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Data governance: A conceptual framework, structured review, and research agenda

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ABSTRACT

Data governance refers to the exercise of authority and control over the management of data. The purpose of data governance is to increase the value of data and minimize data-related cost and risk. Despite data governance gaining in importance in recent years, a holistic view on data governance, which could guide both practitioners and researchers, is missing. In this review paper, we aim to close this gap and develop a conceptual framework for data governance, synthesize the literature, and provide a research agenda. We base our work on a structured literature review including 145 research papers and practitioner publications published during 2001-2019. We identify the major building blocks of data governance and decompose them along six dimensions. The paper supports future research on data governance by identifying five research areas and displaying a total of 15 research questions. Furthermore, the conceptual framework provides an overview of antecedents, scoping parameters, and governance mechanisms to assist practitioners in approaching data governance in a structured manner.

1. Introduction

Data governance is the exercise of authority and control over the management of data (DAMA International, 2009, p. 19). It aims at implementing a corporate-wide data agenda (Dyché & Levy, 2006, pp. 150), maximizing the value of data assets in an organization (e.g. Carretero, Gualo, Caballero, & Piattini, 2017, p. 143; Otto, 2011a, p. 241), and managing data-related risks (e.g. DAMA International, 2009, p. 41; Morabito, 2015, p. 99). While data governance used to be a nice to have in the past, today it is taking on a higher level of importance in enterprises and governmental institutions (Haneem, Kama, Taskin, Pauleen, & Abu Bakar, 2019, pp. 37). This is due to some key trends. The amount of data created annually on the whole planet is expected to increase from 4.4 zettabytes in 2013 to 44 zettabytes in 2020 (IDC, 2014, p. 2). The growing data volumes from diverse sources cause data inconsistencies that need to be identified and addressed before decisions are made based on incorrect data. Companies introduce more self-service reporting and analytics, which create the need for a common understanding of data across the organization. The continuing impact of regulatory requirements such as the General Data Protection Regulation (GDPR) increases the pressure on companies to have a strong handle on what data is stored where, and how the data is being used. Organizations are forced to overcome their challenges regarding inaccurate and incomplete data (Kim & Cho, 2018, p. 386; Morabito, 2015, p. 97), fragmented enterprise architecture and legacy systems (Nielsen, Persson, & Madsen, 2018, p. 22), and compliance issues related to regulations (Khatri & Brown, 2010, p. 151).

Despite the growing importance of data governance, the current view on this topic is fragmented. Publications either address data governance with a focus on specific decision domains such as data quality, data security, and data lifecycle (e.g., Donaldson & Walker, 2004, p. 281; IBM, 2014, p. 26; Otto, 2011c, pp. 5; Tallon, Ramirez, & Short, 2014, p. 142) or comprise smaller reviews to corroborate the conceptual or empirical content (e.g., Brous, Herder, & Janssen, 2016, pp. 304; Lee, Zhu, & Jeffery, 2017, p. 1; Neff, Schosser, Zelt, Uebernickel, & Brenner, 2013, p. 3; Rasouli, Trienekens, Kusters, & Grefen, 2016, p. 1356). We identified six existing literature reviews related to data governance (Alhassan, Sammon, & Daly, 2016; Alhassan, Sammon, & Daly, 2018; Al-Ruithe, Benkhelifa, & Hameed, 2018; Brous, Janssen, & Vilminko-Heikkinen, 2016; Lillie & Eybers, 2019; Nielsen, 2017). Though they aim to advance the knowledge base regarding data governance, they have some limitations. Three literature reviews focus on narrowly defined areas of data governance, i.e. cloud data governance (Al-Ruithe et al., 2018a, p. 16), data governance principles (Brous, Janssen et al., 2016, p. 3), and agile capabilities of data governance (Lillie & Eybers, 2019). Nielsen (2017) conducts a classification of research disciplines, methods, and units of analysis concerning data governance with only a minor focus on conceptual

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areas. Both literature reviews conducted by Alhassan et al. present a frequency count of data governance activities. However, they do not provide a detailed description of the underlying data governance concepts. Furthermore, the authors do not describe the antecedents and consequences of data governance, which are necessary to understand the factors that motivate the adoption of different data governance practices and the effects of those practices. To overcome these deficiencies, we attempt to methodologically analyze and synthesize the literature on data governance and provide a firm foundation for future research. The following two questions frame our structured literature review of 145 research papers and practitioner publications covering data governance published up to April 2019: What are the building blocks of data governance? Where do we lack in knowledge about data governance?

The remainder of this paper is structured as follows. First, we explain our literature search and review method. Second, we describe the conceptual framework of data governance that served as the structure for our review of the state of knowledge. Third, we present the results of the actual review and synthesis of the data governance literature. Fourth, we highlight gaps in our understanding of data governance and propose a research agenda, which contains insightful questions for future research. Fifth, we conclude with a summary.

2. Literature search and review

Similar to other existing literature reviews such as Gong and Janssen (2019) and Senyo, Liu, and Effah (2019), our approach comprised a structured, topic-centric literature review. We aimed to better describe the domain of data governance and synthesize the relevant knowledge as available in peer-reviewed scientific literature as well as in selected practitioner publications. In doing so, we followed best practices for literature reviews (Rowe, 2014; vom Brocke et al., 2009; Webster & Watson, 2002; Zorn & Campbell, 2006). Fig. 1 summarizes the search process.

First, we conducted a keyword-based search (Ismagilova, Hughes, Dwivedi, & Raman, 2019, p. 89; Olanrewaju, Hossain, Whiteside, & Mercieca, 2020, p. 91; Rowe, 2014, p. 247). The keyword-based search helped us to avoid bias towards well-known authors or well-cited papers. Through an initial step of probing searches, we identified “data governance” and “information governance” as search terms. We included “information governance” as a search term since it is often used interchangeably with “data governance” (e.g. In, Bradley, Bichescu, & Autry, 2019, p. 508; Rasouli, Trienekens et al., 2016, p. 1357; Tallon et al., 2014, p. 142). We used the databases in Table 1 that provide access to peer-reviewed IS journals as well as proceedings of leading conferences such as the European Conference on Information Systems and the Americas Conference on Information Systems. We included conference papers since recent research may not yet have been, or may never be, published in journals. We conducted the final keyword-based search in April 2019 covering the period from 2002 to 2019. This step resulted in a total of 483 hits across all databases. Next, we conducted a qualitative assessment consisting of two steps. First, we filtered articles based on their titles and abstracts and removed those which did not focus on data or information governance. We also removed duplicate articles. This step reduced the number of hits to 88. Second, we read those remaining 88 articles and excluded non-scientific journal articles and papers that referred to data governance only in passing. This left 55 papers to be included in the review.

Second, we conducted a backward and forward search of the above 55 papers (vom Brocke et al., 2009, p. 8). We again applied the two-step qualitative assessment described above to exclude non-relevant papers. However, we expanded the assessment to include seminal books on data governance and publications by industry associations such as the International Organization for Standardization (ISO) and inter-governmental organizations such as the Organisation for Economic Co-operation and Development (OECD). We added these publications to obtain a comprehensive view of data governance and reduce systematic biases by simply choosing a set of scientific journals and conference papers (Boell & Cecez-Kecmanovic, 2015, p. 166). The backward search resulted in 41 relevant papers. For the forward search, we used Google Scholar. We reviewed an additional 44 relevant papers.

Third, we considered selected publications not identified through either the keyword-based search or the backward and forward search. These included one scientific paper recommended during the review process and four practitioner publications. The latter comprised publications by the European Foundation for Quality Management (EFQM), the Information Systems Audit and Control Association (ISACA), and by leading data governance tooling vendors IBM and Informatica (Peyret & Goetz, 2014, pp. 7). The third step resulted in 5 additional publications.

In total, we reviewed 145 publications on data governance. Table 1 summarizes the search process and results. Fig. 2 provides an overview of the number of publications found per year.

All relevant publications were categorized according to their nature (scientific or practice-oriented) and format (papers in journals and conference proceedings, theses, publications by industry associations and inter-governmental organizations, publications by software vendors and consultants, books). Table 2 presents an overview of the publications within the scope of this literature review.

3. Data governance definition and framework

As proposed by Zorn and Campbell (2006, p. 175), we provide a working definition of the key term “data governance”. Furthermore, we present a conceptual framework for data governance to structure the review. The conceptual framework builds on the rich data we have collected during our literature search process.

We did not find a standard definition of data governance in scholarly literature or in the set of practitioner publications. Hence, we analyzed every definition of data governance in our set of papers and used open coding to find common characteristics. The analysis led us to the following definition of data governance: **Data governance specifies a cross-functional framework for managing data as a strategic enterprise asset. In doing so, data governance specifies decision rights and accountabilities for an organization’s decision-**

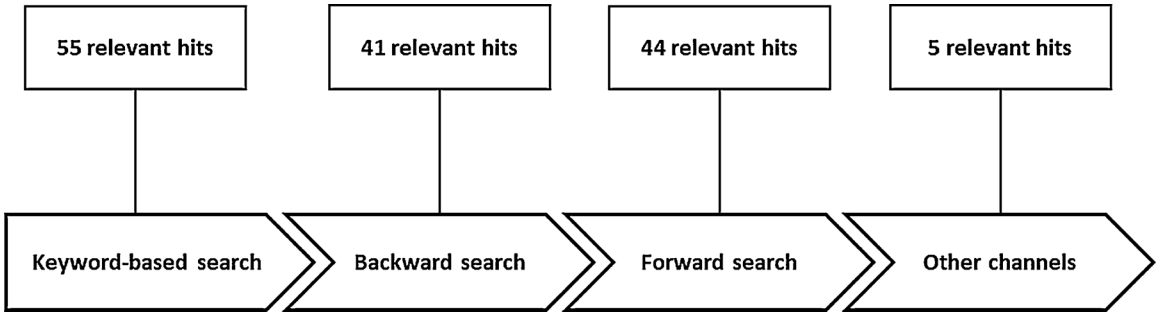

Fig. 1. Literature review search process.

Table 1
Overview of the literature search characteristics.

Database	AIS Electronic Library	EBSCOhost	Emerald Insight	IEEE Xplore	ProQuest	ScienceDirect
Website	aisel.aisnet.org	search.ebscohost.com	www.emeraldinsight.com	ieeexplore.ieee.org	search.proquest.com	www.sciencedirect.com
Search function	Advanced search	Advanced search	Advanced search	Advanced search	Advanced search	Advanced search
Search options	Search in title, abstract, subject	Search in title, abstract, keywords	Search in title, abstract, keywords	Search in title, abstract, keywords	Search in title, abstract	Search in title, abstract, keywords
Period	2002 – 2019	2002 – 2019	2002 – 2019	2002 – 2019	2002 – 2019	2002 – 2019
Publication type	Journals and conference papers (peer reviewed)	Scholarly (peer reviewed) journals	Articles and Chapters	Journals and conference papers	Journals and conference papers (peer reviewed)	Journals
Search date	15.04.2019	15.04.2019	15.04.2019	21.04.2019	15.04.2019	15.04.2019
Gross hits	8	137	51	99	107	81
Relevant hits keyword-based search	2	27	4	10	3	9
Relevant hits backward search				41		
Relevant hits forward search				44		
Other				5		
Total				145[1]		

[1] The total of 145 publications does not contain two publications, since they could not be accessed (one journal paper found via the keyword-based search in EBSCOhost and one dissertation found via the forward search).

making about its data. Furthermore, data governance formalizes data policies, standards, and procedures and monitors compliance.

This definition (bold text) is our own but corresponds to the characterization of data governance in the reviewed literature. Our definition of data governance has six parts. First, data governance is a *cross-functional* effort. It enables collaboration across functional boundaries and data subject areas. Second, data governance is a *framework*, which provides structure and formalization for the management of data. Third, data governance focuses on *data as a strategic enterprise asset*. Data is the representation of facts in different formats. Fourth, data governance specifies *decision rights and accountabilities for an organization's decision-making about its data*. It determines what decisions need to be made about data, how these decisions are made, and who in the organization has the rights to make these decisions. Fifth, data governance develops *data policies, standards, and procedures*. These artifacts should be consistent with the organization's strategy and promote desirable behavior in the use of data. Finally, data governance *monitors compliance*. It includes the implementation of controls to ensure that data policies and standards are followed. This definition also considers the differentiation between data governance and data management made by several authors. Data governance refers to what decisions must be made and who makes those decisions, whereas data management is about making those decisions as part of the day-to-day execution of data governance policies (Dyché & Levy, 2006, pp. 150, Hagmann, 2013, pp. 234, Khatri & Brown, 2010, p. 148; Otto, 2013, p. 96). Table 3 shows how the characteristics of data governance in our definition correspond to the reviewed set of papers. We performed the analysis for all data governance definitions in the papers, and the table provides selected excerpts for illustration.

We aimed to synthesize the literature according to a conceptual framework that allows us to structure the review of important concepts of data governance. A conceptual framework "explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs or variables – and the presumed relationships among them" (Miles & Huberman, 1994, p. 18). It brings together the different currents of thought and helps identify directions for future research (Marshall & Rossman, 2011, p. 58). The process of creating this conceptual framework was as follows: We applied open coding analysis techniques suggested by Corbin & Strauss (2015, pp. 220) to identify the concepts regarding data governance. We used a concept matrix as described by Webster & Watson (2002, p. xvii) to synthesize and document the concepts. We then mapped these concepts against existing frameworks and found that the IT governance cube of Tiwana, Konsynski, and Venkatraman (2014) and the framework for data decision domains of Khatri and Brown (2010) provided useful starting points for grouping these concepts. We used the dimensions proposed in those frameworks to create our conceptual framework for data governance. However, we made several changes to the dimensions to suit the needs of our review. Among others, we divided the content dimension of Tiwana et al. into traditional data and big data, and we added data architecture and data storage and infrastructure to the decision domain dimension of Khatri & Brown. Fig. 3 shows the final framework that we use in this paper.

The conceptual framework for data governance in Fig. 3 encompasses six dimensions. G*overnance mechanisms* represent the core dimension of the framework and encompass structural, procedural, and relational mechanisms. The *organizational scope* determines the organizational expansiveness of data governance and roughly corresponds to the unit of analysis. We differentiate between the intra-organizational and the inter-organizational scope. The *data scope* pertains to the data asset an organization needs to govern. We distinguish between traditional data and big data. The *domain scope* covers the data decision domains, to which governance mechanisms are applied. They comprise data quality, data security, data architecture, data lifecycle, meta data, and data storage and infrastructure. *Antecedents* cover the contingency

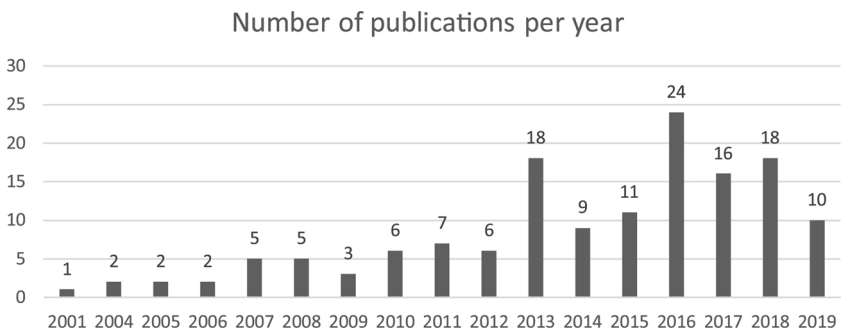

Fig. 2. Number of publications per year.

factors, which impact the adoption and implementation of data governance. We differentiate between internal and external antecedents. Finally, *consequences* contain the effects of data governance. We distinguish between intermediate performance effects and risk management.

4. Analysis and review

In this section, we discuss the state of knowledge regarding data governance as documented in the set of reviewed papers. In doing so, we use the structure of the conceptual framework shown in Fig. 3. We break down each dimension of the conceptual framework and provide an overview of findings and insights. We begin with the description of the core dimension of the framework, namely the governance mechanisms. We then present the organizational, data, and domain scope, to which the governance mechanisms are applied. We continue with the antecedents that influence the setup and configuration of data governance. We conclude this section with the consequences, which describe the effects of data governance. Fig. 4 provides an overview of the concepts per dimension of the conceptual framework.

4.1. Governance mechanisms

As part of their data governance approach, companies utilize a mixture of various governance mechanisms. These mechanisms help to plan and control data management activities (DAMA International,

Table 2
Sources for state-of-the-art analysis.

Nature of contribution	Format	Sources
Scientific	Papers in journals and conference proceedings	(Aisyah & Ruldeviyani, 2018), (Al-Badi et al., 2018), (Al-Ruithe & Benkhelifa, 2017a), (Al-Ruithe & Benkhelifa, 2017b), (Al-Ruithe & Benkhelifa, 2017c), (Al-Ruithe & Benkhelifa, 2018), (Al-Ruithe, Benkhelifa, Benkhelifa et al., 2016), (Al-Ruithe, Benkhelifa et al., 2016), (Al-Ruithe, Mthunzi, & Benkhelifa, 2016), (Al-Ruithe et al., 2018a), (Al-Ruithe et al., 2018b), (Alhassan et al., 2016), (Alhassan et al., 2018), (Alhassan et al., 2019), (Allen et al., 2014), (Becker, 2007), (Begg & Caira, 2011), (Begg & Caira, 2012), (Borgman et al., 2016), (Brooks, 2019), (Brous, Herder et al., 2016), (Brous, Janssen, Janssen et al., 2016), (Brous, Janssen et al., 2016), (Brown & Toze, 2017), (Bruhn, 2014), (Carretero et al., 2017), (Cheng et al., 2017), (Cheong & Chang, 2007), (Choi & Kroeschel, 2015), (Cousins, 2016), (Coyne, Coyne, & Walker, 2018), (Dahlberg & Nokkala, 2015), (Daneshmandnia, 2019), (de Abreu Faria et al., 2013), (Donaldson & Walker, 2004), (Evans, McKemmish, & Rolan, 2019), (Felici, Koulouris, & Pearson, 2013), (Fu et al., 2011), (Gillies, 2015), (Gillies & Howard, 2005), (Grimstad & Myrseth, 2011), (Guetat & Dakhli, 2015), (Hagmann, 2013), (Heredia-Vizcaíno & Nieto, 2019), (Hovenga, 2013), (Hovenga & Grain, 2013), (In et al., 2019), (Jim & Chang, 2018), (Kamioka et al., 2016), (Khatri, 2016), (Khatri & Brown, 2010), (Kim & Cho, 2017), (Kim & Cho, 2018), (Koltay, 2016), (Kooper et al., 2011), (Korhonen, Melleri, Hiekkanen, & Helenius, 2013), (Kravets & Zimmermann, 2012), (Kusumah & Suhardi, 2014), (Lajara & Maçada, 2013), (Lăzăroiu et al., 2018), (Lee et al., 2017), (Lee et al., 2014), (Lemieux et al., 2014), (Lillie & Eybers, 2019), (Lomas, 2010), (Malik, 2013), (Marchildon, Bourdeau, Hadaya, & Labissière, 2018), (Mikalef et al., 2018), (Mlangeni & Ruhode, 2017), (Neff et al., 2013), (Ng, Lo, & Choy, 2015), (Nguyen, Sargent, Stockdale, & Scheepers, 2014), (Nielsen, 2017), (Nielsen et al., 2018), (Niemi & Laine, 2016), (Nwabude, Begg, & McRobbie, 2014), (Otto, 2011a), (Otto, 2011b), (Otto, 2011c), (Otto, 2012), (Otto, 2013), (Palczewska et al., 2013), (Panian, 2010), (Permana & Suroso, 2018), (Prasetyo, 2016), (Prasetyo & Surendro, 2015), (Proença, Vieira, & Borbinha, 2016), (Proença, Vieira, & Borbinha, 2017), (Rasouli, Eshuis, Trienekens, & Grefen, 2016), (Rasouli, Eshuis, Trienekens, Kusters, & Grefen, 2016), (Rasouli, Trienekens et al., 2016), (Rasouli, Eshuis, Grefen, Trienekens, & Kusters, 2017), (Renaud, 2014), (Rifaie et al., 2009), (Rosenbaum, 2010), (Saputra, Handika, & Ruldeviyani, 2018), (Silic & Back, 2013), (Tallon, 2013), (Tallon et al., 2013), (Tallon et al., 2014), (Thammaboosadee & Dumthanasarn, 2018), (Thiarai, Chotvijit, & Jarvis, 2019), (Thompson et al., 2015), (Traulsen & Troebs, 2011), (Tse et al., 2018), (van den Broek & van Veenstra, 2015), (van Helvoirt & Weigand, 2015), (Vilminko-Heikkinen & Pekkola, 2019), (Waltl, Reschenhofer, & Matthes, 2015), (Watson et al., 2004), (Weber et al., 2009), (Weller, 2008), (Wende, 2007), (Wende & Otto, 2007), (Were & Moturi, 2017), (Wilbanks & Lehman, 2012), (Winter & Davidson, 2017), (Winter & Davidson, 2018), (Wright, 2013), (Young & McConkey, 2012), (Yu & Foster, 2017), (Yulfitri, 2016), (Zhang, Gao, Yang, & Song, 2017)
	Theses	(Barker, 2016), (Cave, 2017), (Nguyen, 2016), (Randhawa, 2019), (Rasouli, 2016)
Practice-oriented	Publications by industry associations and inter-governmental organizations	(DAMA International, 2009), (EFQM, 2011), (ISO, 2001), (ISO/IEC, 2005), (ISACA, 2013), (NASCIO, 2008), (OECD, 2017), (Pierce et al., 2008)
	Publications by software vendors and consultants	(IBM, 2007), (IBM, 2014), (Informatica, 2012), (Soares, 2013), (Thomas, 2006)
	Books	(Dreibelbis et al., 2008), (Dyché & Levy, 2006), (Loshin, 2008), (Morabito, 2015)

Table 3
Definition elements of data governance.

Definition elements	Excerpts	Source
Cross-functional	"It pervades the enterprise, crossing lines of business, data subject areas, and individual skill sets (…)"	Dyché & Levy, 2006, p. 145
	"(…) encompassing professionals from both business and IT departments."	Weber et al., 2009, p. 2
	"A decision-making and cross-functional charter (…)"	Informatica, 2012, p. 4
Framework	"Data governance specifies the framework for decision rights and accountabilities (…)"	Weber et al., 2009, p. 6
	"A good data governance framework typically answers questions about (…)"	Rifaie et al., 2009, p. 588
	"Data governance programs provide a framework for setting data-usage rules (…)"	Morabito, 2015, p. 99
Data as a strategic enterprise asset	"(…) accountable for an organization's decision-making about its data assets."	Khatri & Brown, 2010, p. 149
	"(…) exercise of decision-making and authority for data-related matters."	Thomas, 2006, p. 3
	"(…) operating discipline for managing data and information as a key enterprise asset."	NASCIO, 2008, p. 1
Decision rights and accountabilities for an organization's decision-making about its data	"(…) who holds the decision rights and is held accountable for an organization's decision-making about its data assets."	Khatri & Brown, 2010, p. 149
	"(…) answers questions about how decisions related to data are made, who makes the decisions, who is held accountable (…)"	Rifaie et al., 2009, p. 588
	"(…) who in a company is allowed to make what decisions regarding the handling of data (rights), and what the tasks related to this decision-making are (duties)."	Otto, 2011b, p. 47
Data policies, standards, and procedures	"(…) to create data management policies, processes, and standards (…)"	Informatica, 2012, p. 4
	"(…) that formalizes a set of policies and procedures to encompass (…)"	Korhonen et al., 2013, p. 11
	"(…) develops and implements corporate-wide data policies, guidelines, and standards (…)"	Weber et al., 2009, p. 6
Compliance monitoring	"Key aspects of data governance include decision making authority, compliance monitoring (…)"	NASCIO, 2008, p. 1
	"(…) along with the processes for monitoring conformance to those information policies."	Loshin, 2008, p. 68
	"The exercise of authority and control (planning, monitoring, and enforcement) over the management of data assets."	DAMA International, 2009, p. 19

2009, p. 21; Informatica, 2012, pp. 17). Governance mechanisms comprise formal structures connecting business, IT, and data management functions, formal processes and procedures for decision-making and monitoring, and practices supporting the active participation of and collaboration among stakeholders. Following the literature on information technology governance (De Haes & Van Grembergen, 2005, pp. 4; De Haes & Van Grembergen, 2009, pp. 123; Peterson, 2004, pp. 14; Weill & Ross, 2005, p. 28), we distinguish between (a) structural; (b) procedural; and (c) relational governance mechanisms.

4.1.1. Structural mechanisms

Structural governance mechanisms determine reporting structures, governance bodies, and accountabilities (Borgman, Heier, Bahli, & Boekamp, 2016, p. 4903). They encompass (i) roles and responsibilities and (ii) the allocation of decision-making authority.

The main roles and governance bodies comprise the executive sponsor, data governance leader, data owner, data steward, data governance council, data governance office, data producer, and the data consumer. The executive sponsor provides strategic direction, business prioritization, and funding for data management initiatives (Informatica, 2012, p. 8; NASCIO, 2008, p. 7; Weber, Otto, & Österle, 2009, p. 11). He or she is ideally one of the highest-level executives, i.e. the C-level (Dreibelbis, Hechler, Milman, Oberhofer, & van Run, 2008, p. 492; Informatica, 2012, p. 8; Loshin, 2008, p. 83; Weber et al., 2009, p. 11). The data governance leader is responsible for the day-to-day management of the data governance program (Loshin, 2008, p. 83). He or she provides guidance concerning the design, delivery, and maintenance of data and oversees compliance with data policies (Dyché & Levy, 2006, pp. 156; Loshin, 2008, p. 83). Furthermore, the data governance leader coordinates tasks for data stewards and provides periodic reports on data governance performance (Informatica, 2012, p. 8; Loshin, 2008, p. 83). Data owners are often line-of-business executives and accountable for the data assets in their business unit (Cheong & Chang, 2007, pp. 1004; IBM, 2014, pp. 194; Otto, 2011c, p. 7). They communicate broad data requirements and risks (IBM, 2014, pp. 194). Data stewards are business leaders or designated subject matter experts, who have detailed knowledge about the business and data requirements and who can translate those requirements into technical specifications

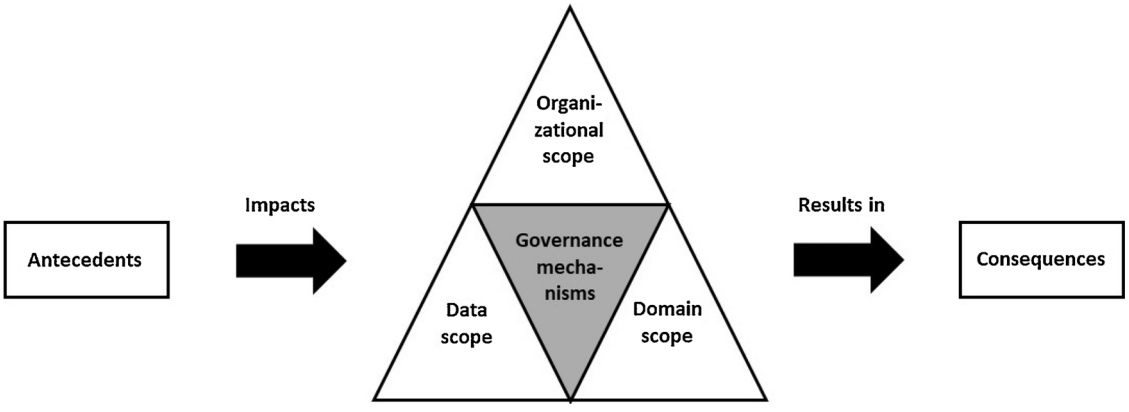

Fig. 3. Conceptual framework for data governance.

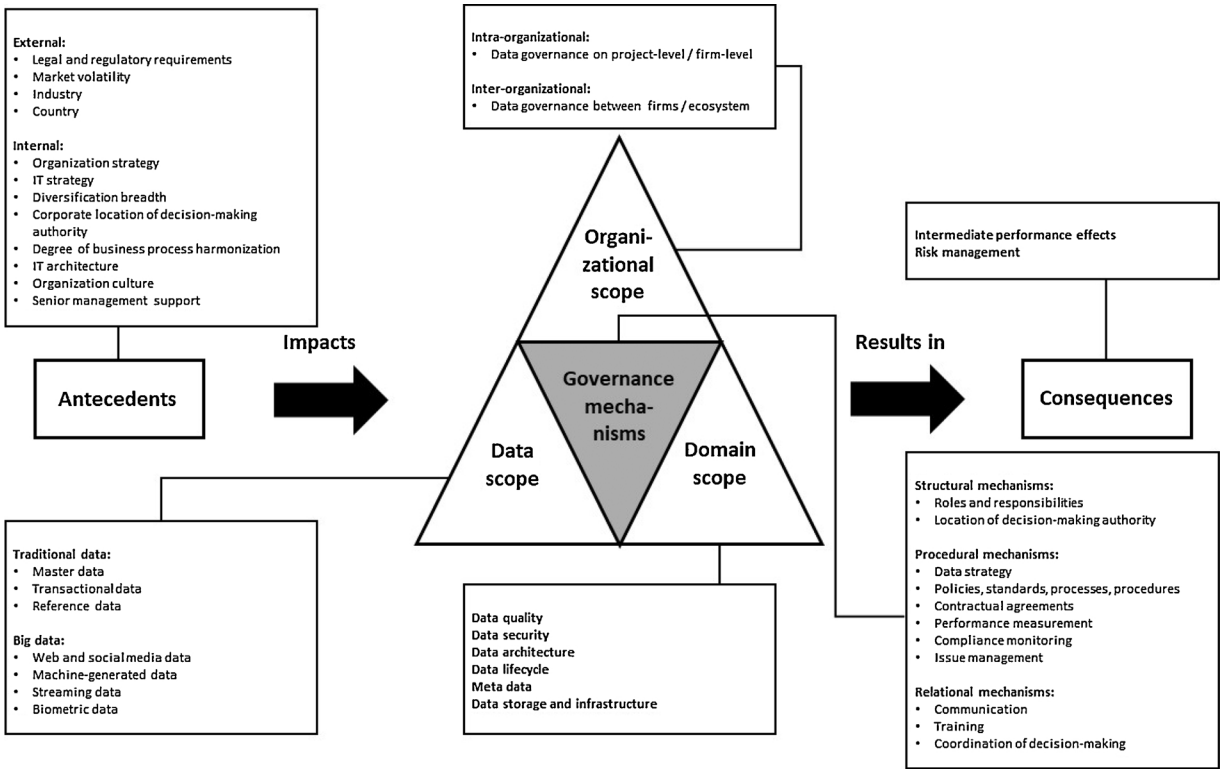

Fig. 4. Concepts within the conceptual framework for data governance.

(e.g., Cheong & Chang, 2007, pp. 1004; DAMA International, 2009, pp. 39; Informatica, 2012, p. 8). Business data stewards are subject matter experts from specific business areas (e.g., Dyché & Levy, 2006, pp. 156; Informatica, 2012, p. 8). Technical data stewards are professionals within IT that act as the counterparts of business data stewards (e.g., DAMA International, 2009, pp. 5; Weber et al., 2009, p. 11). The data governance council is a hierarchy-overarching, cross-functional governance body (Otto, 2011b, p. 49; Watson, Fuller, & Ariyachandra, 2004, p. 437). It establishes the strategic direction for the entire data governance program and aligns it with organizational goals (e.g., Cheong & Chang, 2007, pp. 1004; Watson et al., 2004, p. 443). Moreover, the data governance council monitors the program including ongoing improvement activities (Dyché & Levy, 2006, pp. 156; Loshin, 2008, p. 83; Thomas, 2006, p. 17). The data governance office is a staff organization that supports the governance and decision-making activities of the data stewardship teams and the data governance council (DAMA International, 2009, pp. 44; Thomas, 2006, p. 18). The data governance office establishes communication channels, prepares meetings, coordinates issue resolution, and educates stakeholders (DAMA International, 2009, pp. 31; Thammaboosadee & Dumthanasarn, 2018, p. 2; Thomas, 2006, p. 18). The data producer creates the data or aggregates and maintains the data created by others (ISACA, 2013, pp. 27; Kooper, Maes, & Lindgreen, 2011, pp. 197; DAMA International, 2009, pp. 31; Thomas, 2006, p. 17). The data consumer is the user of the data (ISACA, 2013, pp. 27; Kooper et al., 2011, p. 197; Thomas, 2006, p. 17). He or she specifies requirements and reports data-related issues (Cheong & Chang, 2007, pp. 1004).

The allocation of decision-making authority determines, which organizational unit has the mandate for action related to data governance (Khatri & Brown, 2010, p. 151; Otto, 2011b, p. 62). We distinguish between hierarchical positioning, functional positioning, and the positioning of decision-making authority on a continuum ranging from centralized to decentralized (Otto, 2011c, p. 6; Wende & Otto, 2007, p. 9). Hierarchical positioning defines at which hierarchical level of an organization the decision-making authority is situated (Otto, 2011c, p. 6). Functional positioning determines which department holds the decision-making authority (e.g., DAMA International, 2009, p. 38; Otto, 2011c, p. 6; Watson et al., 2004, pp. 436). The positioning of decision-making authority on a continuum determines whether decisions are taken by a central unit, by decentral units, or by both (e.g., Barker, 2016, pp. 70; Begg & Caira, 2012, p. 10; Tallon et al., 2014, p. 147; Weber et al., 2009, p. 5).

4.1.2. Procedural mechanisms

Procedural governance mechanisms aim to ensure that data is recorded accurately, held securely, used effectively, and shared appropriately (Borgman et al., 2016, p. 4903). They comprise (i) the data strategy; (ii) policies; (iii) standards; (iv) processes; (v) procedures; (vi) contractual agreements; (vii) performance measurement; (viii) compliance monitoring; and (ix) issue management.

The data strategy represents a high-level course of action based on strategic business objectives (e.g., Cheng, Li, Gao, & Liu, 2017, p. 518; DAMA International, 2009, pp. 45; Guetat & Dakhli, 2015, p. 1091). It consists of a vision statement (Al-Ruithe & Benkhelifa, 2017a, p. 226; Barker, 2016, pp. 68; Informatica, 2012, p. 7), a business case (e.g., Al-Ruithe et al., 2018a, pp. 13; Weber et al., 2009, p. 10), guiding principles (e.g., Brous, Janssen et al., 2016, p. 5; Fu, Wojak, Neagu, Ridley, & Travis, 2011, p. 3; Khatri & Brown, 2010, p. 149), long-term and short-term objectives (Alhassan, Sammon, & Daly, 2019, p. 107; DAMA International, 2009, pp. 45; Weber et al., 2009, p. 10), and an implementation roadmap (DAMA International, 2009, pp. 45; Prasetyo & Surendro, 2015, p. 51).

Data policies provide high-level guidelines and rules regarding the creation, acquisition, storage, security, quality, and permissible use of data (e.g., Alhassan et al., 2019, p. 106; DAMA International, 2009, pp. 47; Thompson, Ravindran, & Nicosia, 2015, p. 320). Organizations use data policies to communicate key objectives, data accountabilities, roles, responsibilities, and data retention periods (e.g., DAMA International, 2009, pp. 47; Donaldson & Walker, 2004, p. 283; Morabito, 2015, p. 89). Enterprises enforce, monitor, evaluate, and

revise data policies (e.g., Brous, Janssen et al., 2016, p. 10; Cheong & Chang, 2007, p. 1002; Donaldson & Walker, 2004, p. 283).

Data standards ensure that the data representation and the execution of data-related activities are consistent and normalized throughout the organization (e.g., DAMA International, 2009, pp. 48; Kim & Cho, 2017, p. 387; Palczewska et al., 2013, p. 576). They facilitate interoperability within and across organizations and ensure their fit for purpose (e.g., Cheong & Chang, 2007, p. 1002; DAMA International, 2009, p. 185; Otto, 2012, p. 274). Data standards are defined internally by data stewards and data architects, or externally by standardization organizations such as ISO (DAMA International, 2009, pp. 48; Dreibelbis et al., 2008, pp. 493; Hovenga & Grain, 2013, pp. 82; Otto, 2012, p. 274).

Clear data processes are considered a fundamental element of a successful data governance implementation (Alhassan et al., 2019, p. 105). Processes are standardized, documented, and repeatable methods used to govern data (Al-Ruithe, Benkhelifa, & Hameed, 2018, p. 10; Thomas, 2006, pp. 18). Examples include processes for developing and maintaining rules for data handling as well as modeling and documenting the data lifecycle (EFQM, 2011, pp. 17; Khatri, 2016, p. 675; Kim & Cho, 2018, p. 40). Further examples comprise processes for the assessment of the current state, processes for the alignment and validation of policies, processes for decision-making, performance measurement, and issue resolution (Dreibelbis et al., 2008, pp. 484; Loshin, 2008, p. 77; Rifaie, Alhajj, & Ridley, 2009, p. 588; Thomas, 2006, pp. 18).

Procedures are “the documented methods, techniques, and steps followed to accomplish a specific activity or task” (DAMA International, 2009, pp. 48). They vary widely across companies. For example, procedures describe how to establish accountabilities and decision rights (Thomas, 2006, pp. 18), develop a data model (DAMA International, 2009, pp. 48; Thomas, 2006, pp. 18), or identify and resolve data errors (Rifaie et al., 2009, p. 588; Thomas, 2006, pp. 18).

Data provisioning and data sharing settings require contractual agreements between participating internal departments or external organizations. Examples of such agreements are service level agreements (SLA) and data sharing agreements (DSA). An SLA defines what data services will be provided by an internal team or a third-party provider, how the services will be provided, and what happens if expectations are not met (Al-Ruithe et al., 2018b, p. 16; Barker, 2016, pp. 44). A DSA determines the legal and data governance aspects before two or more organizations start sharing data (Allen et al., 2014, pp. 1).

Performance measurement aims at assessing the effectiveness of data governance by measuring the level of goal attainment (e.g., Al-Ruithe et al., 2018a, pp. 13; Carretero et al., 2017, p. 143; Otto, 2011b, p. 62; Weber et al., 2009, pp. 10). Performance measures on firm-level are based on strategic business goals such as revenue growth, increased profitability, and cost savings (e.g., EFQM, 2011, p. 24; Tallon et al., 2014, p. 166; Thomas, 2006, pp. 14). Performance measures on intermediate-level are based on operational business goals or decision domain specific goals, both derived from strategic business goals on firm-level (Otto, 2011b, p. 62; Panian, 2010, pp. 944; Pierce, Dismute, & Yonke, 2008, p. 31). Performance measures on program-level focus on the progress and impact of the data governance program (EFQM, 2011, pp. 25; Informatica, 2012, pp. 13; Thomas, 2006, pp. 14).

Compliance monitoring aims at tracking and enforcing conformance with regulatory requirements and organizational policies, standards, procedures, and SLAs (e.g., Al-Ruithe et al., 2018a, pp. 13; Bruhn, 2014, p. 3; ISACA, 2013, p. 24). This includes the supervision of data professionals and the oversight of data management projects and services (DAMA International, 2009, p. 21). Compliance monitoring encompasses auditing, which aims at providing stakeholders with objective, unbiased assessments and recommendations for improvement (DAMA International, 2009, pp. 159). Based on audit results, companies can take corrective and preventive actions (ISO/IEC, 2005, p. vi).

Issue management refers to the identification, management, and resolution of data-related issues (DAMA International, 2009, pp. 50). It includes processes for the standardization of data issues and for issue resolution (DAMA International, 2009, pp. 303; Thomas, 2006, pp. 18) and the identification of persons, who are accountable to resolve issues (DAMA International, 2009, p. 307). In addition, an escalation process helps to address issues to higher levels of authority (DAMA International, 2009, pp. 50; IBM, 2014, p. 40). This enables stakeholders to give feedback, e.g. concerning policy changes to meet new business requirements.

4.1.3. Relational mechanisms

Relational governance mechanisms facilitate collaboration between stakeholders (Borgman et al., 2016, p. 4903). They encompass (i) communication; (ii) training; and (iii) the coordination of decision-making.

Communication aims at continuously generating awareness for the data governance program among stakeholders (e.g., Begg & Caira, 2012, p. 10; Cheong & Chang, 2007, p. 1002; Lomas, 2010, p. 188; Watson et al., 2004, p. 443). Creating awareness is an essential step in establishing shared commitment (Rifaie et al., 2009, p. 589), ensuring buy-in and active participation of stakeholders (DAMA International, 2009, p. 294; EFQM, 2011, p. 17; Young & McConkey, 2012, p. 72), and eliminating resistance to required changes (EFQM, 2011, p. 17; Guetat & Dakhli, 2015, p. 1092; Otto, 2012, pp. 287). A communication plan can help by determining stakeholders, communication channels, supporting tools, and initiatives to retain commitment (Al-Ruithe et al., 2018a, pp. 13; EFQM, 2011, p. 31; NASCIO, 2008, p. 6; Thomas, 2006, p. 19).

Training programs ensure that stakeholders have the necessary knowledge and qualifications to support the implementation of data governance (EFQM, 2011, p. 17; Tallon, Short, & Harkins, 2013, p. 196). In addition, continuous training helps them act according to data policies, processes, and procedures (Alhassan et al., 2019, p. 104; Randhawa, 2019, pp. 119). Training can be conducted in form of computer-based training, classroom training, job-specific and project-related training, and one-on-one coaching (Cave, 2017, p. 125; Watson et al., 2004, pp. 444). Communication and training facilitate the creation of an organizational culture that values data assets (Informatica, 2012, p. 16).

The coordination of decision-making describes practices for the alignment across functions. The hierarchical (or vertical) approach is characterized by a pyramid-like structure with decision-making authority located at top-level. The main elements of the hierarchical approach include steering and control (Hagmann, 2013, p. 237; Kooper et al., 2011, p. 199). The cooperative (or horizontal) approach makes use of collaborative behavior to clarify differences and solve problems (Wende & Otto, 2007, pp. 10). It utilizes formal coordination mechanisms such as working groups, committees, task forces, and integrator roles, but also informal coordination mechanisms such as interdepartmental events, performance reviews across business units, and job rotation (Bruhn, 2014, p. 6; Borgman et al., 2016, p. 4903; Tallon et al., 2014, p. 147; Weber et al., 2009, p. 15).

4.2. Organizational scope

The organizational scope represents the expansiveness of data governance and roughly corresponds to the unit of analysis. We subdivide the organizational scope into (a) intra-organizational and (b) inter-organizational.

The intra-organizational scope determines data governance within a single organization. It comprises data governance on the project- or on firm-level (Tiwana et al., 2014, p. 8). Data governance on project-level focuses on managing the quality and integrity of project-related data (DAMA International, 2009, pp. 52). Data governance on firm-level covers the entire enterprise and coordinates the interests and demands of different stakeholder groups such as business and IT departments

(DAMA International, 2009, p. 41; Dyché & Levy, 2006, p. 151; Otto, 2011b, p. 47; Pierce et al., 2008, p. 26; Weber et al., 2009, p. 2).

The *inter-organizational scope* encompasses data governance between firms or even for an ecosystem of firms (Tiwana et al., 2014, p. 8). Companies increasingly partner with external collaborators such as vendors, industry peers, and public-sector organizations to create new information products (Bruhn, 2014, p. 5; Cheong & Chang, 2007, p. 1002; Lee, Madnick, Wang, Wang, & Zhang, 2014, pp. 7; Rasouli, Trienekens et al., 2016, pp. 1362; Winter & Davidson, 2018, pp. 5). Although this enables companies to exploit environmental opportunities, it can also result in loss of control on data, unsecured information access, and low-quality information products (e.g., Al-Ruithe et al., 2018a, p. 2; Rasouli, Trienekens et al., 2016, p. 1357). To counteract these issues, companies need to set up governance mechanisms such as data integration and usage policies (Bruhn, 2014, pp. 6; Morabito, 2015, p. 86), data exchange standards (Lee et al., 2014, pp. 6; Rasouli, Trienekens et al., 2016, pp. 1362), processes for interaction and collaboration (Panian, 2010, p. 942), service level agreements (Al-Ruithe, Benkhelifa, & Hameed, 2016, pp. 382; IBM, 2014, pp. 26), and data sharing agreements (Allen et al., 2014, p. 1; Bruhn, 2014, p. 3; ISO, 2005, p. 14).

4.3. Data scope

Data is the representation of facts in the form of text, numbers, images, sound or video (DAMA International, 2009, p. 2). Every data governance program must specify, which type of data is in focus (Weller, 2008, p. 254). Most data governance articles we analyzed focus on the traditional data space as described by Lee et al. (2014). However, a few articles also describe data governance in the context of big data, having partially different requirements on data governance than traditional data. Corresponding to Lee et al. (2014), we cluster data into the following two categories: (a) traditional data and (b) big data.

Traditional data builds the basis for an organization's operations (Lee et al., 2014, p. 4). It comprises master data, transactional data, and reference data. Master data describes the key business objects within an organization (e.g., Loshin, 2008, pp. 6; Otto, 2012, p. 274; Soares, 2013, p. 57). Typical domains of master data are customer, employee, finance, patient, product, location, material, and supplier data (e.g., Dreibelbis et al., 2008, p. 2; Khatri, 2016, p. 681; Loshin, 2008, pp. 6). Transactional data represents records about business transactions in different domains (Dreibelbis et al., 2008, p. 35; IBM, 2014, p. 221). Examples include customer orders, shipments, product invoices, bills, guest visits, or patient stays (Dreibelbis et al., 2008, p. 35; EFQM, 2011, p. 9; IBM, 2014, p. 221). Reference data refers to an agreed-upon set of common values used throughout an organization (Dreibelbis et al., 2008, pp. 34). Product codes and order status are examples for internally defined reference data whereas postal code abbreviations for U.S. states and ISO currency codes are examples for externally defined reference data (Dreibelbis et al., 2008, pp. 34; EFQM, 2011, p. 9). Data governance with a focus on traditional data often aims to ensure the consistent use of traditional data across the organization (Dreibelbis et al., 2008, p. 483). To achieve this, organizations specify data policies and processes for monitoring conformance to those policies (Loshin, 2008, p. 68).

Big data possesses multiple definitions comprising diverse nuances in current literature (De Mauro, Greco, & Grimaldi, 2014, p. 97). The Meta Group report from 2001 presents one of the more prominent definitions of big data comprising data variety, velocity, and volume as the three main dimensions of big data (Laney, 2001, pp. 1). Variety refers to the data format, which may be structured, semi-structured, or unstructured (e.g., IBM, 2014, pp. 198; ISACA, 2013, p. 46; Tallon, 2013, p. 37). Velocity refers to the high processing rate, which enables organizations to quickly respond to events as they happen (ISACA, 2013, p. 46; Malik, 2013, p. 1). Volume refers to high growth rates of big data (Laney, 2001, p. 1; Tallon, 2013, p. 37). This definition has been expanded to include further dimensions such as veracity and value (Khatri, 2016, p. 677; Lee et al., 2014, pp. 1). In addition, broader definitions of big data have emerged stating big data as a "common term for a set of problems and techniques concerning the management and exploitation of very large sets of data" (ISACA, 2013, p. 46). Examples of big data comprise web and social media data (e.g., Brous, Janssen, & Herder, 2016, p. 575; Tallon, 2013, p. 37), machine-generated data (e.g., Brous, Janssen, Janssen et al., 2016, p. 575; Dahlberg & Nokkola, 2015, p. 32), streaming data (e.g., IBM, 2014, p. 16; Tallon, 2013, p. 37), and biometric data (Malik, 2013, p. 1; Soares, 2013, pp. 6). Though the analysis of big data promises potential benefits, it also comes along with risks such as privacy infringements and data inconsistencies (Kim & Cho, 2018, pp. 37; Tse, Chow, Ly, Tong, & Tam, 2018, p. 1633). Data governance focusing on big data needs to address these new risks without hampering innovation. It needs to consider new privacy requirements regarding sensitive data (Morabito, 2015, p. 89; Soares, 2013, pp. 2) and find new ways to measure and monitor big data quality (Al-Badi, Tarhini, & Khan, 2018, p. 275). This includes updated data quality criteria such as timeliness, trustfulness, meaningfulness, and sufficiency (Kim & Cho, 2017, p. 388). Data governance also needs to assess value and costs of big data and update retention and deletion requirements accordingly (Morabito, 2015, pp. 89; Soares, 2013, p. 2; Tallon, 2013, p. 35). Finally, data governance needs to include new stakeholders such as data scientists and adjust the responsibilities of existing data stewards (Al-Badi et al., 2018, p. 275; Morabito, 2015, p. 89; Soares, 2013, p. 2).

4.4. Domain scope

Many data governance programs address goals in two or three areas (Thomas, 2006, pp. 6). Corresponding with Khatri & Brown (2010, p. 149), we name these focus areas data decision domains. Based on our analysis, we classify the main data decision domains as follows: (a) data quality; (b) data security; (c) data architecture; (d) data lifecycle; (e) meta data; and (f) data storage and infrastructure.

Data quality refers to the ability of data to satisfy its usage requirements in a given context (e.g., de Abreu Faria, Maçada, & Kumar, 2013, p. 4439; Khatri & Brown, 2010, p. 150). Data governance with a focus on data quality comprises the development of a data quality strategy (e.g., EFQM, 2011, p. 10; Thomas, 2006, p. 8), the definition of roles and responsibilities, and the determination of data quality management processes (e.g., EFQM, 2011, p. 10; Loshin, 2008, p. 72; Malik, 2013, pp. 8). Monitoring data quality includes the definition of data quality metrics (e.g., Brous, Herder et al., 2016, p. 305; Dyché & Levy, 2006, pp. 156; Malik, 2013, pp. 8) and the continuous measurement of data quality levels (e.g., DAMA International, 2009, p. 303; Dreibelbis et al., 2008, p. 498; Weber et al., 2009, pp. 10). Further tasks include the management of data quality issues (DAMA International, 2009, p. 303; Dreibelbis et al., 2008, pp. 498; Rifaie et al., 2009, p. 588).

Data security refers to the preservation of security requirements concerning the accessibility, authenticity, availability, confidentiality, integrity, privacy, and reliability of data (e.g., Carretero et al., 2017, p. 142; Donaldson & Walker, 2004, p. 281; de Abreu Faria et al., 2013, p. 4439; ISACA, 2013, p. 31). Data governance with a focus on data security includes the execution of risk assessments (e.g., de Abreu Faria et al., 2013, p. 4439; IBM, 2014, pp. 140; Khatri & Brown, 2010, p. 151), the setup of data security roles (DAMA International, 2009, pp. 153; Khatri & Brown, 2010, p. 151), and the definition of data security policies, standards, and procedures (e.g., Khatri & Brown, 2010, p. 149; Morabito, 2015, p. 89). Furthermore, data governance comprises the definition of data security controls (DAMA International, 2009, p. 22; IBM, 2014, pp. 140; Palczewska et al., 2013, p. 573; Tallon et al., 2014, p. 166) and auditing to ensure that the implemented procedures and practices comply with security policies, standards, and guidelines (DAMA International, 2009, pp. 159; Palczewska et al., 2013, p. 571).

Data architecture comprises the definition of enterprise data objects

(e.g., Dyché & Levy, 2006, pp. 156; EFQM, 2011, p. 19; Thomas, 2006, p. 9) and the development of an enterprise data model on a conceptual, logical, and physical level (e.g., DAMA International, 2009, p. 21; Watson et al., 2004, pp. 437). Data governance with a focus on data architecture contains the determination of enterprise data requirements (DAMA International, 2009, p. 19; IBM, 2014, p. 31) and the definition of architectural policies, standards, and guidelines (e.g., DAMA International, 2009, pp. 48; EFQM, 2011, p. 19; Thomas, 2006, p.9). Furthermore, data governance determines the responsibilities of data architects and the data governance council concerning the enterprise data model (DAMA International, 2009, p. 48; Dreibelbis et al., 2008, pp. 493).

Data lifecycle represents the approach of defining, collecting, creating, using, maintaining, archiving, and deleting data (e.g., Khatri & Brown, 2010, p. 149; Morabito, 2015, pp. 89). Data governance with a focus on data lifecycle comprises the identification of business processes that use data (Carretero et al., 2017, p. 143; EFQM, 2011, pp. 17; Informatica, 2012, pp. 16;ISACA, 2013 p. 34) and the analysis of the information flow to identify potential overlaps in data storage (IBM, 2014, p. 38; Weller, 2008, p. 252). This step further encompasses the derivation of data retention requirements from business needs, regulatory requirements, and accountability demands (e.g., Cousins, 2016, p. 355; ISO, 2001, p. 11; Khatri & Brown, 2010, p. 149). In addition, organizations need to specify when data is authorized for deletion (DAMA International, 2009, p. 246; ISO, 2001, p. 16).

Meta data is used to classify data sensitivity levels (Cousins, 2016, p. 349), data provenance (Lee et al., 2017, p. 6; Were & Moturi, 2017, p. 582), and data retention periods (Weller, 2008, pp. 256). Data governance with a focus on meta data comprises the delineation of a meta data strategy (DAMA International, 2009, pp. 23; Grimstad & Myrseth, 2011, p. 2; ISO, 2001, p. 6), the definition of common meta data standards (e.g., de Abreu Faria et al., 2013, p. 4439; Khatri & Brown, 2010, p. 149), and the specification of processes to build a meta data repository (e.g., Grimstad & Myrseth, 2011, p. 3; Rasouli, Trienekens et al., 2016, p. 1367). Furthermore, data governance defines the roles such as enterprise data architects and data modelers, who are responsible for meta data management (Informatica, 2012, p. 10; Khatri & Brown, 2010, pp. 150).

Data storage and infrastructure focus on IT artifacts that enable effective data management across the organization (Dreibelbis et al., 2008, p. 484; Tallon et al., 2014, p. 149). Companies must consider various hardware and software requirements such as functionality, cost, reliability, complexity, capacity, scalability, and maintainability (Al-Ruithe et al., 2018a, pp. 12; Panian, 2010, p. 946; Tallon et al., 2014, p. 149). Data governance with a focus on data storage and infrastructure comprises the initial assessment of the application and storage landscape (Dreibelbis et al., 2008, p. 493; Randhawa, 2019, pp. 117) and the planning of software applications and storage capacity to support data quality, data security, and data lifecycle (EFQM, 2011, p. 10; Tallon, 2013, p. 35). Further governance mechanisms include the definition of policies, standards, processes, and procedures regarding storage and distribution of data (e.g., ISO, 2001, p. 14; Palczewska et al., 2013, p. 572; Tallon et al., 2014, p. 163; Weber et al., 2009, p. 12), the control of storage costs (e.g., Soares, 2013, p. 10; Tallon et al., 2014, pp. 164), and the education of stakeholders regarding storage utilization (Tallon, 2013, p. 35).

4.5. Antecedents

Antecedents describe the external and internal factors that precede or predict the adoption of data governance practices (Tallon et al., 2014, p. 143). They have an impact on the implementation and the level of adoption of data governance (Tallon et al., 2014, p. 168; Wende & Otto, 2007 p. 11). In the following, we present the main antecedents categorized into (a) external and (b) internal.

External antecedents comprise legal and regulatory requirements (e.g., Al-Ruithe et al., 2018b, p. 18; Dyché & Levy, 2006, pp. 156; Tallon, 2013, p. 36). They vary by industry (DAMA International, 2009, p. 153) or by region (IBM, 2014, pp. 17; Tallon, 2013, p. 36). Examples include the Health Information Protection and Portability Act (HIPPA) (e.g., Khatri & Brown, 2010, p. 149; Tallon et al., 2014, p. 156) and the Sarbanes-Oxley Act (SOX) (e.g., Cheong & Chang, 2007, p. 1000; Khatri & Brown, 2010, p. 149). Legal and regulatory requirements have an impact on the business use and control of data (Khatri & Brown, 2010, p. 149; Kooper et al., 2011, p. 198; Tallon et al., 2014, p. 156), data security and data quality (e.g., Cheong & Chang, 2007, p. 1000; ISO, 2001, pp. 4; Watson et al., 2004, p. 439), as well as data retention and archiving (e.g., Cousins, 2016, p. 355; ISO, 2001, pp. 4; Khatri & Brown, 2010, p. 149). Furthermore, highly regulated markets require a more centralized organizational structure than markets with less or no regulations (e.g., Weber et al., 2009, p. 18). Further external factors encompass market volatility (Otto, 2011b, p. 61), the industry the company operates in (Dreibelbis et al., 2008, p. 488; Otto, 2011b, p. 61; Tallon, 2013, p. 36), and the country the company is located in (Nguyen, 2016, pp. 247).

Internal antecedents contain strategic, organizational, system-related, and cultural factors. On the strategic level, internal antecedents comprise the organization strategy, IT strategy, and diversification breadth. Companies with a profit-oriented organization strategy may adopt a centralized organizational structure, whereas growth-oriented companies benefit from a decentralized setup (Weber et al., 2009, p. 19). Internal antecedents on the organizational level contain the corporate allocation of decision-making authority and the degree of business process harmonization. A centralized corporate approach in business and IT facilitates data governance adoption (Tallon et al., 2014, p. 161). Companies with globally harmonized processes enable a centralized placement of decision-making authority in contrast to companies with local processes (Weber et al., 2009, p. 18). Internal antecedents on the system level include IT architecture. A high degree of IT standardization and process integration enable the adoption of data governance, whereas the usage of legacy IT systems with its application silos and low degree of process integration hamper data governance adoption (e.g., Tallon et al., 2014, p. 161). Internal antecedents on the cultural level encompass the organization culture, senior management support, and active leadership participation (e.g., Daneshmandnia, 2019, pp. 30; de Abreu Faria et al., 2013, p. 4439; Randhawa, 2019, pp. 107; Silic & Back, 2013, pp. 82). An organization culture, which promotes the strategic use of information and creates a business vision about data governance, enables the adoption of data governance (Hagmann, 2013, p. 235; Tallon et al., 2014, p. 161).

4.6. Consequences

Consequences refer to the outcomes of data governance (Tallon et al., 2014, p. 166; Tiwana et al., 2014, p. 10). We identified two types of consequences of data governance: (a) intermediate performance effects and (b) risk management.

Intermediate performance effects occur in different ways. Kamioka, Luo, and Tapanainen (2016, p. 7) describe the positive effect of data governance on data utilization level, which contributes to marketing performance by the increased number of sales and customer spending. Mikalef, Krogstie, van de Wetering, Pappas, and Giannakos (2018, p. 4917) demonstrate the positive effect of data governance on both a firms' dynamic and operational capabilities by improving the existing operational mode and leading to renewed means of competing in the market. Furthermore, data governance is attributed to improving data quality due to increased accuracy, availability, completeness, consistency, and timeliness of data and the limitation of errors due to data inconsistencies (Barker, 2016, pp. 165; Niemi & Laine, 2016, p. 8). Otto (2013, p. 96) even defines data governance effectiveness as the ratio of the number of preventive data quality management measures to the total number of data quality management measures conducted by the

company. The rationale behind this definition is that a higher number of preventive measures leads to increased data quality and thus to higher effectiveness of data governance. Companies without data governance spend more time reacting to data-related issues, which in turn limits the time spent on running the business and making process improvements (Barker, 2016, pp. 165). Then again, companies reduce the cost to clean-up data by implementing data policies (Randhawa, 2019, p. 120).

The second consequence of data governance is the *management of data-related risk* (e.g., Dreibelbis et al., 2008, pp. 488; Malik, 2013, p. 2; Otto, 2011c, p. 5; Tallon et al., 2014, p. 150). Risks may arise due to non-conformance with information policies or the absence of oversight regarding data quality (Loshin, 2008, pp. 72). Further risks concern security and privacy breaches (Loshin, 2008, pp. 72; Rifaie et al., 2009, p. 589). Data governance reduces these risks by creating risk-mitigating policies and introducing controls for monitoring compliance (Khatri & Brown, 2010, p. 149; Loshin, 2008, p. 77; Thomas, 2006, p. 17).

5. Research agenda and outlook

The review above provides a conceptual framework for data governance and a comprehensive overview of research findings and insights relevant for data governance to date. Deriving from particular aspects of our above analysis, we briefly outline an agenda for future research on data governance. Our research agenda comprises five major areas: (1) governance mechanisms; (2) scope of data governance; (3) antecedents of data governance; (4) consequences of data governance; and (5) generalizability and replicability of findings.

5.1. Governance mechanisms

Determining the data owner can be a difficult task (Vilminko-Heikkinen & Pekkola, 2019, p. 77). Current literature does not provide a common understanding of the data owner role. First, we found ambiguous definitions regarding the ownership and accountability for data. Some definitions clearly allocate accountability for data to a dedicated data owner role (Otto, 2011c, p. 7), whereas other definitions assign ownership and accountability to the data steward or data producer (Dreibelbis et al., 2008, p. 496; Dyché & Levy, 2006, pp. 156; NASCIO, 2008, p. 10). Researchers should further analyze in which cases a dedicated data owner role is beneficial. Second, we lack knowledge of how the data owner is identified. Do organizations determine the data owner based on the application, where the data is stored, or based on the process, which uses the data? Vilminko-Heikkinen & Pekkola (2019, pp. 80) describe both options in their case study comprising two master data management projects in a Finnish municipality, but the data owner concept and approach remains unclear during both projects. Future research should further investigate the process of data ownership determination. Third, we know little about the scope of data ownership. For a regulation-driven data governance program, the scope might be narrowly defined focusing on key data elements, whereas for an analytics-driven program it might be more meaningful to widen the scope to comprise entire data domains. Future research should conduct a richer analysis on how to define the scope of data ownership, as it might impact the effectiveness of data governance design.

The allocation of decision-making authority also requires further research. As part of our review, we identified basic categories regarding the allocation of decision-making authority, i.e. hierarchical positioning, functional positioning, and the positioning of decision-making authority on a continuum ranging from centralized to decentralized. However, we do not know which allocation of decision-making authority is most suitable under which circumstances. In case of functional positioning, Otto (2011b, pp. 60) states that business benefits related to data governance are eventually attributed to the data governance organization to a larger extent if the decision-making authority is allocated to a business function. However, this proposition requires substantiation through quantitative empirical studies on a larger and more representative sample of companies. Researchers should analyze whether allocating decision-making authority to a business function is more effective than allocating it to an IT function or a separate data governance organization. Weber et al. (2009, pp. 18) provide a qualitative description of the factors that impact the allocation of decision-making authority on a continuum ranging from centralized to decentralized. However, they do not provide empirical evidence of this contingency approach. Researchers should conduct further studies to analyze under which circumstances a centralized, decentralized, or hybrid allocation of decision-making authority is most suitable. Understanding how to allocate decision-making authority could greatly improve the effectiveness of data governance.

Furthermore, data governance is an ongoing program and a continuous improvement process (Cheng et al., 2017, p. 518; DAMA International, 2009, p. 38). New internal data needs and changing external demands such as legal and regulatory requirements force data governance to evolve and adapt (Tallon et al., 2014, p. 171; Weber et al., 2009, p. 23). However, most of the reviewed publications take a "one-off" perspective on data governance and do not reflect how data governance arrangements might need to change over time. We identified a few publications which focus on the evolution of specific data governance concepts such as the evolution of the data governance strategy (Tallon et al., 2013), data ownership (Vilminko-Heikkinen & Pekkola, 2019), and data governance effectiveness (Otto, 2013). Future research should build on these results and conduct further qualitative, quantitative, and longitudinal studies to deepen the knowledge about data governance evolution. The findings could provide a better understanding of which governance mechanisms should be applied during different phases of a data governance program.

5.2. Scope of data governance

Data governance for ecosystems of public and private organizations is another promising research area. Firms increasingly collaborate with partnering companies, outsourcing vendors, and cloud service providers to manage parts of the data value chain (Bruhn, 2014, pp. 4; Panian, 2010, p. 942). Research institutions team up and form distributed research networks which allow researchers to use data from multiple institutions (Kim et al., 2014, p. 714). Current research has started investigating data governance for specific types of inter-organizational settings such as cloud computing (Al-Ruithe, Benkhelifa, & Hameed, 2016), platform ecosystems (Lee et al., 2017), dynamic business networking (Rasouli, Trienekens et al., 2016), supply chains (In et al., 2019), and inter-organizational data collaborations (van den Broek & van Veenstra, 2015). However, we do not know much about how organizations ensure data ownership and control in inter-organizational relationships. Especially the exchange of sensitive data such as personal health information raises new concerns about privacy (Winter & Davidson, 2018, p. 2). Future research should investigate which data governance mechanisms can help organizations to retain control over their data in inter-organizational settings. Researchers should also explore governance practices that support individuals and groups in effectively co-determining how their data is governed and (re)used. For example, additional governance bodies might be required to monitor compliance and balance interests in inter-organizational settings. Furthermore, companies need to create a standardized and trustworthy data exchange environment (Cohn, 2015, p. 821; Rasouli, 2016, p. 97; Rasouli, Trienekens et al., 2016, pp. 1362). Future research should investigate how meta data and other concepts can be used to facilitate interoperability between organizations and traceability of data provenance. Finally, the complexity of ecosystems increases with the number of participating organizations (van den Broek & van Veenstra, 2015, p. 9). Researchers should conduct further qualitative studies to explore the most appropriate governance designs for one-to-one, one-to-many, and

many-to-many inter-organizational settings.

Data governance for big data has been a specific focus in research (e.g. Kim & Cho, 2018; Malik, 2013; Winter & Davidson, 2018). As organizations try to integrate and use big data, having an effective data governance design becomes substantive. However, no general data governance approach for big data has been agreed upon. We identified four major big data challenges and research opportunities regarding data governance. First, data quality for big data needs to be addressed given the incomplete and often uncertain nature of big data (Lemieux, Gormly, & Rowledge, 2014, p. 129; Malik, 2013, p. 5). Data quality issues concerning big data could become an increasing risk, as organizations keep on applying data-driven decision-making (Kim & Cho, 2018, p. 386; Morabito, 2015, p. 97). Future research should determine how data quality metrics should be defined for big data and how accurate big data needs to be. Second, big data raises concerns regarding privacy infringements (e.g. Tallon, 2013, p. 37; Winter & Davidson, 2018, p. 2). The extent to which organizations can act upon big data insights is still an unresolved issue (Tallon, 2013, p. 37). For example, combining data sources to reveal new patterns could cause unanticipated exposure of personal habits (IBM, 2014, p. 6). Researchers should explore governance mechanisms that enable innovation through big data analytics with simultaneous consideration of privacy requirements. This could include policies determining the ethical and permissible use of big data without violating privacy rights. Third, not all data is equally useful, but have varying degrees of value (Malik, 2013, p. 6). However, the definition of the intrinsic data value and the methods of how to measure it still prompt questions (Kooper et al., 2011, pp. 199; Malik, 2013, p. 11). Future research should investigate how to quantify the intrinsic data value. The results could help companies to adjust data retention policies and determine when to migrate data to low-cost storage tiers and when to delete data. Finally, integrating big data with traditional enterprise data poses challenges (Malik, 2013, pp. 4). Data is often fragmented and stored in incompatible IT systems (Lemieux et al., 2014, p. 129; Morabito, 2015 p. 98). The reason for these data silos is often a lack of cross-organizational collaboration (Nielsen et al., 2018, p. 23). Researchers should investigate how governance mechanisms can be applied to foster cross-organizational collaboration to deconstruct data silos.

5.3. Antecedents of data governance

We found that organizations need to design data governance considering contextual factors. Research informing these design decisions will be useful as it helps organizations to tailor data governance according to their specific environment and needs. Although these antecedents have received some attention (Tallon et al., 2014; Weber et al., 2009), we do not know much about their relative importance, their interrelations, and their causal chains. We found in the review that many data governance approaches do not consider contextual factors, which seems reductionist and unrealistic. For future research, rather than ignoring the context, it would be useful if researchers analyzed contextual factors and their impact on data governance design and implementation. This includes the investigation of additional antecedents such as specific industries, firm size, and corporate culture (Begg & Caira, 2012, p. 12; Cave, 2017, pp. 152; NASCIO, 2008, p. 6; Neff et al., 2013, p. 8; Yu & Foster, 2017, p. 345), but also the impact of antecedents on data governance implementation. Based on those findings, organizations could decide upon the amount of structure and formality for their data governance design. Tallon et al. (2014, p. 170) state that some antecedents facilitate the adoption of data governance practices, while others inhibit the adoption. Future research should determine which antecedents are likely to dominate if organizations concurrently possess both enabling and inhibiting antecedents.

5.4. Consequences of data governance

Another relevant but under-researched area comprises the effectiveness of data governance. Current research only provides brief evidence of the intermediate performance effects and the ways how to measure those effects (Kamioka et al., 2016, p. 7; Mikalef et al., 2018, p. 4917; Otto, 2013, p. 96; Tallon et al., 2014, p. 166). On the other hand, organizations still struggle to provide a compelling use case that links data governance to value generation (Nielsen et al., 2018, p. 24). To fully comprehend data governance, we need to understand how intermediate performance effects impact strategic business outcomes such as revenue growth, cost reduction, and regulatory compliance. Future research should conduct a richer analysis of intermediate-level performance effects and their impact on strategic business outcomes. This could be achieved by identifying the causal links between intermediate-level and firm-level performance effects. The findings could help organizations to quantify the benefits of data governance and to derive the business case. Furthermore, we presently cannot define the point beyond which users can feel constrained by data governance. If organizations use too bureaucratic, complex, and restrictive data governance mechanisms, this 'over-governance' could lead to a performance decrease by limiting data-led innovations and motivating users to bypass policies and take unnecessary risks with their data. Tallon et al. (2014, p. 168) describe this as the curvilinear relationship between data governance and firm performance. Future research should conduct a richer analysis of this curvilinear relationship and the inflection point, which determines the optimal data governance design. In doing so, researchers should consider the influence of antecedents as well as the organizational, data, and domain scope.

5.5. Generalizability and replicability

In addition to the research areas described above, the use of further research methods could unveil new findings. Prior research mainly conducted single and multiple case studies. This may pose limitations in making controlled observations and deductions as well as limitations concerning the replicability and generalizability of the findings (Lee, 1989, p. 35; Tallon et al., 2014, p. 171). Transforming the propositions developed in the case studies into testable hypotheses could lay the foundation for further quantitative research (Otto, 2011b, p. 61). Researchers should aim at substantiating the propositions on data governance through quantitative empirical studies on a larger and more representative sample of companies (e.g., Otto, 2011b, p. 62; Tallon et al., 2014, p. 171; Weber et al., 2009, p. 23). In addition, researchers should broaden the sample of study participants. Prior case studies selected primarily IT and data management executives as interview partners (Neff et al., 2013, p. 8; Otto, 2011b, p. 51; Tallon et al., 2014, p. 171; Weber et al., 2009, p. 24). Future research should include additional stakeholders such as the legal counsel, data architects, application and process owners, and data stewards. In doing so, researchers could improve internal validity and gain a holistic understanding concerning the effectiveness, limitations, and challenges of data governance.

Table 4 outlines the research areas for data governance and lists potential research questions for future research.

6. Conclusion

In this study, we conducted a structured literature review, provided an overview of the state-of-the-art of data governance, and identified a research agenda. Two research questions framed our literature review: What are the building blocks of data governance? Where do we lack in knowledge about data governance? We answered the first question by developing a conceptual framework for data governance comprising six dimensions: governance mechanisms, organizational scope, data scope, domain scope, antecedents, and consequences of data governance. We

Table 4
Research agenda for data governance.

Research area	Topics of interest	Research questions
Governance mechanisms	Data ownership Allocation of decision-making authority Data governance evolution	RQ 5.1.1: How do organizations determine the data owner and his/her responsibilities? RQ 5.1.2: How does the allocation of decision-making authority impact data governance effectiveness? RQ 5.1.3: How do data governance mechanisms evolve over time?
Scope of data governance	Application of governance mechanisms on the organizational, data, and domain scope Data quality measurement for big data Data value measurement	RQ 5.2.1: How do organizations retain control over their data in inter-organizational settings? RQ 5.2.2: How do companies facilitate interoperability and traceability of data? RQ 5.2.3: Which data governance designs are effective in one-to-one/one-to-many/many-to-many inter-organizational relationships? RQ 5.2.4: How do organizations define data quality metrics for big data? RQ 5.2.5: How do organizations enable innovation through big data analytics with simultaneous consideration of privacy requirements? RQ 5.2.6: How do organizations quantify the intrinsic value of data? RQ 5.2.7: How do companies foster cross-organizational collaboration to deconstruct data silos?
Antecedents of data governance	Impact of antecedents on data governance Relationship between antecedents	RQ 5.3.1: How do industry/firm size/corporate culture impact data governance design? RQ 5.3.2: Which antecedents are likely to dominate if companies concurrently possess both enabling and inhibiting antecedents?
Consequences of data governance	Measurement of data governance effectiveness	RQ 5.4.1: What are the effects of data governance mechanisms on intermediate-level performance? RQ 5.4.2: What is the relationship between intermediate-level performance effects of data governance and strategic business outcomes? RQ 5.4.3: How does the amount of applied governance mechanisms correlate with intermediate-level performance effects?

answered the second question by analyzing gaps within the dimensions of the conceptual framework and deriving areas for which further research is required. We identified five promising fields for future research: governance mechanisms, the scope of data governance, antecedents of data governance, consequences of data governance, and further research strengthening the generalizability and replicability of findings.

From the perspective of the practitioners' community, the results of the literature review can be considered valuable as the conceptual framework supports practitioners to approach data governance in a structured manner. For example, practitioners could first identify the antecedents that affect their organization. Second, they could determine the organizational scope, data scope, and domain scope for their data governance design. Data governance with a focus on data quality for master data is likely to be different than data governance with a focus on data privacy in the context of big data. Based on those previous two steps, practitioners could choose and customize the set of data governance mechanisms most appropriate for their organization. Reflecting on these results will help to avoid approaching the topic prematurely. The conceptual framework also builds the foundation to exploit synergies between decision domains such as data quality and data security.

Despite the efforts we have made to present a complete review of data governance literature, the study has its limitations. The major focus of our search process was on the term "data governance" including synonyms, but less on the broader concept of data management. Future research should review the literature on data management and screen for governance concepts. Moreover, we included the search term "information governance", as the term is often used interchangeably with the term "data governance". However, we identified few publications that differentiate between both terms (de Abreu Faria et al., 2013, p. 4437; Jim & Chang, 2018, p. 203; Kooper et al., 2011, p. 198). Future research should further investigate the usage of these terms. Due to lack of access, we were not able to use certain scientific databases such as Scopus and Web of Science. Though we are convinced that we have compiled most of the studies carried out on this topic, future research should conduct a literature search in those databases. The study did not validate the practical applicability of the conceptual framework. First, we did not distinguish, which findings describe norms of data governance and which describe the actual practice. Future research should conduct expert interviews or case studies to ascertain which data governance concepts are applied in practice. Second, our conceptual framework does not provide the information on which data governance mechanisms to choose for a given set of antecedents and a given organizational, data, and domain scope. Researchers should conduct a quantitative study to identify the correlations between antecedents, the scoping parameters, and data governance mechanisms. This could provide further insights on how to configure data governance in a specific environment.

With our research agenda, we support the call from Tiwana et al. (2014, p. 9) for more research on the governance of data. We provided a comprehensive overview of the topic that is valuable for both researchers and practitioners in the field of data governance. We hope that our work facilitates future research on data governance by providing a conceptual foundation.

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