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Tensions in Inter-Organizational Data Sharing: Findings from Literature and Practice

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Abstract—Inter-organizational data sharing is a powerful engine required for driving the data economy. However, a major issue in research and practice remains overcoming barriers, such as a lack of trust preventing data sharing from penetrating all levels of business and fully exploiting its potential. Given the interplay of generating value from shared data and the barriers one needs to overcome, those wanting to share their data must balance what motivates them (incentives) and what hinders them (barriers) and solve the resulting conflicts (tensions). Solving these tensions enables organizations to make informed and sensible decisions on how to share data. Since sharing data has become more prevalent in research and practice, our paper tackles precisely that issue. We explore emerging tensions in inter-organizational data sharing using data generated from a systematic literature view and qualitative expert interviews. We complete our research with workshops to supplement the results and validate them.

Keywords— Data Sharing, Tensions, Incentives, Barriers

I. INTRODUCTION

The steadily increasing amount of data produced in industry and society is a highly relevant source for creating new business potential. The volume of data within Europe was 33 zettabytes in 2018 and is predicted to rise to 175 zettabytes by 2025 [1]. Political as well as management studies highlight that sharing this data among companies is a pivotal instrument to predict and achieve business success in the data economy (e.g., [2]). Data sharing requires organizations to overcome various barriers, such as breaking down data silos or generating trust between data providers and data consumers [3, 4]. One tangible example is sharing data in the health sector resulting in more extensive databases for making more accurate diagnoses and treatment plans, ultimately improving patient care [5]. Another example is improving crop yields through services based on shared data in agricultural data spaces [6]. These examples highlight the versatility data sharing entails and illustrate the range of opportunities it can bring, such as creating new business value and being used in scenarios related to sustainability and the public good [7].

While data sharing, per se, is not something new, technological progress in recent years has made data sharing possible on a seemingly unlimited scale and shifted the view from a ‘simple’ technical process to a complex socio-technical activity (e.g., [8]). To leverage this potential, many initiatives strive to support inter-organizational data sharing on different levels. For example, *GALA-X* is explicitly dedicated to helping the formation of data sovereign data ecosystems in a broad spectrum of industries, such as agriculture or manufacturing [9]. Another example is the *Catena-X Automotive Network*,

which is dedicated to constructing a data ecosystem tailored explicitly to the Automotive industry, including Original Equipment Manufacturers (OEMs), as well as suppliers and other actors (e.g., IT services) along the supply chain [10]. The European Commission is currently funding a project that supports initiatives in designing data spaces, e.g., by accumulating design knowledge on a wide variety of issues, such as legal frameworks or design options, called the Data Spaces Support Centre [11]. All these initiatives point to a common goal: solving emerging problems through effective and secure data sharing and overcoming barriers.

Recent studies have found that there are still a variety of technical, legal, organizational, and business barriers hindering efficient inter-organizational data sharing [3, 4, 12]. Complementarily, we can report from our analysis of the literature as well as an expert interview study in the field of data sharing that our findings mirror those found in the literature. These barriers stand against various incentives that motivate stakeholders to engage in data sharing. For example, while it seems plainly evident that data sharing can generate new business opportunities, it is often unclear what exactly those are and how they can be leveraged in practice (e.g., [3]). Resulting, we see *tensions* arising between those factors that incentivize data sharing against those barriers that hinder them. The paper starts precisely at this point since we set out to conceptualize the resulting tensions for data sharing as a product of opposing incentives and barriers. We identified Privacy Calculus Theory (PCT) as a suitable *theory for explaining* (e.g., [13, 14]) the underlying interplay of incentives, barriers, and the resulting tensions for three reasons [15]. First **(1)**, while the theory is historically embedded in personal decisions on a consumer level, it dedicatedly deals with finding a balance between benefits and risks in sharing data. Second **(2)**, it is highly potent in transferring the basic premise of inter-organizational data sharing since the constructs perfectly match the typical incentive and barrier structure of inter-organizational data sharing (e.g., [4, 16]). Third **(3)**, resolving the existing tensions between incentives and barriers is, naturally, a product of weighing benefits and risks, which is precisely what PCT promotes and explains. For example, Bélanger *et al.* [17] and Majumdar and Bose [18] explain the conflicting risks and benefits that one has to weigh when deciding to share data. Because of the above, we pursue the following research question: *Which tensions result in the interplay of incentives and barriers in inter-organizational data sharing?*

In order to tackle the research question, we pursue a threefold research strategy, consisting of a **(1)** systematic literature review, **(2)** interviews with experts from the field,

and (3) evaluation workshops with knowledgeable experts in data sharing. We do this to triangulate and validate our findings from multiple perspectives and include the knowledge from the literature and the field. The paper is structured as follows. After the introduction, we present the relevant theoretical background outlining the fundamentals of data sharing. Section 3 details our research design. In Section 4, we report our findings and critically discuss them in Section 5. Finally, Section 6 summarizes the contributions, limitations, and further research needs based on our findings.

II. BACKGROUND

A. Data Sharing

As of now, data sharing as a research phenomenon lacks a unifying definition and is instead defined somewhat blurry through intermixing other terms, such as *data exchange* [8]. Instead of simply being a technical transfer of digital data, we find it is a socio-technical, complex activity requiring multiple levels of consideration that come in different forms. For example, Nokkala *et al.* [19, p. 2] define data sharing “*as an exchange of data between different stakeholders, and when happening on a platform,*” explicitly referring to exchanging data through a platform and considering different actors. Data sharing can be implemented with data marketplaces to grant actors outside of one’s own company elective and conditional access to data [20–22]. The European Commission [23] focuses on the compensatory aspect of data sharing, i.e., either sharing it free of charge or by different ways of monetization, such as financial compensation or against data-based services.

An additional angle is analyzing data sharing from another point of view, such as *business models*. In this regard, data sharing business models are a subset of data-driven business models focusing explicitly on the ‘sharing’ elements, requiring distinct consideration of incentive mechanisms or security in data sharing [24]. Recent publications show that data sharing can be the basis for a variety of new business and societal improvements across sectors and a wide range of application areas, such as the health sector [25], supply chains [26–28], education [20] or the food industry [29, 30]. These domains represent examples, whereby it should be noted that data sharing, generally, is detached from the domain or application context [31].

The examples above illustrate how multi-faceted the concept of data sharing is. It is not only a technical process but includes many issues, such as data access or the development of new business models. Data sharing is further complicated through new legislation, such as the Data Act (DA) or the Data Governance Act (DGA) [1, 8, 32]. This legislation is set to mandate some aspects of data sharing, such as installing trusted data intermediaries that must be neutral stakeholders. Additionally, legal agreements can be defined between data providers and data receivers in agreements generally focusing on the conditions under which data is shared. At the same time, usage contracts deal with the issues of access and usage control [33].

B. Tensions, Incentives, and Barriers

To conceptualize the interplay of incentives and barriers to data sharing, we draw from PCT. Since the theory proposes a model to weigh the benefits and risks of sharing data for individuals, we only draw from the core logic because it explains what we experience in practice with organizations very well [15]. Even with the focus on personal data, one can

argue that companies face similar decisions: to share or not to share data based on weighing various benefits and risks (e.g., [3, 16, 34] 3, 16, 34). However, there is some research applying PCT to the organizational context. Sugumaran *et al.* (2016) apply PCT, among others, to the technology ‘*Internet of Things*’ and the perception of companies of benefits and risks. In our work, we adapt PCT to the standard constructs of inter-organizational data sharing. Subsequently, we position benefits as *incentives* (e.g., [16]) and risks as *barriers* (e.g., [3]). In the following, we will outline all three constructs, tensions (1), incentives (2), and barriers (3) (see Fig. 1).

Tensions are paradoxical phenomena resulting from a dyadic perception of “two sides of the same coin” [36, p. 761] and are defined as “*a situation in which the fact that there are different needs or interests causes difficulties*” [37]. They are the contradictory embodiment of these two sides, which are logical independently, but paradoxical when combined [38]. Consider the following case, which is very typical for data sharing (e.g., [3, 4]). An organization wants to share data and get data back in return. The data can be used to make processes in a supply chain more transparent (incentive). However, the barrier then arises when the organizations enter into a transaction. Either the data must be compensated monetarily or by an equivalent trade (barrier). Since data valuation is anything but trivial, this results in a field of tension. The added value on the one hand versus the unclear value of one’s data and that of the other on the other. Recent papers look at the issue of tensions from different angles regarding the use of data as an elementary resource. For example, Lauf *et al.* [39] investigate tensions that arise in the context of linking data sovereignty and data economy in using personal data. Other papers show how versatile the term *tensions* is used, including the tensions in sharing and protecting health data [40], tensions in creating value through big data [41], and tensions in developing business models for digital platforms [42].

Incentives imply “*something that encourages you to do something*” [43] and “*something that incites or has a tendency to incite to determination or action*” [44]. Gelhaar *et al.* [16] propose a taxonomy of incentive mechanisms for data sharing in data ecosystems, outlining potential incentives actors can have to share data. They illustrate a key aspect of incentives in that they are not merely monetary compensation but also include the mutual exchange of data or services. Stepanovic and Mettler [45] refer to financial incentives that insurance companies, for example, use to motivate their customers to share data.

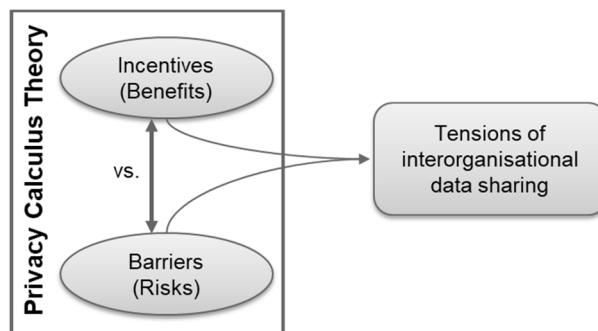


Fig. 1. PCT applied to inter-organizational data sharing terminology guiding our research.

A barrier is defined as “*a problem, rule or situation that prevents somebody from doing something, or that makes something impossible*” [46] or “*a circumstance or obstacle*

that keeps people or things apart or prevents communication or progress” [47]. Looking at the broader literature on the use of the term barriers in the data context, we see a few publications on this topic. Cranfield *et al.* [48] and Hjalmarsson *et al.* [49] explore barriers to using Open Data. Dremel [50] investigates barriers to introducing big data in the automotive industry. Fassnacht *et al.* [4] address the barriers to data sharing between private-sector organizations.

III. RESEARCH DESIGN

We use a multi-level research design (see Fig. 2) to answer the research question above. In addition to an in-depth literature review and interviews to develop a foundation, it includes workshops to expand and evaluate the findings.

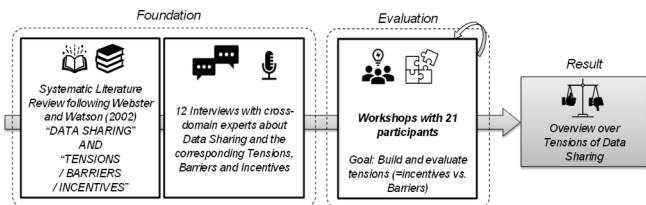


Fig. 2. Overview of the Research Design

A. Phase 1: Extracting Incentives, Barriers, and Tensions from the Literature Corpus

The literature review was carried out using keywords in various combinations of the terms “data sharing” AND “tensions/barriers/incentives” in the AISel and Scopus databases, considering the VHB ranking for Information Systems (IS) research [51]. We delimited that search strategy since it enables us to focus on quality, peer-reviewed papers from the domain we are primarily researching, which is, IS research (e.g., *ECIS*, *ICIS*, *Electronic Markets*, *Decision Support Systems*) [52]. In the first iteration of the literature review, we checked the papers to see whether their title and abstracts fit our research scope and whether they were written in English. As a result of this iteration, we selected 48 papers. During the second iteration, we searched through all the papers and looked at the extent to which they contained information on data sharing tensions, barriers, and incentives. Resulting is a corpus of 17 papers for deeper analysis. While we focused on inter-organizational (B2B) data, we also analyzed papers dealing with personal data and B2C scenarios. We did this to account for potential issues that might also be relevant in the organizational context and installed the workshops and interviews as a filtering mechanism for B2B relevancy. Subsequently, the experts can mitigate for us if tensions, barriers, or incentives in personal data are (partly) transferable to the organizational context. In the papers, we did not only restrict our analysis to tensions, barriers, or incentives but also included synonyms. For example, we also looked for *problems*, *risks*, *concerns*, or *challenges* counting as barriers. For incentives, we also looked for *benefits* or *solutions*. The literature review did not focus on a specific domain but looked broadly, including diverse domains, such as healthcare (e.g., [25]), automotive (e.g., [53]), and the food industry (e.g., [30]). Similarly to the context of personal data, we opted to go into the field with the most comprehensive picture possible and narrow it down with the experts. We analyzed the literature following a concept-centric approach [54], extracting statements relevant to the study (see Table 1 for examples).

TABLE 1. EXAMPLES OF THE LITERATURE ANALYSIS.

Literature Statement	Coding
„Data sharing can allow organizations to access complementary data sources and help them develop innovative applications and services” [25, p. 303].	Access to complementary data sources (incentive)
“Similarly, it is not clear who is liable in the case of data misuse. The strict procedures by the review board aim to prevent any misuses (...)” [55, p. 7].	Data misuse, lack of control (barrier)

B. Phase 2: Collecting and Reaffirming Incentives, Barriers and Tensions from an Interview Study

We conducted an interview study with informants knowledgeable in inter-organizational data sharing to both triangulate and extend the findings of the systematic literature review. The interview can be used well in research to look more closely at the experiences and views of an individual or group on a particular topic [56]. We found this to be a sensible strategy since the literature corpus on inter-organizational data sharing is relatively small to date. Our sampling process was as follows: **(1)** The informants had to be familiar with data sharing on a day-to-day basis, **(2)** work in a data sharing initiative either as an orchestrator or as part of a company being a user, and **(3)** have extensive knowledge to report on the peculiarities of data sharing. This ensured that each informant had the relevant knowledge to contribute to investigating our shared phenomenon, which is *inter-organizational data sharing* [57]. In total, we interviewed 12 informants from European data sharing initiatives reporting on 14 data sharing cases from Germany, Netherlands, France, Italy, Portugal, and Switzerland. The data sharing cases included early to mid-stage data spaces (i.e., technical infrastructure to share data) and large-scale live data sharing initiatives, both public and private. More precisely, we conducted semi-structured interviews enabling the informants to draw flexibly from their rich experiences [58]. Using the interviews, we planned to confirm and, if necessary, extend the findings from the literature review. Each interview took between 50 to 60 minutes, resulting in over 10 hours of transcribed material on the workings of data sharing initiatives, incentives, and barriers. After the initial interview round, we reaffirmed our findings in a session of about 20-30 minutes each with nine of the twelve informants and received written feedback from another.

C. Phase 3: Finalizing Tensions of Inter-Organizational Data Sharing in a Workshop Series

Based on the interviews and the findings from the literature, we constructed the first set of tensions through logical aggregating of incentives and barriers that stood against each other. We did not do this in a vacuum since both the literature and the interviews indicated fields of tension. However, to further refine our findings and make them as robust as possible, we invited knowledgeable experts to a workshop series, helping us to validate the tensions we had found and match incentives and barriers to tensions on their own. Holding a workshop seemed sensible for us since it allowed for a more creative and interactive room for the purpose of finding tensions and potential solutions for them in a shared problem setting [59]. Subsequently, we aimed to conjointly develop a result rather than hold formal interviews again [60].

TABLE 2. OVERVIEW OF THE WORKSHOP SERIES.

	Participants	Execution
1	Two members of large-scale, long-established data space in the manufacturing industry are organizing data sharing today	Digital
2	One project lead in a large-scale industry-driven data space working on secure inter-organizational data sharing	Digital
3	Two members of an umbrella organization for data space design enabling inter-organizational data sharing	Digital
4	16 members of a research project dedicated solely to incentives mechanisms for data sharing	In Person

In this type of workshop, on the one hand, it is essential to fulfilling the participants' expectation of showing a link to their interests. On the other hand, this workshop method aims to pursue an explicit research purpose and thereby collect reliable and usable data for a specific area [59]. We implemented the workshops using Miro.¹ as a digital working space, as well as a printed version for one live meeting. Each workshop had two tasks for the participants. First (1) to match incentives and barriers presented to them and find tensions as well as potential solutions, and second (2) to either agree or disagree with those tensions we had developed as a research team. In both cases, the participants were free to add incentives if they thought something was missing. Table 2 shows an overview of the workshop series. In the workshop series, we successively incorporated and iteratively adapted the knowledge.

IV. FINDINGS: TENSIONS IN INTER-ORGANIZATIONAL DATA SHARING

Our starting point for conceptualizing tensions for inter-organizational data sharing is to understand what *motivates* stakeholders to share data in the first place. We find that there is a great variety, reflecting the blurriness of the issue in practice, which starkly contrasts with widespread recognition of the importance of data sharing. We will go through these incentives (and later barriers) in no order of merit.

A. Incentives of Inter-Organizational Data Sharing

A pivotal advantage of sharing information is uncovering something that you do not already know. Inter-organizational data sharing is reflected by the incentive to **enhance inter-organizational transparency** e.g. with supply chain stakeholders [55]. Referring to similar examples, we see a push toward fostering transparency for sharing data in other domains, such as in research [61]. From our interviews, we find that inter-organizational data sharing is a pivotal component of an efficient supply chain that enables them to work in the first place. For example, one interviewee highlighted that data sharing helps to

“(...) anticipate bottlenecks sooner, can detect deviations and initiate countermeasures in time and minimize costs (Interview 11).”

The interviews brought to light a central incentive for data sharing, which is to **optimize (i.e., automate and digitize) existing business processes**. The literature also mirrors this.

For example, Sarathy and Muralidhar [62] name this as the core activity of data sharing. This optimization is not exclusively facing inward but also includes those processes interfacing an organization with its customers.

“(...) improve the services to our customers and adding value using data for the customer. Internally, to improve our processes and lowering costs on using the data (Interview 12).”

From another interview, we extract the incentive to **be a part of growing ecosystems**. While this incentive somewhat lacks concreteness, it reflects companies' pressure to engage in data sharing initiatives. Simply put, they have a sense to 'not be left out' or 'miss anything.' The ultimate goal is to join this ecosystem to realize positive development from a current or future and potentially participate in scalability effects emerging from a successful ecosystem. These new services represent new business opportunities for the companies. Besides new collaborations [61], these also include differentiation from market competitors [30]:

“Being part of this catalog is even for private and public players an opportunity of brand awareness [...] and from this point of view is a way to create even business relationships with other players because related to the ecosystem is not receiving a very effective communication activity (Interview 7).”

An organization's natural incentive is to find new ways to **generate new business value** from shared or received data. More precisely, finding and realizing financial rewards (i.e., data monetization) is a particularly prominent incentive to share data [16, 53, 63]. Naturally, the idea of generating new revenue from data is tightly coupled with the incentive to **develop new business models and services** and innovative applications or services for the end consumer [25, 30, 61, 64].

„Data sharing can allow organizations to access complementary data sources and help them develop innovative applications and services.” [25, p. 303].

Another incentive to engage in inter-organizational data sharing is the ability to **define and set data sovereignty policies** of data usage of data providers and the **pseudonymization and encryption of the data origin** [21, 31]. Data sovereignty varies depending on where it is applied. Suppose one needs to define usage policies for personal data as opposed to data for supply chain data. Naturally, there are differences in complexity and content relevant to both particular scenarios [25]. van den Broek and van Veenstra [55] point out that the regulation of aspects such as data governance depends on the type of data sharing, for example, whether there is a central actor (pooled) or the data is shared mutually between all actors (reciprocal). Similar statements were made by the interview partners:

“They decide with whom to share data (...) There [are] strict rules and mechanisms to ensure that the data sharing is done only on the few data assets they want to share (Interview 9).”

Inter-organizational data sharing is an enabler in **developing new data standards** [31, 55]. For example, one informant reported on large-scale data sharing initiatives with

¹ Reference: <https://miro.com/>

many large companies as stakeholders, which require the standardization of data formats making data sharing possible.

Yes, we are ensuring data quality because, first of all, this data must be in the European standard format. And this standard format is specified by a set of XML schemas data quality here is (Interview 1)."

Through data sharing, organizations obtain **access to complementary data sources** [16, e.g., 25, 30, 64]. These interviews extend this through another dimension: access to algorithms or data-based services, i.e., abstractions generated from underlying shared data. This incentive goes closely with the incentive to not only access complementary services but also **access to better services** based on shared data. An example is that data consumers are offered the option to receive services based on a broader database under the condition they share data themselves, i.e., become a data prosumer and so leverage and sustain community data.

"...make use of that information for all the purposes, but equally as well, [the company] can offer a service so that we also do the specific calculation based on that data for those customers, and they pay for the service and not for the data (Interview 12)."

B. Barriers to Inter-Organizational Data Sharing

A multitude of barriers hinders organizations from engaging in data sharing. Perhaps one of the most fundamental is **missing trust and transparency between actors**, which the literature and interviewees commonly referred to [27, 30, e.g., 53, 65].

"First is the issue of trust in the processing of data so that the organizations, the offices, the people are willing to share data at all (Interview 8)."

A complementary barrier is that data providers have **concerns about retaining control over their data** (e.g., their future use after they have been shared) and, in the worst case, about **data misappropriation**. A typical example is the unintentional or unallowed (i.e., no permission was given) disclosure of data to third parties who did not receive the data from the original data provider [53, 61, 64]. This problem is aggravated by a lack of clarity on who is liable in case of data breaches or data misuse (van den Broek and van Veenstra, 2015). Obviously, actors sharing data have concerns about **data security**, such as the lack of guarantees that the security of their data is upheld [17, 21, 65]. The concern that external third parties can gain unauthorized access to data and thus draw conclusions from it scares off many actors [62].

"Today, it is the case that we at the large, hyper scalers are happy to make our data available or make it available unknowingly or make it available knowingly and do not profit from it and, in the final analysis, do not know what happens to the data (Interview 8)."

An organizational barrier we find that is typical from our experience is **existing data silos**, which are a demarcated set of data or knowledge confined to borders between organizations (or even inside of organizations) [66]. Subsequently, prevailing data silos are a barrier, and breaking them down is a prerequisite for data sharing.

"Accessing different silos, so the concept of data sharing is very important to us (Interview 4)."

Another organizational barrier is existing **moral, ethical, or cultural concerns** that prevent actors from sharing data. For example, Schomakers *et al.* [65] and Vesselkov *et al.* [25] relate this barrier primarily to the sharing of personal data, which can lead to discrimination in the worst case. These types of concerns mentioned above are extended by a distinct barrier in organizations having **legal concerns**, such as the validity of consent mechanisms [55]. This also contrasts legal concerns in personal data, where this is even more complex, such as in the health context (e.g., patient data) [25]. For example, there are a variety of legal concerns intersecting with data sovereignty in data sharing based on the geographical and legislative fields data sharing occurs.

"... and we need to cope not only with European regulation but whereas we are global player we need to adjust with all the local regulation that we are operating in. Especially in China, especially in some countries in North America (Interview 9)."

A significant and typical barrier related directly to the data is **poor data quality** [25, 27, 67]. Data quality issues have a variety of origins, such as actors' inexperience in handling and collecting data (e.g., [30]). Additionally, data quality requirements of data receivers vary based on how the data are used.

"But this is also connected to the fact that companies have different requirements for this data. So, again, the example of addresses. Someone has Chinese suppliers and would like to have them in Chinese, and someone else would like to have them in English with Latin letters [...] you store Munich or München (Interview 2)."

Engaging in the technical sharing of data sharing is hindered by a **lack of know-how** in handling and processing data. Even if data from others are available, some data consumers and data providers fail to evaluate or optimally use the data and its information content due to their lack of technical skills [55, 64].

"Then you need certain technical skills in-house, and that is not always there (Interview 4)."

Three barriers complement the technical view of barriers, which are **missing interoperability, missing standards, and insufficient data availability**. These refer to various technical solutions on the market, instantiated in different IT systems, exchange standards, or the mere availability of data that potential consumers require.

"All these different IT systems that do not talk together were also built in a set certain with a certain purpose wizard analytics (Interview 9)."

Data sharing is an enabler for new business models and generating revenue (e.g., [24]). However, an interesting barrier is that the **specific business value often remains unclear**. This includes an unclear benefit for one's own company [55, 67], the unclear data value itself [16], and the general lack of business models also pose a problem:

"There are certainly companies that want to have less to do with sharing than others and who would also then be prepared to pay more for it (Interview 2)."

Unclear business value is accompanied by **unclear costs of data sharing**. While van den Broek and van Veenstra [55] generally refer to costs Vesselkov *et al.* [25] explicitly name the high integration costs. Gelhaar *et al.* [16] expand this to

include costs that arise from data maintenance or general costs due to time investments.

"I think that's the major blocking issue and especially if you have estimates they simply cannot afford costs of connections, but that's the only way of communicating with the partners and the supply chain with off the self highly scalable as solutions (Interview 5)."

Ultimately, data providers have concerns that sharing data can lead to **competitive advantages** for competitors. Often, the sensitivity of the data additionally influences actors in their concern about a competitive advantage over others [31]. According to Cichy *et al.* [53], existing studies show that high data sensitivity negatively influences the willingness of actors to share data with others:

"The second challenge is, of course, that this thinking in terms of cooperative business models is something that is seen to be relevant and is becoming more and more so, but there is little experience that people are actually prepared to actually share data. There is also a lack of trust between these individual actors (Interview 10)."

C. Tensions in Inter-Organizational Data Sharing

The incentives and barriers represent those elements in PCT that reflect a *perceived benefit* and *perceived risks* that directly influence the decision of a data provider to share data or not. We extracted these tensions from multiple sources. First **(1)**, some tensions already became apparent in the literature analysis and the interview study. Second **(2)**, the team of authors logically aggregated a set of preliminary tensions based on the knowledge we gained in the study. Third **(3)**, we performed four workshops with knowledgeable experts in data sharing (*see Section 3.3*) and let them construct tensions on their own based on the incentives and barriers we found (with the option to extend them) and, in a second task, asked them to assess the tensions we had found earlier. Additionally, we asked the informants to propose management strategies from their experience. *Table 3* lists the incentives, the corresponding barriers, the resulting tensions, and approaches to management strategies potentially mitigating these tensions [42]. We clustered these tensions inductively in three dimensions.

Business Model Tensions: These tensions subsume interplays of incentives and barriers relating to business models as an umbrella concept for economic activity and revenue generation (e.g., [68, 69]). First, the **Data Value Tension** represents the fundamental antagonism between the desire to monetize data and, on the other hand, having a lack of clarity about the value of the data. Naturally, this is problematic since those wanting to share data would be required to find different mechanisms to avoid the feeling of a "bad deal." One management strategy is implementing a swap, which enables sharing of data of perceived (i.e., not objective) equivalence. In this case, the *quid pro quo* principle is applied; thus, no additional data monetization is needed (e.g., between OEMs and suppliers). The unclear value of data also affects the tension **Cooperation Value**. Data and its value depend on the context, and it is not clear to the data provider what value the data consumer can create with the data in terms of new business models and services. In particular, this is important in scenarios of competitors that may collaborate via data sharing but may have unclear implications for the competitive advantage of others. Therefore a management strategy is the introduction of strict usage control policies that regulate

precisely how and for what purpose (e.g., how long) this data may be used. For example, these usage control policies can restrict how long a data consumer is allowed to access data, for what purpose they can use them, who is allowed to access them in the data consumers organization and in which systems they may be stored (e.g., [70]).

The **Service Value Tension** defines a field of tension resulting from the incentive to gain access to better services (e.g., validation of data quality through data based on a community as opposed to just freely available data) against the large barrier of missing trust and transparency or more concretely the unwillingness to share data. In this scenario, from one interviewer, the data consumer must become a data provider to profit from the community's data. One way to solve this issue is to enable the data provider to have strict control over how data is shared (what data, in what form) and start with no direct data sharing or only use updates of data as opposed to sharing the data themselves.

Data Usage Tension compares the incentive of access to new complementary data sources (e.g., data, data-driven services, algorithms) and the barriers of unclear business value as well as the lack of know-how and existing data silos. One management strategy can be to develop different levels of data sharing business models to make it easier for interested actors to get started. For example, one could start by sharing metadata at longer intervals, and these intervals and the corresponding data volumes can then be intensified step by step. Ultimately, entire services can also be offered as part of data sharing (e.g., for predictive maintenance).

Organizational Tensions: The tensions assigned here include the juxtaposition of incentives and barriers between the actors or organizations involved [55, 71]. **Efficiency Tensions** arise when optimizing business processes based on shared data. On the one hand, there are obvious benefits, such as saving costs. On the other, there might be a lack of interoperability in IT systems, a lack of technical know-how, poor data quality, and a general unawareness of the associated cost when engaging in data sharing. One approach to managing this tension is to start with small projects, the "low hanging fruits" (quote of a workshop participant), learning by doing, and extending the scope step by step. Therefore a workshop participant recommended concepts like single-loop learning and double-loop learning that can help improve business processes. One example would be optimizing one specific demarcated business process based on (a small set of) shared data as a use case. One result of data sharing is an activity involving multiple stakeholders needing to find a consensus about which standards to use for data sharing. This results in a

Data Interoperability Tension, which reflects the interplay of the need for standardization to enable data sharing but the barrier of missing common standards and missing interoperability. While this seems paradoxical, it makes perfect sense. In one case, the data sharing initiative consists of many large organizations as stakeholders in one domain, each having its view of standardizing data sharing. Subsequently, the need is obvious. However, the current lack of standards results in conflict since each party naturally wants to push the standards they have been using to this date.

TABLE 3. INCENTIVES, BARRIERS, TENSIONS AND MANAGEMENT STRATEGIES IN INTER-ORGANISATIONAL DATA SHARING

	Incentive	Barrier	Data Sharing Tension	Approaches to management strategies
Business Model Tensions	Data monetization	Unclear business value, Unclear costs of data sharing	Data Value Tension: Organizations want to create new business value from their data and the data of others. Still, there is a lack of clarity about the value of the data and the business solutions that can be manifested from it.	<i>Equivalent data sharing:</i> One management strategy is the non-monetary valuation of data, e.g., the sharing of 'equivalent' data. This so-called <i>quid pro quo</i> implies that everyone benefits equally from data sharing. Example: Two-way sharing of inventory data from OEMs and suppliers.
	Develop new business models and services	Competitive advantage for others, Unclear costs of data sharing	Coopetition Value Tension: Sharing data inevitably means that a company has to give something to others. On the other hand, it is unclear what exactly this means for competitors and whether they can derive any kind of advantage or benefit from it.	<i>Strict Usage Control:</i> One management strategy is implementing strict usage control policies that organizationally and technically enforce that data are only used in ways the data provider approves. Example: Restricting access conditions (time, roles), sharing options with 3 rd parties or systems.
	Access to better services based on shared data	Missing trust and transparency between actors	Service Value Tension: Some cases require data consumers to become data providers to access a service based on more extensive community data. Against that stands a general unwillingness to share data, given an assortment of concerns.	<i>No direct data sharing:</i> One management strategy mitigating these issues is enabling the data provider only to share the meta-data of their data rather than the data themselves. Example: No sharing of data, just updates. The particular origin of the data is unknown, just 'community data.'
	Access to complementary data sources	Unclear business value, Lack of know-how, Existing data silos	Data Usage Tension: New data (sources) stand against a lack of competencies, existing data silos at the data provider and data recipient, and the initially unclear potential benefits of the data.	<i>Develop levels of data sharing business models:</i> One management strategy is the development of different levels of data sharing business models. These levels are supposed to make it easier for the actors to get started with data sharing and to enable a step-by-step development of the business models based on it. Example: Starting with sharing metadata, then more specific data until you share whole services for data sharing (e.g., predictive maintenance).
Organizational Tensions	Optimize existing business processes	Missing interoperability, Lack of Know How, Poor Data Quality, Unclear Costs of data sharing	Efficiency Tension: Shared data is a powerful vehicle for optimizing processes, but on the other hand, it must meet quality criteria and operability standards. Their integration must not cause more costs than benefits (e.g., know-how)	<i>Low hanging fruits:</i> One way to mitigate the tensions is to start with simple, demarcated processes and then gradually increase the complexity in the sense of 'learning by doing.' Example: Start optimizing single processes based on shared data in one specific field (e.g., production planning).
	Development of common data sharing standards	Missing standards, Missing interoperability	Interoperability Tension: Data sharing requires the same standards to create interoperability. In contrast, there are long-established standards in specific industries or proprietary standards of stakeholders who want to share data together.	<i>Consensus Finding:</i> Standards are set by a <i>central authority</i> or by <i>prioritization of standards</i> , distinguishing which standards are needed at which point in time. Example: Start by defining fundamental standards (e.g., data formats, regularity of exchange) and expand the standards step by step.
	Be a part of a growing ecosystem	Unclear Business Value, Moral, ethical and cultural concerns	Participating Tension: Participation in data ecosystems can give future benefits (e.g., scalability) and is up against a range of ethical, cultural, and legal concerns.	<i>Best practices:</i> Show interested stakeholders how data sharing can be successfully implemented, e.g., through an intermediary taking care of some concerns. Example: Pioneering examples for ecosystems, exemplifying successful data sharing.
	Enhance inter-organizational transparency, Access to better services	Missing trust and transparency between actors, Insufficient Data Availability	Motivation Tension: Enhancing inter-organizational transparency between actors and access to better services motivates actors to share data, while a lack of trust and transparency and poor data availability hinder organizations.	<i>External and neutral intermediaries:</i> Another management strategy can be the usage of an external and neutral intermediary to jointly define data sharing policies and reduce barriers such as a lack of transparency or security concerns. Example: Intermediaries (such as data trusts) can act as consultants to support the participants in defining policies or security measures such as pseudonymization.
Data Sovereignty Tensions	Ability to define and set data sovereignty policies	Legal Concerns, Data Security Concerns, Technical practicability	Data Control Tension: The ability to define usage control policies for data helps organizations retain control. However, against that stands a current unclarity on the legal implications of usage control policies.	
	Pseudo-nymization and anonymization	Data Misappropriation, Data Security Concerns	Data Trust Tension: While pseudonymization and anonymization of data increase trust between actors, data misuse and security concerns still remain barriers.	

To address the tension of data interoperability, we have derived two possible management strategies. On the one hand, a central actor could set the standards in an ecosystem. Alternatively, the standards could also be prioritized. Then the actors differentiate jointly to what extent standards are needed directly at the beginning of data sharing and which standards can also be added step by step in the ongoing process. Another tension that involves an organizational focus is the

Participating Tension. Companies want to be part of a growing ecosystem to "not miss the boat" (quote of a workshop participant) and benefit from potential positive developments. However, they are often unclear about the business value or have moral, ethical, or cultural concerns about sharing their data with other actors. A possible management strategy for this tension could be developing best practice examples. These examples should be representative of how interested stakeholders successfully implement data sharing. The use of an intermediary can also be helpful here to implement such pioneering examples.

The **Motivation Tension** describes how the incentives enhance inter-organizational transparency and access to better services and stand against the barriers of missing trust and transparency between the actors and insufficient data quality. One management strategy is implementing a data trust or, more generally, a data intermediary facilitating data sharing under fixed rules and quality standards. This intermediary could, for example, help the actors with know-how in implementing data sharing, which they do not possess. The use of an intermediary as a neutral third party, who is not directly involved in data sharing, can ensure that trust and transparency between the actors increase.

Data Sovereignty Tensions: Data sovereignty is about the self-determination of organizations to handle their data and retain some level of control over it, which is highly relevant in inter-organizational data sharing [72]. The **Data Control Tension** deals with the incentive of defining data sovereignty policies. However, this possibility is countered by concerns about the security of one's own data as well as concerns about what is legally compliant with the relevant laws. In addition, during the evaluation phase, the barrier of technical feasibility was added to this tension. This implies that the actors potentially have the necessary know-how but that the intended policies cannot be implemented with the current technologies. The possibility to define usage policies on an operational level does not automatically mean that they are legally binding, clear, or valid. In this case, intermediaries can take on the role of an advisory party that supports the actors in defining policies. Another tension within the framework of data sovereignty implies

Data Trust Tension. This tension includes using pseudonymization and anonymization options to increase data security. This data security and the concern of data misappropriation inhibit the actors before data sharing begins. It can be a management strategy to use an external and neutral intermediary to support the actors with their know-how when introducing security measures such as pseudonymizing data.

V. CONTRIBUTIONS, LIMITATIONS, AND OUTLOOK

Our work has multiple **contributions**, which we outline below. First, while there is some work on the benefits of data sharing and barriers to data sharing, we contribute something new: tensions of inter-organizational data sharing. We see this as highly relevant, as we have learned that the complex nature

of data sharing in practice exceeds mere benefits and risks but requires mitigating different facets.

Subsequently, our work supports **practitioners** facing decisions in data sharing with typical tensions they will face and initial approaches to managing them. For instance, while data sharing generally gets attention on a large scale, using data trusts as data intermediaries and a neutral third-party mitigating, to some degree, some issues of trust are yet relatively unexplored. For research, we build on and extend the existing knowledge about inter-organizational data sharing, which we see as a primary way to leverage the digital economy and a drastic push for digital transformation in organizations. Resulting, we extend existing research (e.g., [4, 8, 73]4, 8, 73).

Naturally, our research has **limitations**. Our results build on a literature review as well as interactions with informants in interviews and workshops. While we sampled the informants to ensure they are highly knowledgeable in inter-organizational data sharing, our results are still within their experiences' boundaries. We extracted incentives, barriers, and tensions from the literature, as well as interview transcripts and notes in workshops with informants. However, given that we do the extracting, our view might naturally influence how we interpret the findings. Additionally, we only reported on approaches to management strategies for tensions that we could derive at this point, meaning that we expect there to be a variety of additional management strategies that could complement our work. Moreover, the application of PCT has strongly influenced the development of our results.

Our research offers a few ways for new **research**. First and foremost, the tensions we have are only broadly categorized. We see significant potential in finding the relationships between these tensions in two dimensions. First (1), some tensions are on a conceptually higher level than others, which, for us, indicates a hierarchy of tensions (e.g., the data value tension could be subordinate to the business value tension). Second (2), we expect to find interrelationships between these tensions. One potential way to tackle this issue is by performing interpretative structural modeling [74], which is a method suitable for exactly that purpose. Each tension offers ways to go deeper and explore management strategies in-depth. We only have outlined some management approaches but expect that there is a variety of options in tackling these tensions. For example, based on our findings, we propose sharing data of perceived equal value as a way to mitigate the data value tension. Naturally, this strategy might not be suitable for all data sharing, which would open up the potential to explore the range of management strategies. In terms of our underlying theory, we used PCT to explain what we see in the interviews and interactions with informants. The next step from the theories perspective would be completing incentives, barriers, tensions, and management strategies and finding a way to rank-order them to give organizations advice on when they have crossed a certain threshold to share data. This could lead to decision support for organizations. Many areas of tension exist in inter-organizational data sharing. Solving these currently poses significant problems for the actors involved and simultaneously represents a challenge that needs to be solved in the future.

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