In the context of digitalization, it is important to distinguish between data sovereignty, digital sovereignty, and technological sovereignty (Hellmeier & von Scherenberg, 2023). The data sovereignty of organizations is often neglected because it is frequently disregarded (Lauf et al., 2022). Yet, the importance of data sovereignty as a digital literacy is increasingly recognized (Glasze et al., 2023). The goal is to empower data owner in data ecosystems and foster fair environments that benefit both individuals and organizations (Hellmeier & von Scherenberg, 2023). Organizations' biggest challenge is acquiring new competencies related to digital literacy, highlighting the often underestimated importance of data expertise in preserving data sovereignty. (Moschko et al., 2023). The growing importance of data sovereignty, which involves data controll, presents a challenge for organizations seeking to share data securely while protecting against potential leaks, particularly in cross organizational data ecosystems, i.e. data spaces (Hellmeier et al., 2023).

Data spaces are seen as a means for secure and sovereign data transfer (Otto, 2022b; Steinbuss et al., 2023). Initiatives such as the National Initiative for AI-based Transformation to the Data Economy (NITD) are pushing the establishment of a strong ecosystem, i.e., data spaces, for data driven innovations in the data economy (acatech – National Academy of Science and Engineering, 2023). Gaia-X also aims to create a secure and federated data infrastructure (Gaia-X, 2022; P. Kraemer et al., 2022; Tardieu, 2022). The European Union's Data Space Strategy supports organizations in pursuing data sovereignty, innovation, and competitiveness (European Commission, 2018). Data is increasingly recognized as a strategic resource for competitiveness in the digital economy and requires a new perspective on its value potential (Fassnacht et al., 2023; Hunke et al., 2022). Currently, the challenges of multilateral data sharing between organizations are significant due to trust issues and unclear benefits (Hoßbach-Zimmermann et al., 2023; Jussen, Schweihoff, Dahms, et al., 2023). Efforts are being made to promote widespread data sharing between organizations, but broad data sharing in data ecosystems remains uncommon (Bartelheimer et al., 2022; Beverungen et al., 2022; Gelhaar et al., 2023). Many organizations are unaware or do not take advantage of the new opportunities for value creation through data (Institut der deutschen Wirtschaft, 2021). Concerns about disclosing and trusting data continue to hinder the use of data spaces and prevent the realization of benefits, such as innovation, collaboration, and improved competitiveness (Bitkom, 2022). Overcoming these barriers is critical for industries and enterprises to fully leverage data spaces and realize their full potential (Gaia-X Hub Germany, 2023). Based on the scenario described above, organizations must cultivate data sovereignty as a digital competency within their organizational framework. The existing literature explored the adoption of data spaces by data-driven organizations (DDOs) but primarily outlined capabilities (Hupperz & Gieß, 2024). In this context, we aim to delineate our focus on developing actionable recommendations for data spaces.

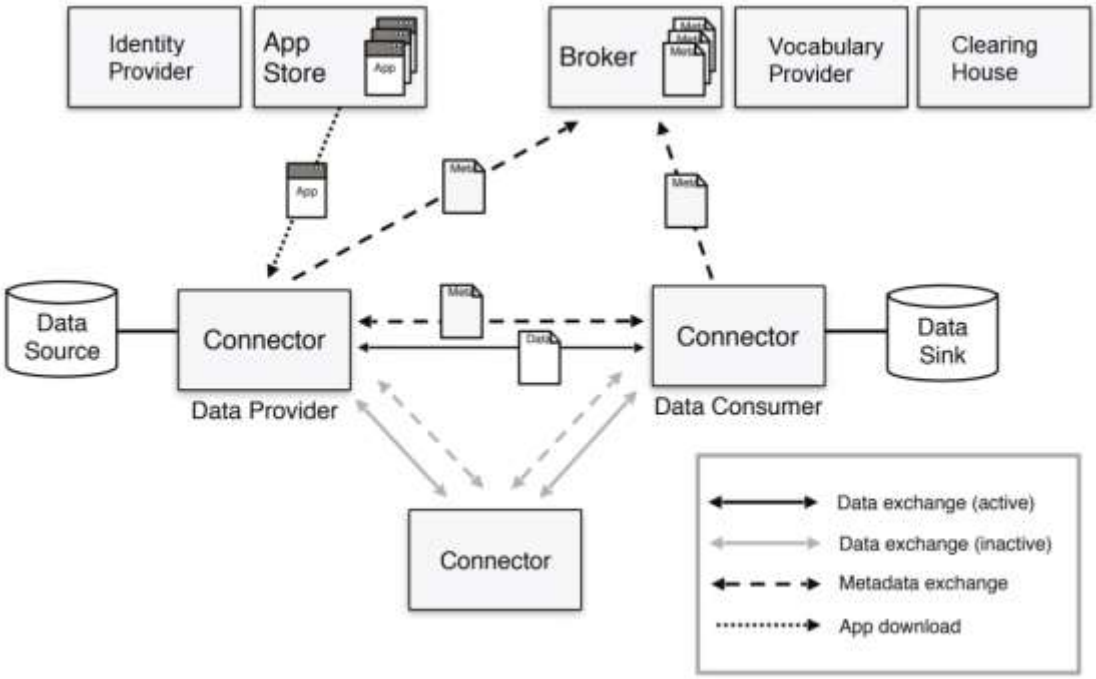
The goal of this study is to identify a common conceptual understanding of data spaces' practical applications (Hirsch-Kreinsen et al., 2022). The paper aims to improve understanding of data spaces by recommending actions to promote data sovereignty. The researchers conducted expert interviews to gain insights and develop recommended actions for data spaces. First, data spaces and the research methodology are explained. Subsequently, the derived recommended actions are presented, and then the results are discussed along with suggestions for future research. This paper concludes by addressing the findings' implications and limitations.

BACKGROUND INFORMATION

The term ‘sovereignty’ has been increasingly used in different forms in recent years, i.e., digital sovereignty (Glasze et al., 2023; Kagermann et al., 2021). Based on this ambiguity, the IS literature attempts to create clarity and categorize these general terms into individual areas (Hellmeier & von Scherenberg, 2023). Thus, the term ‘sovereignty’ can be differentiated in data sovereignty, digital sovereignty, technological sovereignty in order to specify their different focuses (Hellmeier & von Scherenberg, 2023). Further contributions distinguish between data sovereignty, digital sovereignty and cyber sovereignty (Hummel et al., 2021). It was found that the concept of “sovereign technology” has been insufficiently studied in the IS literature, despite its importance (Hummel et al., 2021). In contrast, cyber sovereignty has already been extensively researched in the literature (Pedreira et al., 2021), but data sovereignty as the concept of data ownership from an IS perspective has been scarce (Asswad & Marx Gómez, 2021). With the increasing importance of cross-organizational data sharing in the ecosystem, the challenges with regard to different barriers become apparent, i.e., fear of loss of control (Fassnacht et al., 2023). Unfortunately, there are many barriers to implementing data sovereignty (Hellmeier et al., 2023). Organizations in particular must develop competencies in the area of data sovereignty in order to be able to handle data in a compliant manner (Moschko et al., 2023). Other authors focuses on issues of data sovereignty, including technological sovereignty (Mawere & Van Stam, 2020). Remarkably, the various concepts of sovereignty require further research (Couture & Toupin, 2019). Also, questions of sovereignty also arise in connection with the control of data spaces (Kagermann et al., 2021). Specifically, a common understanding of the term is missing (Couture & Toupin, 2019). Data Spaces are seen as a solution to data sovereignty (Hutterer & Krumay, 2022; Jarke et al., 2019), i.e., agricultuaral domain (Falcão et al., 2023), and digital sovereignty (Firdausy et al., 2022), as this represents a way to maintain control over one's own data resources (Nagel & Lycklama, 2021; Sarabia-Jacome et al., 2019). However, data sovereignty is influenced by technological and digital sovereignty (Hellmeier & von Scherenberg, 2023). To better understand what data sovereignty is, we use the following definition:

> “Concepts of self-determination and the ability of a data provider to maintain control over its own data assets form the term data sovereignty. It is used, among other things, in the IS and SE areas to create technical solutions to protect personal and company data and depends heavily on economic, political and legal aspects.” (Hellmeier and von Scherenberg, 2023, p. 9)

Data spaces were introduced to integrate heterogeneous data sources (Franklin et al., 2005). In deatil, data spaces are based on a hybrid architecture that combines schema-centralized and data-decentralized approach and enables the integration of all organizational data, regardless of format, location, or model (Halevy et al., 2006). Nowaday, data spaces are suitable for facilitating cross-organizational data sharing (Otto et al., 2019). The term “data space” is often used to describe sharing and integrating data in a federated data ecosystem (Hutterer et al., 2023). However, this term has no clear, comprehensive definition, leading to inconsistencies and ambiguities (Hutterer & Krumay, 2022). Most research focuses on the technical aspects of data spaces, but different understandings to ambiguities (Curry et al., 2022; Strnadl & Schöning, 2023). Specifically, data spaces can differ in architecture (Schleimer et al., 2023), design (Gieß et al., 2023) or components, i.e., connectors (Gieß et al., 2024). Thus, there is a need to establish a common understanding of data spaces (Hirsch-Kreinsen et al., 2022; Siska et al., 2023). The increasing demand for data as a strategic asset and the heterogeneity of data have driven the development of data management concepts (Freitas & Curry, 2016). Centralized data storage was the norm in the early years, while decentralized storage has gained prominence recently (Halevy et al., 2006). Traditional database management systems (DBMS) are limited in dealing with heterogeneous data sources and semantic integration (Freitas & Curry, 2016). In contrast, a data space management system (DSMS) is an approach that manages, retrieves, and secures data. It uses an on-demand approach that requires a low initial cost for data integration (Elsayed et al., 2006). The Data Space Support Platform (DSSP) is therefore an autonomous system that provides services without human interaction and continuously improves through a pay-as-you-go approach (Sarma et al., 2009). DSSPs realize the integration of heterogeneous data from distributed systems and provide on-demand access (Wang et al., 2016). Data spaces use an agile data integration method to identify data relationships and do not focus on data management (Guo et al., 2021). Data spaces operate without semantic integration and have no control over the data (Wang et al., 2016). The concept of data spaces is based on a decentralized approach that allows participants to share data while regulating access (Franklin et al., 2005; Otto & Jarke, 2019). The basis for the International Data Space (IDS) is the DSSP concept as a multi-sided data platform (IDSA, 2019; Otto & Jarke, 2019). The hybrid architecture of the IDS aims to establish the digital platform while leveragin trusted infrastructures to enforce data sovereignty (IDSA, 2019). In doing so, it is guided by a reference architecture proposed by the IDS Initiative (IDSA, 2022). The digital platform is an intermediary that facilitates direct data sharing between stakeholders and promotes interoperability between different data platforms (Volz et al., 2023). As depicted in Figure 1, data space architectures include elements such as a connector, a metadata broker, a vocabulary provider, an identity provider, an app store, and a clearinghouse (Drees et al., 2021; Pettenpohl et al., 2022).



Source: (Volz et al., 2023).
Figure 1: Data space by IDSA.

The concept of data spaces is a promising paradigm for platform-based ecosystems (Franklin et al., 2005; Hutterer & Krumay, 2022) that can connect isolated systems (Falk et al., 2021). However, issues related to data sovereignty and data sharing persist, hindering the adoption of data platforms (Jarke, 2020; Jarke et al., 2019). Establishing a federated infrastructure where individual actors agree on data-sharing guidelines is a novel strategy to address this problem (Gaia-X Hub Germany, 2022; Otto, 2022a; Siska et al., 2023). Decentralized data spaces aim to ensure the data sovereignty of organizations (Duisberg, 2022; Hutterer & Krumay, 2022; Winter et al., 2022). Many organizations face data-sharing challenges (Fassnacht et al., 2023; Heinz, Benz, et al., 2022; Kraemer et al., 2021), and a federated platform approach can increase trust and mitigate these challenges (Curry et al., 2022). The adoption of data spaces faces several challenges (Gaia-X Hub Germany, 2023), as the current literature focuses mainly on technical (Hutterer & Krumay, 2022) and capacity (Hupperz & Gieß, 2024) aspects, making broad adoption challenging (Hutterer & Krumay, 2024; Otto & Jarke, 2019). Data spaces realize a technical, legal, and economic environment for the multilateral use of data across organizational boundaries (Marko et al., 2023). There is uncertainty about the concept of data spaces and their practical implementation (Hutterer et al., 2023).

Research in this area aims to develop concrete recommendations for effectively using data spaces (Mertens et al., 2023). As mentioned, there are several data space architecture and design options (Gieß et al., 2023; Schleimer et al., 2023), such as the more centralized framework of the International Data Spaces Association (IDSA, 2022) and the more decentralized Pontus-X (Pontus-X, 2023) based on distributed ledger technology (Ocean Protocol Foundation, 2022). Currently, only a few organizations are involved in data spaces, including Catena-X (2023), Mobility Data Space (2023), and EuProGiant (2023). In addition, other initiatives are underway to create a federation of data spaces in a domain. The Manufacturing-X initiative (Plattform Industrie 4.0, 2022) is an example of an overarching industrial data space (Data Space 4.0 Alliance, 2023), while mobility data will be federated in a European Mobility Data Space (EMDS) (PrepDSpace4Mobility, 2023b).

METHODOLOGY

This study determines recommendations for action for data spaces based on grounded theory (Glaser, 1992). Grounded theory is a scientific method in which qualitative data is analyzed to develop one's own theories based on the data. This provides a comprehensive understanding of complex social phenomena and unearths new insights. In the first step, data are divided into themes, concepts, and patterns; in the second step, categories are connected and integrated to understand their relationships. Selective coding identifies core categories that represent the emerging theory. This method is often used to study social processes, such as organizational culture, social networks, and power dynamics, and provides a careful and structured approach to qualitative data analysis. An exploratory study using a qualitative approach was conducted to take advantage of the limited knowledge available on data space implementation (Sekaran & Bougie, 2013). The authors established guidelines for a structured yet open-ended interview process and used semi-structured interviews as the primary data collection method to allow flexibility for follow-up and exploratory questions (Edwards & Holland, 2013; Lenz, 2006).

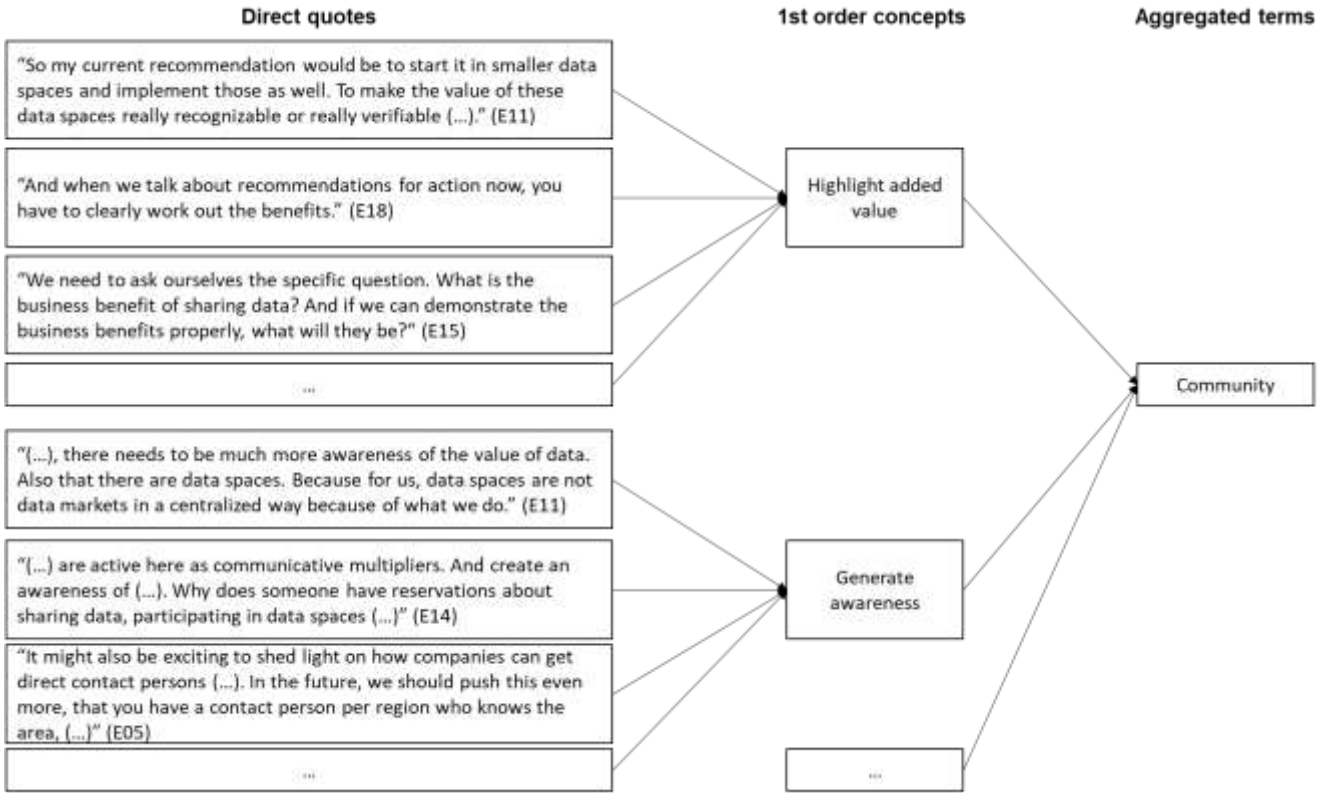
Due to the novelty and limited familiarity with the research topic, a non-probability sampling strategy was used to select respondents (Etikan et al., 2016). The goal was to find data-space experts with the necessary involvement in decision-making

processes. We chose experts (see Table 1) for their engagement in inter-organizational data sharing or projects pertaining to data spaces. These experts hailed from organizations of varying sizes, with eight from small and medium-sized enterprises (SMEs), six from mid-sized organizations, and 14 from large enterprises. Interviews continued until theoretical saturation was reached. Twenty-eight experts (E01-E28) involved in cross-organizational data space projects were initially interviewed. Interviews were conducted between October and December 2022, both in-person and online.

Table 1: Listing of experts and interview length.

Expert	Job Position	Length [min]
E01	CEO	31
E02	Head of Solution Architects	58
E03	Partner Development Manager	62
E04	Team Lead & Gaia-X Expert	35
E05	Head of the digitalisation and resilient production	51
E06	Solution Architect	113
E07	CEO	62
E08	CEO	45
E09	Senior Project Manager	45
E10	Scientific Researcher	33
E11	Data space Lead Architect	53
E12	Principal Scientist	50
E13	Principal Scientist	44
E14	Head of Data Science	44
E15	Department Lead	51
E16	Partner	49
E17	Global Head of Digitalization	34
E18	CEO	28
E19	Principal Researcher	29
E20	Senior Business Development Manager	56
E21	Director Business Chief Digital Office Industry	52
E22	Executive Partner	53
E23	Co-Founder and Business Lead	41
E24	Project Manager	42
E25	Lead Project Manager	35
E26	Deputy CTO	58
E27	Head of Digital Business	37
E28	Senior Architect/Product Manager Business Customers	38

The interviews lasted an average of 47 minutes and were conducted using Zoom during the period spanning from October to December 2022. The interviews were recorded, transcribed, and subjected to a systematic coding process rooted in the grounded theory methodology (Corbin & Strauss, 2015). One researcher executed the coding procedure. The initial coding phase involved open coding, wherein codes were generated from the raw interview data. For instance, a representative code emerged from the data, exemplified by the statement, “Organizations that were the most experimental were the most successful” (E04). Subsequently, in the axial coding phase, pre-existing codes were systematically clustered into 1st order conepts based on their shared characteristics. In the last steps the terms were aggregated forming higher-level categories. For example, the codes “Organizations that were the most experimental were the most successful” (E04) and “Create momentum to support and encourage organizations to do so” (E08) were first aggregated into the 1st order concept “creating awareness” and further aggregated to form the category labeled “Community.” Throughout the coding process, efforts were made to ensure the reliability and validity of the identified categories. We commenced our analysis by systematically examining expert statements, employing Gioia diagrams as a method for analyzing and synthesizing data (Gioia et al., 2013). Gioia diagrams, as demonstrated in studies by Kraus et al. (2022), Kujala et al. (2022) and Holzmann and Gregori (2023), are typically associated with grounded theorizing. Traditionally, they are utilized to analyze transcribed interviews and derive concepts and theories from the data (Gioia et al., 2013). As depicted in Figure 2, we employed Gioia diagrams to establish a coherent connection between expert statements and a concluding category.



Source: (Gioia et al., 2013).

Figure 2: Illustrative visualization of the data analyisis via Gioia diagram.

RESULTS

Based on the coding used, we derived and discussed recommended actions for four categories (community, infrastructure, interoperability, and governance). Some of the recommended actions relate to technology, others to general experiences related to cross-organizational data sharing. Interestingly, the community category (n=21) was cited most often, followed by infrastructure (n=16) and equity (n=12) for interoperability and governance. This is likely due to immature practical experience with implemented data spaces. Accordingly, a significant portion of the identified recommended actions overlap with data sharing challenges described in the literature. By combining a secure, interoperable technical infrastructure, a trusted governance framework, and a dynamic community, decentralized data sharing can thrive in data spaces. A decentralized approach to data spaces fosters trust, data sharing readiness, and collaboration while enabling secure and efficient data sharing. Ongoing technology development, community engagement, and ongoing improvement efforts should unlock the potential of data space sharing. The following recommendations for action were derived from the expert interviews and are presented in Table 2.

Table 2: Recommended actions for data spaces.

Category	Recommended action	Occourence
Community	Promoting data spaces is to actively engage relevant stakeholders and reach a critical mass of actors.	E01, E03, E04, E05, E06, E08, E10, E11, E12, E13, E14, E17, E18, E19, E21, E22, E24, E25, E26, E27, E28
Infrastructure	Building data spaces requires establishing a trusted data infrastructure for data sharing.	E01, E04, E05, E06, E07, E09, E10, E14, E15, E16, E20, E21, E23, E24, E26, E27
Interoperability	Early connectivity between data spaces is intended to establish links to ensure interoperability.	E01, E02, E06, E07, E08, E11, E12, E15, E16, E20, E21, E28
Governance	Data spaces require appropriate governance for cross-organizational data sharing.	E01, E06, E07, E08, E11, E12, E14, E20, E21, E24, E25, E28

Community

The term "community" refers to a collaborative network that includes various stakeholders, including data providers, data users, organizations, and individuals. All have the goal of contributing to the development and use of data spaces. In the expert discussions, it became clear that using the network concept of a collective movement is critical to drive the proliferation of data spaces. This approach requires the active participation of all relevant stakeholders within the community throughout the collection process, with the goal of achieving a critical mass of participation. By fostering a stimulating social environment, data spaces can facilitate collaboration. For example, Expert E21 offered the following critique:

"Digital transformation is something that every organization has already tackled to some extent. If we don't implement this digital transformation within the organization piece by piece, then the topic of the data spaces won't really work either, because

that is the digital transformation of an entire ecosystem. … And I first have to lay the foundation for digital transformation within a[n] organization. And if I'm not prepared to break up existing structures piece by piece, then it will be very difficult." (E21)
To address improvement, it is recommended to identify all potential stakeholders and gain insight into their respective roles, needs and motivations. To foster broad representation and proactively engage a critical mass of stakeholders, facilitating knowledge and resource sharing is critical, with a focus on building a foundational social ecosystem. Establishing a platform or community, i.e., an association, can promote networking and collaboration and support stakeholder participation. Stakeholders should play an active role in the design and implementation of data space initiatives, with participant exchanges serving as a means to continuously improve the community. During this process, it is critical to emphasize the added value of data spaces, as demonstrated by Expert E25 perspective.

"That's where you could look beyond the organizational boundaries. Can you share the data in your immediate environment, find like-minded people in your ecosystem? Medium-sized organizational in particular live from the fact that they have very good customer relationships and also good relationships with suppliers. Why not sit down? And let's talk about data spaces." (E25)

Participant experiences can be used to refine implementation strategies and improve data space dynamics. Continued assessment of stakeholders and their needs is essential to fostering an active community that engages all relevant participants in the data space implementation process, including identifying use cases. For example, existing communities, i.e., associations, may collectively decide to establish a federated data space. In particular, larger organizations may form a core group of entities that are convinced of the need for data spaces. Over time, the data space may attract more participants through network effects. Stakeholder participation can be encouraged by introducing additional incentives and rewards, such as financial support for innovative data use. Awareness initiatives, such as national data initiatives, can effectively promote data spaces by highlighting their benefits and value proposition. In addition, financial support for innovative data projects can create momentum. Organizations need direct contacts who can provide support services, such as a data space support center, to address concerns about data sharing and participation in data spaces. To alleviate these reservations, highlighting positive examples can raise awareness, as suggested by Expert E11.

"In any case, there needs to be much more awareness of the value of data. Also that there are data spaces. Because data spaces ... are not data markets in a centralized way." (E11)

The experts recommend greater collaboration and networking among stakeholders involved in data space creation initiatives. The collaborative approach exemplified by the Gathering movement encourages the creation of data spaces by facilitating diverse perspectives and promoting the sharing of data resources, particularly through federated data spaces. This approach ultimately culminates in the creation of data spaces that encompass a broad range of stakeholders.

Infrastructure
The term "infrastructure" in this context encompasses various elements, including hardware, software, networks, services, policies and more. In addition, they all facilitate the use, storage, sharing and processing of data within and between data spaces, i.e., between interconnected systems and organizations. Expert discussions have revealed the need to create a reliable decentralized infrastructure to facilitate sovereign data sharing. In particular, with the primary goal of strengthening trust between data providers and consumers within data spaces. Trust provides the foundation for decentralized data sharing and ensures the integrity and reliability of shared data. Create data ecosystem infrastructures that support trustworthy data sharing between organizations. In addition, creating value within data spaces is a major challenge for organizations, primarily due to insufficient digital literacy. Expert E26 particularly emphasized the challenges of data integration in data spaces.

"The organizations don't even have a handle on the data within the organization. So we're still getting to organizations where there are silos of data in the organization, let alone that you could expose or merge." (E26)

In addition, the expert interviews resulted in the following recommendations. To improve data spaces, investments should be made in a decentralized infrastructure that includes security measures to protect data during both transmission and storage, i.e., security by design. In addition, all stakeholders should actively participate in standardization processes aimed at developing common frameworks and best practices for building a reliable infrastructure. In addition, data protection regulations and regulatory requirements should be implemented to ensure responsible data sharing. To promote trust and transparency among stakeholders, technological guidelines must be embedded in the infrastructure. In addition, prioritizing privacy and consent mechanisms will strengthen individuals' control over their data, i.e., data sovereignty. To minimize barriers to acceptance, data space services, i.e., data space connectors as a service, should be offered as soon as possible. To ensure data use complies with the law, comprehensive security measures should be taken to identify and eliminate vulnerabilities, especially to prevent data misuse.

"The decisive factor for the success of a data space is the combination of a decentrally networked technical infrastructure with a fair organizational-legal framework, moderated by a neutral actor, and the development of a dynamic ecosystem." (E01)

The experts also advocate starting with concrete use cases. This includes identifying and implementing practical use cases in data spaces that can demonstrate tangible benefits and build trust. The focus should be on demonstrating real-world benefits rather than relying on overly broad or complicated approaches. In this way, the potential of data spaces can be quickly grasped, and collaboration across organizational boundaries becomes more attractive. Consequently, interest in building a trusted infrastructure also increases. A trusted infrastructure involves not only sharing data within the organizational ecosystem, but also collaborating with like-minded partners. Such collaborative efforts within data spaces can yield strategic benefits and drive innovation in the evolving landscape of the data economy. As highlighted by expert E16, the establishment of data spaces should be accelerated by initiating specific use cases that are implemented at a smaller scale.

"I believe that the point is to actually underpin the benefits that such data spaces offer as concretely as possible, i.e., to start with use cases that are as concrete as possible, which will then hopefully also be implemented somewhat faster than something generic." (E16)

The recommendations aim to create a secure environment that promotes a decentralized infrastructure while ensuring security, privacy, and trust. Maintaining data sovereignty, particularly control of data access, can be most effectively achieved through a decentralized infrastructure. Within a data space, participants should focus on maintaining a trusted ecosystem. Improving data integration within the organization and data spaces creates a solid foundation for decentralized data sharing. This decentralized environment fosters collaboration, encourages active engagement, and increases data transparency. Active participation in small-scale standardization processes and pilots ensures compliance with established domain requirements and legal standards. In the broader context of technological sovereignty, a trusted data infrastructure enables the establishment of data spaces for robust collaboration among stakeholders and thus data sharing.

Interoperability

The term "interoperability" refers to the seamless exchange, integration and understanding of data between different systems, i.e. data spaces, participants and data. Data spaces are currently implemented as independent, self-contained stand-alone solutions. Experts have pointed out that interconnection of data spaces is important for cross-domain data spaces or a federated ecosystem, i.e., the European single market for data. Interoperability should ensure the success and effectiveness of data spaces in the data economy and increase data availability. Therefore, early networking efforts between data space initiatives from a given domain must be prioritized. In this area, fundamental challenges have been identified in terms of actively collaborating with other initiatives, promoting interoperability between data spaces, and connecting with data spaces from neighboring domains. However, there are currently several approaches to implementing data spaces. The resulting challenge of a lack of convergence through individual technological implementations is explained by Expert E12.

"Another major topic is that there are blockchain-based approaches in this Ocean Protocol, the Gaia-X architecture, the IDS architecture, and there is an initiative or an association of organizations with the Data Space Business Alliance. They want to create a certain convergence and are working intensively on it. But as long as this convergence is going on and it's not really clear what it's about. For people who want to start developing, there are still a few uncertainties and risks as to which technologies or how the technologies will develop further in this large architecture. But what that looks like is not quite certain, and at the moment there are still several technology options that you can rely on. And that's perhaps also a reason why people are still waiting." (E12)

During the discussions, experts emphasized the importance of promoting the interconnectedness of data spaces by ensuring their interoperability and underscored the need to actively network with other initiatives such as Gaia-X, IDS, and the Data Space Business Alliance Initiative to establish clear direction and standards within these wide-ranging architectures. Thus, it became clear that stakeholders should actively work on the convergence of decentralized blockchain-based approaches and more centralized architectures. To increase simplicity and security while avoiding vulnerabilities, they advocated for establishing simple rules that prioritize certain technologies and standards, rather than trying to integrate all options, which would accelerate the achievement of interoperability between data spaces. Collaborative efforts and common guidelines for the adoption of data space technologies were seen as a means to reduce uncertainty for organizations, enabling them to initiate projects with minimal interface complexity. The goal was to facilitate effortless communication between organizations involved in data spaces and to promote interconnectivity and compatibility within or between different domains. Central to this effort has been the essential role of standardization in data spaces, which includes the coordination of standardized interfaces and data sharing protocols. Adopting these standards would simplify interactions with different organizations in data spaces and eliminate the need to create separate, proprietary interfaces for each data space participant. Overall, standardization was seen as a means of streamlining complexity in data spaces that promotes collaboration across value chains, as emphasized by Expert E07, who highlighted the fundamental benefits of standardized connectors and services to facilitate data sharing across data spaces.

"I have to commit to this standard once and then I don't need 100 interfaces to any organizations. I don't need to check 100 of my own identities with the organizations, because someone has already done that out there. I can take over and use a lot of things and don't have to program a new crutch or do anything else to get the data there when I exchange data with every organizations." (E07)

In addition to the technical adaptation of the data spaces, the experts emphasized the importance of simplifying data use by establishing data standards that enable users to easily derive value from the data. This should take into account the different data formats in each area and the need for standardization and annotation across all areas. To address common challenges, strategic partnerships or networks, i.e., associations, should be used to improve data interoperability. Joint initiatives can engage stakeholders to make data work by identifying needs and aligning data standardization. Collaboration with organizations that have relevant expertise should support data format standardization and data annotation practices, i.e., for a commen ontologie. However, a balanced approach was recommended, emphasizing pragmatism and flexibility, and prioritizing immediate action over waiting for comprehensive standards, so that organizations can establish internal standards while leveraging proven technologies and integration services for efficiency and flexibility. Nonetheless, in promoting data convergence, the importance of standardization was emphasized to facilitate the development and widespread establishment of data standards and ultimately improve data interoperability, as expert E15 pointed out.

"The most important things would be to promote the standardization of data, formats and the way in which data is annotated. This could be achieved through targeted support programs and by strengthening the relevant organizations that already have the know-how and could provide it, so that more data standards are developed and also used. This would be very important for the interoperability of data and data spaces." (E15)

Enabling connectivity between data spaces and promoting interoperability serve to prevent the isolation of data in silos, with the goal of unlocking the full potential of data sharing for stakeholders. By collaborating with other initiatives, valuable insights and synergies can be leveraged. This will improve the decision-making process for setting standards in data spaces that embrace the convergence of technologies, services, and data. Flexibility in the use of data spaces is essential to take full advantage of their benefits. Standardization that unifies and standardizes practices creates a level playing field in the data economy and promotes cross-organizational data use within data spaces.

Governance

The term "governance" refers to the legal and factual regulatory framework for data spaces. Previous attempts at cross-organizational data sharing have been criticized due to problems related to interdependence and restrictive regulations (e.g., antitrust, privacy). Therefore, it is recommended that data spaces establish a consensus-based governance framework for cross-organizational data sharing. Thus, collaboration among stakeholders should be fostered through equitable and inclusive mechanisms that serve the interests of all stakeholders in neutral, federated data spaces. However, clear governance and regulations should eliminate confusion and disputes over issues such as data ownership, usage rights, and responsibilities within data spaces and build trust. Expert E28 succinctly described the challenge posed by the lack of trust among participants as follows:

"Then, the trust position must adapt to each other. After all, these are multi-layered. So not every data space is such that every participant is equally trustworthy per se. Another complex that arises there." (E28)

Expert discussions have underscored the need for clear and simple rules for data sharing within data spaces. To build stakeholder trust in data spaces, it is critical to develop and implement transparent and straightforward rules for data sharing. Establishing transparent and inclusive governance mechanisms is critical to maintain data sovereignty, enable data monetization, define access rights, and ensure security, with the active participation of all stakeholders. Clear delineations of roles and responsibilities, combined with the necessary autonomy and resources, should be established to facilitate effective operations. These rules should increase the transparency of activities within data spaces and eliminate ambiguities or uncertainties that may arise from legal frameworks, such as the General Data Protection Regulation (GDPR), the EU Data Protection Act, or the German Mobility Data Act. In addition, discussions are focused on creating a streamlined governance framework for data spaces that builds trust among participants while addressing regulatory concerns to prevent excessive regulation, such as dual-use technologies or antitrust. Reducing uncertainty within data spaces should encourage the use of data across organizations. Governance should embed these principles in the infrastructure and enable participants to actively engage in standardization and regulatory processes, which is consistent with the findings of Expert E01.

"The basis for sharing data is trust between data providers and data consumers. To achieve this, it is important, on the one hand, to anchor the prerequisites in the infrastructure and, on the other, to be actively involved in standardization and regulatory processes." (E01)

The need to promote a multi-layered approach to regulation and to create a governance framework that incorporates regulatory boundaries was noted. For example, intra-domain data transfer has been prevented due to antitrust concerns. Excessive regulatory oversight has hindered cross-organizational data use. In this context, data use policies, i.e., data access, data anonymization, and data privacy, need to be adjusted. Regulatory regimes, e.g., the General Data Protection Regulation (GDPR), should be based on commercially oriented guidelines to build trust in data sharing in data spaces and ensure both departments and organizations handle data responsibly and in compliance with the law. To facilitate cross-border data sharing, promoting legal interoperability is essential. Participating in data protection harmonization initiatives removes barriers and promotes seamless collaboration. Legal aspects, including data anonymization, should be included from the outset in initiatives such as GAIA-X Hubs and Data Space Support Centers to ensure that legal aspects are considered alongside technological aspects. In addition, the creation of a governance framework, particularly for initiatives such as the Digital Product Passport or the Supply Chain Act, provides clear

guidance on data sharing and collaboration and enables companies to realize the full potential of data spaces. Encouraging the development of legislation such as the EU initiatives, including the Digital Services Act, the Digital Markets Act, the Data Governance Act, the Data Act, and the AI Act, aims to promote data sharing. To address the unique challenges of dual-use goods, i.e., data in data spaces, export control regulations should be reviewed and adjusted to ensure they facilitate digital collaboration without creating unnecessary barriers. In addition, it is important to address intellectual property concerns, as noted by expert E25.

"I think that when we talk about data spaces now, we have to take another critical look at such regulations. … At the moment, there are already very general regulations that create many obstacles to the use of data spaces. So I think this is an important topic. The authorship of data and the intellectual property involved are also appealing. I think there are many things that need to be worked on in order to really achieve better data transparency." (E25)

Data space governance includes measures aimed at improving governance within data spaces to facilitate data sharing. It also addresses the legal aspects, taking into account the historical legal challenges that have hindered cross-organizational data sharing, including complex regulations such as antitrust and privacy laws that have hindered collaboration. The proposed recommendations aim to foster collaboration among stakeholders and create a neutral environment for cross-organizational data use. Further governance development should support responsible data sharing and value creation within data spaces. By implementing clear governance and regulatory provisions, potential disputes regarding data ownership, usage rights, and responsibilities can be effectively resolved, ultimately building trust in the data space ecosystem.

DISCUSSION

Our goal was to develop recommended actions for data spaces associated with challenges. Using 28 qualitative interviews and coding techniques based on grounded theory (Glaser, 1992), we identified four categories and described recommended actions for data spaces. These findings are an important contribution to understanding this complex topic and help to promote the further development of data spaces. The challenges we identified were both technological and socio-organizational. Collaborating with existing initiatives, promoting interoperability, and establishing governance mechanisms within an infrastructure help establish a federated data space ecosystem. Prioritizing the establishment of data spaces for federated data sharing will strengthen data sovereignty for owners. Technological challenges include building a infrastructure and connecting it through interoperability. In addition, the environmental recommendations for action focus on building active communities and establishing appropriate governance mechanisms for data spaces. As data spaces are still at an early stage of development, initiatives face significant challenges (Gaia-X Hub Germany, 2023). Nonetheless, organizations are looking for opportunities to build digital competencies, i.e. data sovereignty (Moschko et al., 2023).

The environmental aspects relate in particular to challenges that have existed in connection with cross-organizational data sharing (Fassnacht et al., 2023; Gelhaar et al., 2023; Jussen et al., 2023). For example, when sharing data between organizations, tensions exist around data sovereignty and organizational and business model (Jussen et al., 2023). Specifically, there is still a lot of untapped potential in the area of business models for sharing data in data spaces (Bub, 2023). Therefore, in order to make business models successful, aspects such as trust in partners, transparency, and the desire for security must be taken into account (Schweihoff, Jussen, Dahms, et al., 2023). Regrettably, organizations are often skeptical about data sharing due to different barriers (Heinz, Park, et al., 2022). Specifically, barriers for data sharing include strategic, operational, technological, cultural, and regulatory perspectives (Fassnacht et al., 2023). Data must be shared more widely to fully realize its potential for innovation and value creation in the data economy (Winter et al., 2022). Data ownership can be strengthened by establishing appropriate governance frameworks (Gelhaar & Otto, 2020; Lee et al., 2017; Lis & Otto, 2020, 2021). Such frameworks can address concerns about data misuse and create a fair playing field for all stakeholders (Lawrenz & Rausch, 2021). Trust and legal certainty are essential to increase willingness to share and use data in a digital single market (Brost et al., 2018). The recommendation to promote a data-friendly legal framework aims to strengthen data sharing in decentralized data spaces in the data economy (Arnold et al., 2020; Fischer et al., 2023). The goal of the collection movement, which focuses on connecting actors to foster communities, i.e, ecosystems (Gelhaar et al., 2021). Specifically, to raise awareness of the value of participants data (Geisler et al., 2022; Gelhaar & Otto, 2020).

The other two recommendations for action focus on the technological aspects of data spaces (Siska et al., 2023). Establishing a trustworthy infrastructure for data sharing is of central importance (Otto, 2022a; Schleimer & Duparc, 2023). A decentralized data platform alone is insufficient to ensure responsible data governance (Torre-Bastida et al., 2022). Interestingly, specific design knowledge is required for the construction and design of data infrastructures (Schleimer & Duparc, 2023). Further, technological data space solutions must be developed to ensure this (Jarke et al., 2019). Research in data spaces was initially focused on developing solutions for integrating heterogeneous data sources (Franklin et al., 2005). However, due to the increasing importance of cross-organizational data sharing, there has been an increased focus on secure data sharing in recent years (Hutterer & Krumay, 2022). Governance has taken on greater importance in defining data spaces (Hutterer et al., 2023). A data space is seen as an opportunity for data users to make self-determined decisions about data use, which contributes to increased data transparency and the associated potential for value creation (Beverungen et al., 2022; Curry et al., 2022; Otto, 2022b). Policy initiatives in Europe are advocating for the development of a data infrastructure based on shared values and standards among stakeholders (Lewis, 2023; Minghini et al., 2022). Uniform standards and specifications must be established to attract a broad range of participants (Siska et al., 2023). The technology used must meet the requirements for trustworthy data sharing (Scerri

et al., 2020). The current challenge is to ensure data sovereignty, as existing technologies do not allow adequate control over the data once it leaves the possession of the data owner (Chowdhury et al., 2020). In this regard, the role of intermediaries for varius data services becomes more important (Schweihoff, Jussen, & Möller, 2023). For this reason, it is recommended to support further data space projects testing different architectures and design options (Gieß et al., 2023; Schleimer et al., 2023). Existing data spaces (Steinbuss et al., 2023), such as the Mobility Data Space (Mobility Data Space, 2023) or Energy Data Space (Energy Data Space, 2021) take a hybrid approach, whearears HEALTH-X (HEALTH-X, 2023) is decentralized (Gieß et al., 2023). In addition, the connection of individual data spaces is necessary to prevent the formation of isolated data space silos (Abbas et al., 2022). The European Commission is committed to creating a single European market for data through initiatives such as the Data Strategy (European Commission, 2020). To this end, early networking between data spaces as a data marketplace is essential (Abbas et al., 2023). Technological solutions need to be developed to ensure interoperability between different data spaces and enable access to a wide range of data (Hemid et al., 2021). Current research initiatives are investigating the interoperable design of data spaces to form a common ecosystem (Solmaz et al., 2022). Connecting data spaces in specific areas, such as mobility (PrepDSpace4Mobility, 2023a) or industry (Data Space 4.0 Alliance, 2023; Plattform Industrie 4.0, 2022), aims to address where organizations expect to add value and increase competitiveness by participating in a data space (Marko et al., 2023).

This research provides valuable insights for various data space projects (Mertens et al., 2023; Steinbuss et al., 2023). In fact, the future of value creation lies in data-driven value networks, leading to the emergence of cooperatively operated data spaces (Plattform Industrie 4.0, 2023). The development of digital literacy is necessary to promote significant growth in the data economy (acatech – National Academy of Science and Engineering, 2023). The outlined action recommendations provide an overview of the necessary steps to establish data spaces successfully. Participants in the design of data spaces can adapt their approaches based on these recommendations for action, promoting the acceptance and adoption of data spaces. Our research helps improve the current state of knowledge about data spaces by identifying challenges, discussing recommended actions, and suggesting measures that positively influence adoption.

CONCLUSION

The concept of data spaces is of interest in both science and business. However, there is currently a lack of comprehensive implementations in practice. We conducted qualitative interviews to gather expert perspectives and formulate recommendations for action for data spaces. The interviews resulted in several recommendations for action to progress data space adoption in four categories. Our study not only provides the basis for future initiatives but also contributes to a better understanding between researchers and organizations by identifying possible approaches and going beyond technical aspects. We thus create a basis for further research on the concept of the data space itself and the acceptance of and participation in data spaces.

The recommendations for action derived from our study provide a solid foundation for stakeholders to strengthen the use of data spaces. Although there is not yet a comprehensive body of knowledge in research on the use of data spaces, the insights gained from the expert opinions can be informative. The different recommendations for action, such as building a decentralized data infrastructure and strengthening awareness for data sharing in organizations, highlight the interdependence of these efforts. It is essential to consider the different areas of action simultaneously. The synergistic benefits offered by data spaces only occur when organizations make a cultural shift and implement strategies to improve data literacy for increased data transparency and availability. Nevertheless, data space initiatives rely on the individual needs of participants and the specific requirements of their respective domains. This requires careful consideration of the degree of autonomy and control of data space participants, considering the varying degrees of willingness to share data across and within data spaces. For perspective, regulatory requirements should encourage all participants to disclose data. For future research, it is crucial to analyze the positive aspects of value creation and innovation generation through the strategic use of data.

Despite the fundamentally sound and targeted recommendations for action discussed in this article, the experts leave numerous questions unanswered, resulting in the need for further research. Although the qualitative study presented here does not include a comprehensive survey of the experts' opinions, some of the highlighted recommendations for action are too abstract and generally formulated to be directly implemented in practice. The experts only give vague indications of suitable technical measures to effectively control and monitor data sharing within the data space without taking legal requirements into account. The calls for more organizational action raise the question of how to meet the demands for increased data transparency and expanded datasets. Due to increasing competition, each organization must decide how to achieve these goals to succeed in the global data economy. Data spaces offer a path to achieving data sovereignty while empowering digital literacy. Consequently, interesting research questions remain open in the field of data spaces, from which valuable and concrete recommendations for action can be derived for corporate practice. In addition to the question of the interactions between data sovereignty and data transparency, further research should examine the opportunities and risks of new technologies.

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