Data Governance Capabilities: Maturity Model Design with Generic Capabilities Reference Model

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Abstract: To measure Data Governance, researchers designed a few Data Governance Maturity Models, but the used capabilities are very different, resulting in different measurement outcomes. This research aims to find a substantiated and validated set of Data Governance capabilities for Data Governance Maturity Models design. We apply the Maturity Model design procedure model of Becker et al. for methodology, which we complement with the Generic Capability Reference model to validate the capabilities. As results, we find a proper set of Data Governance capabilities for designing a Data Governance Maturity Models. Furthermore, we validate the set of DG capabilities against the GCR model, of which we conclude that the Generic Capability Reference model is valid as a reference model for the (re)design of Maturity Models.

1 INTRODUCTION

Data Governance (DG) literature is still growing, and it needs further research on what can be done for DG (Abraham, Schneider, & Brocke, 2019; Lis & Otto, 2021). To learn what an organisation already does, Governance' status quo in an organisation can be measured with Maturity Models (MM) (Becker, Knackstedt, & Poeppelbuss, 2009). So, Data Governance' status quo can be measured with a Data Governance Maturity Model (DGMM).

When comparing the few existing DGMMs, we found a lack of agreement on the capabilities used. We further notice that only a few of these existing models have seen some empirical validation. Yet, capabilities are the foundation of a MM and must be selected appropriately to measure maturity accurately. Therefore, further research is necessary on a properly selected and validated set of DG capabilities to design a DGMM.

To develop a more validated set of DG capabilities, we propose using the recently published Generic Capability Reference (GCR) model (Merkus, Helms, & Kusters, 2020). This reference model is based on research in which existing maturity models have been compared to identify capabilities commonly used in maturity models, i.e., generic capabilities. This research uses this model to identify DG capabilities. Furthermore, a second objective is testing the usability of the GCR model to support MM development.

Therefore, the resulting research questions are twofold:

What is a substantiated set of DG capabilities for designing a DGMM based on literature?

To what extent is the Generic Capability Reference (GCR) model suitable as a reference model for designing MMs to validate the found DG capabilities?

To research these questions we used the following steps, which are also the steps described in the remainder of this paper. First, conduct systematic literature research (SLR) for DG capabilities. Then, classify the SLR results with a hybrid Metaplan technique using the GCR model. Third, synthesise the results in a proper set of DG capabilities for designing a DGMM firmly grounded in the literature. Last, reflect on the useability of the GCR-model for identifying capabilities when designing a maturity model.

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2 BACKGROUND

Data governance aims to safeguard data assets' value in alignment with the business (Al-Ruithe, Benkhelifa, & Hameed, 2018; Brous, Janssen, Vilminko-Heikkinen, & Herder, 2016; Weber, Cheong, Otto, & Chang, 2008; Yebenes & Zorrilla, 2019). In doing so, it aims to to establish data management in and between organisations to achieve accountability for data assets assuring quality and access during its life-cycle (Merkus, Helms, & Kusters, 2019).

For measuring the DG status quo, organizations can use a MM. In the literature, there are several DGMMs proposed already (Dasgupta, Gill, & Hussain, 2019; Heredia-Vizcaíno & Nieto, 2019; Olaitan, Herselman, & Wayi, 2019a; Permana & Suroso, 2018; Rifaie, Alhajj, & Ridley, 2009; Rivera, Loarte, Raymundo, & Dominguez, 2017). Typically, these MMs consist of two main building blocks: capabilities and maturity levels (Merkus et al., 2020). When comparing the maturity levels of existing DGMMs, it can be observed that they use very similar maturity levels. And the origins of these maturity levels can typically be traced back to the CMM model (Paulk, Curtis, Chrissis, & Weber, 1993) or earlier staged models (Nolan, 1973). But when we compare the capabilities identified by the existing DGMMs and other DG frameworks, it can be observed that they are very different. And seemingly, they cannot be traced to a single model or framework.

The origins of the DG capabilities vary. We identified the following approaches that were used for choosing the DG capabilities sets (1) Listing Critical Success Factors was an approach to chart DG activities and identified the DG capabilities needed for their successful execution (Al-Ruithe et al., 2018; Alhassan, Sammon, & Daly, 2019). (2) Categorising common DG activities and/or capabilities into groups of mechanisms originating from the field of IT Governance: structural, procedural and relational mechanisms (Abraham et al., 2019; S. De Haes & Van Grembergen, 2004).

Besides the origins of the capabilities, there are also other differences to be noticed between the capabilities of the different DGMMs. (1) First, DG capabilities are presented using different terminologies, e.g. variables and aspects (Heredia-Vizcaíno & Nieto, 2019), or objectives and practices (Rifaie et al., 2009), or DG dimensions and assessment criteria (Rivera et al., 2017). (2) Second, the DGMMs share some common capabilities, but many other capabilities are unique for each DGMM. (3) Finally, only some of the DGMMs are empirically validated so that only a part of the presented capabilities are confirmed (Dasgupta et al., 2019; Olaitan, Herselman, & Wayi, 2019b; Rifaie et al., 2009; Rivera et al., 2017).

And over time, the scope of the capabilities changed from an internal focus towards the external environment of organisations (Lis & Otto, 2020, 2021; Otto, 2011). This shift of the scope is familiar to what happened earlier in the DG related domain of Information Governance, where a more intra-organisational scope is applied too (Rasouli, Eshuis, Trienekens, & Kusters, 2016).

In other words, the DGMMs found in the literature vary in many different aspects. Therefore, we conclude that there is no common ground for selecting DG capabilities for a DGMM. This lack of common ground results in a wide variety of DG capabilities and is considered a gap in the literature.

To fill this gap, we will select our own set of DG capabilities from literature for designing a properly substantiated DGMM in preparation for validation in practice.

For developing a MM, a MM development procedure has already been formulated (Becker et al., 2009). A MM aims to describe the status quo of organisational behaviour or activities in the selected design area on a maturity scale by assessment criteria for a selection of area capabilities (Becker et al., 2009). These area capabilities are often reused from other MMs to ground the artefact design on literature (Becker et al., 2009; Hüner et al., 2009). In addition to basic MM design principles for more reliability, descriptive MM design principles are given to obtain objectivity and prescriptive principles to achieve validity (Pöppelbuss, Niehaves, Simons, & Becker, 2011; Pöppelbuss & Röglinger, 2011; Röglinger, Pöppelbuss, & Becker, 2012). These development procedure steps and principles are validated in multiple studies when comparing maturity models (Cleven, Winter, Wortmann, & Mettler, 2014; Tarhan, Turetken, & Reijers, 2016; Van Looy, de Backer, & Poels, 2011).

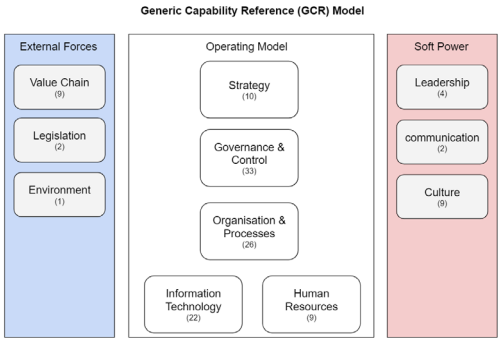


Figure 1: Generic Capability Reference Model(Merkus et al.,2020).

Lately, a reference model was added to enrich this MM design process model for validating generic and area-specific capabilities; see figure 1 *Generic Capability Reference Model* (Merkus et al., 2020).

Only, this reference model has not yet been validated. To do so, we will apply this GCR-model to the set of DG capabilities from literature, resulting in a validated list of DG capabilities and a first validation of the GCR-model.

3 METHOD

To find a proper set of DG capabilities as part of the MM design, we adopt the MM design procedure model according to Becker et al. We follow the four initial procedure steps necessary for finding and validating DG capabilities as a MM section. The following steps in the procedure model remain for further research. We applied the procedure model steps as shown in Figure 2 *MM procedure model + GCR model*.

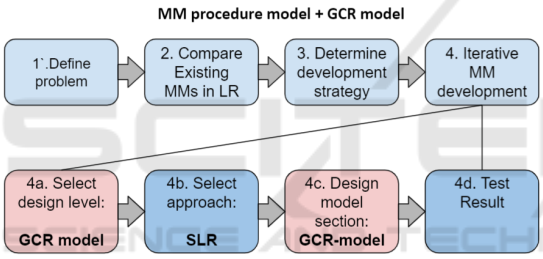


Figure 2: MM procedure model + GCR model.

This figure corresponds to the original procedure model concerning the standard letter display. Our additions are in bold. For sub-step 4a design level, we apply the GCR model. For sub-step 4b, we perform SLR to find DG capabilities. And for sub-step 4c, we apply the GCR model to classify the DG capabilities found in the former sub-step 4b and validate the GCR model. For sub-step 4d, the resulting set of DG capabilities would need the test of this result, followed by the next steps of the MM procedure model like validation in real-life organisational environments. This is for further research.

Step 1 and step 2 are described in the theoretical background above .Step 4d is left for further research. The remaining steps are elaborated as follows.

Step 3 Determine Development Strategy. According to step 3 of the procedure model of Becker, we determine the MM development strategy by elaborating the four sub-steps for step 4, *Iterative MM development*. Chapter 4 Results presents the results of step 4. Following the prescriptions of the procedure model of Becker, we choose the following application.

Sub-step 4a Design Level. For the design level of the DGMM, we choose the GCR model as the highest level of abstraction because it is in line with previous research, brings sufficient abstraction rather than being too detailed and offers diversity in capabilities for designing MMs (Merkus et al., 2020). This reference model gives the DGMM architecture multiple generic dimensions.

Sub-step 4b Systematic Literature Review. Our approach is to find DG capabilities in SLR by searching for DG capabilities in existing DGMMs and other DG frameworks in systematic literature research. We will apply the following steps iteratively,

a. We will search articles with the search string "*Data Governance Maturity Model*" in Google Scholar and Open Universiteit library. We will also apply forward and backwards snowballing for more relevant articles.

b. we will apply inclusion and exclusion criteria to the set of found articles. Articles selected based on inclusion criteria will be reviewed and possibly de-selected based on exclusion criteria to ensure the quality of the study. (i) As inclusion criteria, we will only select articles related to research on DG in IS. Furthermore, we will only select blind double peer-reviewed articles written in English, online available and remove duplicates.

(ii) As exclusion criteria, we will exclude articles that have not been published in a journal or conference with ranking A, B or C according to journal or conference ranking websites, e.g. ERA.

c. We will extract and combine all capabilities from the selected articles in one resulting list of potential DG capabilities.

Sub-step 4c Design DGMM Capabilities with GCR Model. We design the DGMM capability section by classifying the DG capabilities found in SLR with the GCR model thus validating whether the GRC model covers the required scope.

Consequently, we plan the classification of harvested DG capabilities. Classification is required, since the results from the SLR will be partly overlapping, contain homonyms and synonyms, and will deliver results at different levels of abstraction. We classify these DG capabilities with the GCR-model as a reference model for designing MMs but leave the option open for other DG capability dimensions. This closed and open classification has a hybrid character. It is closed for classifying generic

capabilities provided by the reference model. Moreover, it is open for any area-specific capabilities for which no categories are defined yet. This aspect of the approach will test the usability of the GRC-model. If the model scope is sufficient, and no additional areas are required, this is a good test of the model. The classification is simultaneously executed in a group of three peers, all researchers of DG and MMs. This odd number of participants excludes stalemate when making decisions. And three researchers prevent researcher bias. Also, a smaller number of participants improves quick, intuitive classification as intended by classification approach. Moreover, expert knowledge is assured by inviting only subject matter experts. As a classification approach, the Metaplan technique was selected since it has proven its usefulness in previous research (Howard, 1994; Merkus et al., 2019). Because of its brainstorming nature, this research technique is usually executed on paper with yellow sticky notes (Harboe & Huang, 2015; Howard, 1994).

The Metaplan technique will be applied as follows. We will conduct research using an online collaboration tool. The 'online' format was chosen because of the prevailing Covid'19 pandemic and health precautions. For each of the capabilities collected in SLR, yellow sticky notes will be created on an online virtual board. For classifying the capabilities, virtual boxes are created for each GCR group and empty space when no GCR group is applicable. When executing the Metaplan online, the researchers will drag and drop the digital cards into the relevant group boxes or outside the group boxes when no relevant GCR groups are applicable. The cards in each GCR group and the not grouped cards will be classified even further for each group to find more generic or more area-specific DG capabilities.

Validity and Reliability. Evaluating the validity and reliability of this research, we consider four aspects; construct validity, internal validity, external validity and reliability (Saunders, Lewis, & Thornhill, 2015).

To obtain construct validity, we tried to improve the reliability of the collected data. We applied SLR as a research method for grounding on literature comparing existing DGMMs and DG frameworks with applying inclusion and exclusion criteria for quality improvement and excluding unpublished research material to advance research quality.

To improve internal validity, the reliability of our conclusiuon are improved by applying the following measures. (1) We classified the DG capabilities found against the (GC) reference model based on existing organisational readiness MMs, aimed at connecting with similar research. (2) Furthermore, we researched with three researchers in this research area for peer scrutiny. (3) By applying the MM design procedural model of Becker, we based our initial MM design on research that compared several Business Process Management MM designs and thus improved the suitability of the MM that we design as a measurement tool. (4) Moreover, we have applied the Metaplan technique, which is a tried and tested classification technique, improving the rigor of our research.

To increase external validity, we have sought connection with existing DGMMs in literature which was validated. External validity could be further improved by validating and testing the initial MM in real-life organisations as further research.

To ensure the reliability of our research, we have tried to make the research process transparent by providing a reasonably detailed method description so that others can check or reproduce our research.

4 RESULTS

We conducted our research according to the above method in 2020 and early 2021. The results are given for both research questions.

SLR for DG Capabilities. For finding substantiated DG capabilities, we conducted literature research to compare DG capabilities in existing DGMMs and other DG frameworks in early 2020. When searching DG capabilities, we found a set of 179 relevant articles with the search string *"Data Governance Maturity Model"*. Other optional search strings returned too many results to investigate. The search string *"Data governance" AND "critical success factor"* seems adequate, but MM capabilities consist out of more than CSFs alone (Merkus et al., 2020). Forward and backwards snowballing resulted in five more relevant articles, making a total of 184 relevant articles. As described in table 1 *Selection results*, we were left with only 17 articles describing DG capabilities when applying inclusion and exclusion criteria.

Next to the six DGMMs (Dasgupta et al., 2019; Heredia-Vizcaíno & Nieto, 2019; Olaitan et al., 2019b; Permana & Suroso, 2018; Rifaie et al., 2009; Rivera et al., 2017) we found six more DG frameworks (Abraham et al., 2019; Al-Ruithe & Benkhelifa, 2018; Al-Ruithe et al., 2018; Brous et al., 2016; Khatri & Brown, 2010; Otto, 2011; Yebenes & Zorrilla, 2019). Additionally, snowballing result in five other DG frameworks (Alhassan, Sammon, & Daly, 2016; Brennan, Attard, & Helfert, 2018; Janssen, Brous, Estevez, Barbosa, & Janowski, 2020; Krumay & Rueckel, 2020; Lis & Otto, 2020).

Table 1: Selection results.

Article selection criteria	Results
Step 2a articles resulting from search	184
After applying Inclusion criteria	29
After applying Exclusion criteria	17

When extracting capabilities from the article, we found 123 very different DG capabilities. These differences demonstrate that researchers disagree on what DG capabilities include. Sometimes authors added more granularity to their dimensions or capabilities with more specific qualifications, which we excluded from our list because it would not enrich the DG domain. Three articles contained such highly abstracted capabilities or dimensions that we decided to use the sub-dimensions as dimensions because they were comparable in level of abstraction to dimensions or capabilities from other research.

DGMM Design with GCR Model. To design DGMM capabilities with the found DG capabilities in SLR, classification with the GCR model is executed in late 2020 and by three peers who all research data governance and maturity models. Furthermore, because of the absence of an online Metaplan tool, we selected an online tool for affinity diagramming technique that enabled online card sorting research instead of paper.

Of the 123 DG capabilities we found in SLR, we created 123 digital cards in the online collaboration tool to create the affinity diagram for DG capabilities. Together with peers, we grouped all 123 digital cards into groups, in fit with the GCR model and adding other categories when necessary. For the results. see table 2 *Capabilities Distribution.*

The outcome of the online classification of all found capabilities against the GCR-model is presented in a screenshot in figure 3.

Most of the digital cards could be classified according to the predefined groups of the GCR model (94) but not all. The remaining cards (29) contained non-relevant DG aspects such as data management capabilities or even maturity criteria which were considered to be out of scope for our purpose.

Moreover, we found *zero* DG area-specific capabilities (0), giving a correct first validation of the GRC-model, since it did seem to cover all aspects required. We did make one change to this model when we decided that the capability group *Organisation & Processes* could improve into *Organisation Management & Processes* because the capabilities concerned only management activities or processes.

Table 2: Capabilities Distribution.

		cards
Generic DG capabilities		***94***
	Leadership	1
	Culture	3
	Communication	4
	Strategy	10
	Governance & Control	35
	Management & Processes	16
	Information Technology	8
	Human Resources	4
	Value Chain	6
	Environment	1
	Legislation	6
Area-specific DG capabilities		**0**
Total		**94**

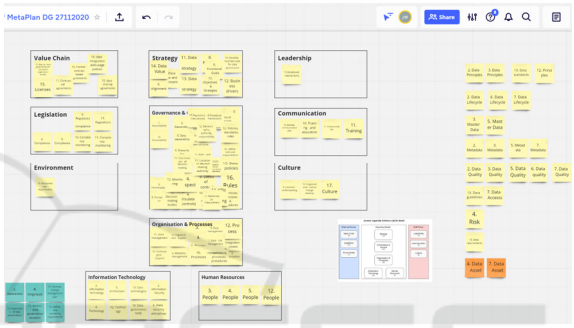


Figure 3: Screenshot Online Metaplan outcome based on the GCR-model.

Cluster	Dimension	Capability	# Cards
Soft Power	Communication	Communicate	1
		Train	2
	Leadership	Lead	2
	Culture	Change culture	3
Operating Model	Strategy	Quantify data value	2
		Align with the business	1
		Formulate data strategy	2
		Make business case	1
		Set goals & objectives	4
	Core Governance & Control	Establish accountability	2
		Establish decision making authority	5
		Establish committees	1
		Establish roles & responsibilities	6
		Establish data stewardship	3
		Establish policies, principles, procedures	11
		Establish KPI's	1
		Establish performance management	3
		Establish Monitoring	2
		Establish Auditing	1
	Organisation Management & Processes	Manage processes	7
		Manage data	5
		Manage metadata	1
		Manage organisation	1
		Manage risk	1
		Manage issues	1
	Information Technology	Setup security & privacy	1
		Setup DG tools	1
		Setup IT	2
	Human Resources	Organize people	4
External Forces	Value Chain	Align & integrate data	1
		Contract data sharing agreements	5
	Environment	Establish environmental response	6
	Legislation	Comply with regulations	1

Figure 4: Data Governance Maturity Model capabilities.

Further classifying of the cards within each GCR-group resulted in a final list of distinct DG

capabilities. The synthesis of the classification outcomes into a list of DG capabilities organised according to the GCR model, including the number of cards per DG capability, is given in figure 4 *Data Governance Maturity Model capabilities.* These DG clusters, dimensions and capabilities can, after further validation in practice, be used to design a DGMM.

5 CONCLUSION, DISCUSSION, AND LIMITATIONS

Concluding, we determined a list of relevant DG dimensions and capabilities in SLR as a result of our initial MM design. This outline of the DG area can be used to continue designing a DGMM. This outline of the DG area may also serve as a basis for further DG research or education.

When using the GCR-model in MM design to classify the found DG capabilities, we disqualified 29 of the 123 capabilities found, being 24% of all. This percentage indicates insufficient clarity on what should or should not be included as a capability in a DGMM. Moreover, we found that the GCR model can support a focus on a consistent interpretation of the concept of capability.

Another conclusion is that the absence of area-specific capabilities supports the validity of the GCR model as a reference model for designing MMs.

When comparing our results with the earlier DGMMs found, several interesting observations can be made. For comparison, we have compared the DG capabilities of each of the six DGMMs found in our SLR together with the DG capability set resulting from our classification, see table 3 *DG capability sets comparison.*

Table 3 clearly shows that designers of existing DGMMs disagree on a single set of DG capability, supporting the claim made in section 2. Table 3 also shows 14 more relevant DG capabilities than the 20 used in existing DGMMS which originate from other DG frameworks and which fit the GCR model.

Furthermore, classifying the found DG capabilities found in SLR against the GCR-model uncovers generic MM capabilities for DGMM design and clearly shows differences between existing DGMMs. It is noteworthy that three DG capabilities in non-validated DGMMs which are not supported by other DGMMS are still supported by the GCR model. So, the GCR-model provides a broader view of MM capabilities, resulting in a more diverse set of DG capabilities. This uncovered set of generic DG capabilities may serve as research agenda for designing a DGMM specifically or DG research in general.

An interesting result is that we found substantial proof for extra-organisational dimensions in other DG frameworks (cluster External Forces, coloured blue) which are absent in existing DGMMs but which are supported by the GCR model. Also, we found proof for the dimensions Leadership & Culture (cluster Soft Power, coloured red), which are missing in existing DGMMs but supported by the GCR model.

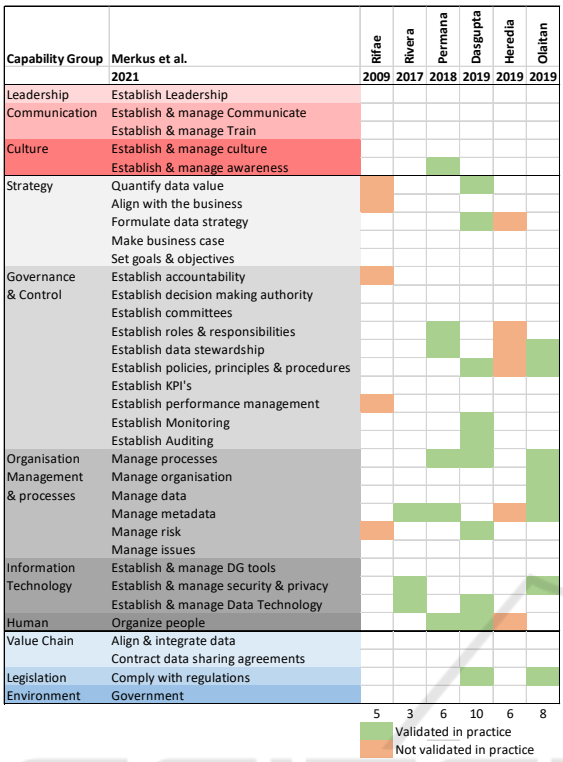
We see an interest in the GCR model capabilities group *Strategy* (Brennan et al., 2018). There is an even greater interest for the DG capabilities group *Governance & Control* and the capability group *Organisation, Management & Processes* (Brous et al., 2016; Khatri & Brown, 2010; Weber et al., 2008). Just like the groups *Information Technology* and *Human Resources*, which both depend on other more advanced research areas (Steven De Haes & Van Grembergen, 2008; Schein, 2004). Furthermore, for the specific DG capabilities *establishing & managing awareness* and also for *compliance* as DG is increasingly required by law, e.g. Sarbanes-Oxley, Basel I-V, GDPR or the latest EU law on DG (Marelli, Lievevrouw, & Van Hoyweghen, 2020). Hence, existing DGMMs measure the DG status quo for most capabilities in the DG capability cluster *Operating Model* of the GCR model together with the capabilities *awareness* and *compliance*. We see that these capabilities (groups) rather focus on the internal organisation or risk mitigation.

We also see no interest in the specific DG capabilities *making business cases* and *setting goals & objectives*, nor *identifying KPI's* although these capabilities were found relevant in other MMs according to the GCR model. These missing capabilities could indicate that not all relevant DG capabilities have yet been explored to measure DG precisely, as a whole and so accurately. In particular, the setting of objectives aligned with the business to measure results in terms of specific KPIs.

In addition, we already saw a widening scope in nearby research areas of DG towards an organisations external environment in section 2, which is supported by other DG frameworks and the GCR model but not yet present in existing DGMMs.

Moreover, the most noticeable absent capability group is Leadership, Culture and Communication. This uncovered area indicates a gap in the body of knowledge and might explain why DG is not yet on organisational boards priority lists (Alhassan, Sammon, & Dal, 2018).

Table 3: DGMM capability sets comparison.



It can be concluded that existing DGMMs only include 20 of the 34 relevant DG capabilities identified by this research. They might miss accuracy on DG goals & objectives, rather focus on the internal organisation or risk mitigation and lack leadership and culture capabilities. Therefore, DG is not yet accurately described or measured adequately within organisations, let alone across organisations, because the used sets of DG capabilities are incomplete and therefore still unclear. This lack of a precise DG measure indicates a substantial need for further DG research, both theoretically and in practice.

The study has some limitations. It is limited to the DGMMs and DG frameworks selected in SLR. We have not considered DG capabilities of other DG studies, which could extend or confirm the presented set DG capabilities, although validation with the GCR model should prevent this.

Also, the set DG capabilities needs validation in practice. Further research is necessary to validate the outcomes of this research. We recommend to finalise the MM design process steps by completing the design of the DGMM and validate the designed DGMM per capability and as a whole.

We also suggest applying the GCR model to further research (re-)designing MMs and apply the model to other governance areas.

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