Characterizing Maturity of Digital Transformation in Organizations – A Socio-technical Framework

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Abstract. Digital technologies foster organizations to rethink their business models and socio-technical structures. Thus, digital transformation (DT) has become a compelling priority on organizations' agendas. To meet the new environment, well-considered actions must be initiated and monitored at the operational and strategic levels. Therefore, it requires an understanding of fields of action and possible trajectories of DT within different organizational dimensions. For this purpose, practitioners and academics have designed numerous digital maturity models to keep track of DT progress. Still, most models reveal an incomplete picture of the holistic and socio-technical nature of DT and organizations. This motivates us to answer: *Which set of organizational dimensions and characteristics maps the holistic and socio-technical nature of DT in organizations?* With a systematic literature review and a Delphi study, our paper aims to identify and validate relevant DT-related dimensions and characteristics. The result is a socio-technical framework that serves as a pattern for (re)designing digital maturity models.

Keywords: Digital transformation · Digital maturity · Framework

1 Introduction

Digital technologies continue to grow in importance and transform the environment in which organizations operate. They cause changes in customers' requirements, in the conduct of business, and the competition and interaction between organizations [1]. To meet the new environment and ensure viability, necessary strategic and operational changes must be made within the organization [2]. In this context, the concepts of digitization, digitalization, IT-enabled organizational transformation and digital transformation (DT) are used [3–5]. While the literature on these concepts, especially on DT, focuses largely on digital technologies, these represent only one aspect of the complex phenomena [5]. Organizations represent socio-technical systems [6]. Therefore, to successfully manifest the changes throughout organizations in the long term which corresponds to a DT [3, 4], a socio-technical perspective is required [7, 8]. This means that a multitude of facets of an organization, such as business models, technology infrastructure, processes, leadership style, and culture, should be considered and aligned together [3, 9–11]. Thus, it

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is crucial that managers continuously monitor progress of the organization's DT [12]. In other words, they need to keep the organization's digital maturity in sight. Digital maturity models (DMMs) help assess such progress of transformation activities in a digital context and point out a focused path throughout the transformation [13–15]. With this intention, different DMMs have been proposed in recent information systems (IS) research. However, studies show that most DMM proposals provide a fragmentary picture of digital maturity in terms of the concept of DT [16–18]. Existing DMMs lack consistency, clarification, and applicability [17–21]. Thus, there is a significant need for an application-oriented DMM that takes into account the holistic and socio-technical nature of DT [13, 16, 18, 21]. For this, it is first crucial to know what an organization should assess internally [3, 5, 13, 22–24]. Through this call for further research, we aim to develop a socio-technical framework that maps a complete picture of DT and helps (re)designing DMMs. With a systematic literature review and a Delphi study, we aim to answer the following research question: *Which set of organizational dimensions and characteristics maps the holistic and socio-technical nature of digital transformations in organizations?*

Our literature-based and empirically-validated framework contributes to meeting the research need by pointing out the full extent of DT-related characteristics within organizations, regardless of their industries or sectors. This serves as a pattern for (re)designing DMMs. The paper is structured as follows. The next section gives a brief overview of relevant research background around DT and digital maturity before we outline the research methodology of our study in the following section. In the subsequent section, we present our preliminary results by answering our research questions. The last section provides an overview of the contributions, implications, and limitations of our work.

2 Research Background

DT has become a significant keyword with a variety of definitions and relationships with other similar concepts in the literature. The consensus is that DT is a process of organizational change induced and driven by new digital technologies. It has an organization-wide impact on a multitude of dimensions and their components of an organization, such as business models, operational processes, or customer touchpoints [2, 3, 5, 9, 11, 25, 26]. A DT brings forth a new organizational identity [4]. Therefore, a DT differs in the degree of change to the concepts of digitalization and IT-enabled organizational transformation. Digitalization changes simple business processes and operations, whereas IT-enabled organizational transformation furthermore reinforces the organization's value proposition [3]. A DT goes beyond that by affecting the whole organization [3, 11, 27]. It leverages digital resources to create differentiated value [28]. Induced changes are felt across the socio-technical structures of the organization [5, 7, 8]. Moreover, the changes map the business environment's complexity and the disruptive impact of digital technologies at the individual, organizational and societal levels [5]. Therefore, proper management is needed to guide properly through the DT process [29]. As an organization, it is crucial to embed transformation objectives into the business strategy [30]. Additionally, DT progress needs to be monitored and assessed to be able to take targeted actions [12, 25, 29]. Thus, organizations need to know which organizational

characteristics contribute to DT and therefore need to be taken into account [3, 5]. However, organizations find it challenging to assess an internal status quo [25]. In other words, maturity is not or only vaguely determined.

Maturity, in a broader sense, reflects evolutionary progress made in business objectives or capabilities from a start to a desired respectively defined end-stage [15, 24]. In IS research, maturity is viewed as a measure for assessing organizational characteristics [15]. In a DT context, the term digital maturity is used and specifically expresses which DT progress has already been realized [9, 31]. As stated above, a DT influences socio-technical structures. Therefore, digital maturity goes beyond a purely technological perspective, but also comprises a managerial aspect. It describes what progress have already been achieved within different organizational dimensions [9, 18].

To monitor transformation progress, maturity models are useful and well-established tools in IS research [13, 20, 22, 24, 32, 33]. Maturity models are valuable because they outline typical, predictable, or desired paths of potential trajectories of specific organizational characteristics [34]. Hence, maturity models also appeal in the digital context [20]. Such digital maturity models (DMMs) consist of measurable and relevant characteristics that can be assigned to organizational dimensions and grouped if necessary into components [12, 23]. Researchers have since been engaged in developing DMMs, applying or validating existing ones, mostly in a top-down approach, and analyzing them on a meta-level [33]. Developers of DMMs can draw on various proposals for DMM development methods in the literature [23, 34, 35].

Nevertheless, improvements to enhance the quality of existing DMMs in IS research [22, 33] can be sought out because most DMMs lack consistency, clarification, and applicability [17–21]. Regarding accuracy, Becker et al. [34] see an increasing inconsistency and low accuracy when it comes to DMM development and validation approaches. In particular, and in most cases, the procedure of data collection is not described transparently and the measurement validity is deficient [21]. Gökalp and Martinez [19] add that many DMMs were not published in academic peer-reviewed articles. In terms of clarification, existing DMMs convey an incomplete picture of digital maturity because they only address one or a few dimensions [17, 18, 20]. Moreover, DMM dimensions have rarely been conceptualized and specified in detail [18, 19, 22]. Regarding applicability, Gökalp and Martinez [19] conclude that existing DMMs do not show an integrated and empirically validated approach for application.

With consideration of the stated shortcomings of DMMs, a research gap becomes visible. It requires DMMs that meet the holistic and socio-technical nature of a DT by including all measurable and transformation-relevant characteristics of an organization [13, 18, 21]. Such a DMM should be described in such detail that its containing dimensions possess greater depth. In this context, it is proposed to first understand the complexity of DT by systematically identifying characteristics that are relevant for mastering DT. This is where our paper comes in providing a socio-technical framework as a pattern for (re)designing DMMs.

3 Research Methodology

We use a conceptual framework for systematizing the research results [36]. Methodically, we orientate on acknowledged maturity model development procedures from

previous IS research and on their requirements for the design of a maturity model [23, 34, 35]. In this way, we aim to develop a framework that can be used as a pattern within the procedure of formulating a DMM's architecture and content. When identifying the framework's content, scientific literature proposes to conduct an extensive review of DMM and DT literature. The literature-based findings need to be evolved and tested for "comprehensiveness, consistency, and problem adequacy" [34] by other methods [23]. Expert groups in the context of Delphi studies are one suitable method [23, 34, 35]. Thus, we structure our approach in a literature review and empirical revision phase. In the first phase, we conducted a systematic literature review based on the suggestions of Webster and Watson [37]. In the second phase, we conducted a Delphi study comprising a survey of an expert panel over four rounds.

When reviewing the literature, we identified relevant context- as well as object-related keywords and then set up an adequate search string: *"digital transformation" AND ((maturity OR assessment OR readiness OR capability OR "capability maturity" OR "maturity grid" OR "stage of growth") AND (model OR framework OR map)).* Due to consensual differences in the concepts of DT, IT-enabled organization, digitalization and digitization in literature [3, 4] as well as our research focus on DT, we only included the term *digital transformation.* Previously, the term *digital maturity* was additionally included in the search string. But it was discarded due to the high number of non-fitting literature that mostly deals with the adoption of single technologies and that are out of the context of DT. The search string was then used for a query in the databases *Scopus*, *EBSCOhost*, as well as *IEEE Xplore*. Here, we only included peer-reviewed journal or conference articles in English that are available online. Duplicates were excluded. In an initial review of titles, keywords, and abstracts of 228 hits, we checked on accessibility and whether these articles focus on DT and digital maturity. After excluding non-relevant articles, we reviewed the full texts of 151 articles, excluded other irrelevant articles, and could ultimately extract organizational characteristics related to transformation processes, especially to a DT, from 39 articles. To assign the identified characteristics to organizational dimensions, we reviewed suitable frameworks encompassing dimensions in the context of DT and change management. We see common ground best represented by the 7S framework (7S) enabling a holistic and socio-technical view of essential organizational dimensions. The 7S was formulated and tested by Waterman et al. [38] and initially intended for McKinsey's business consulting purposes. Since then, the framework was used and adapted in various areas of research, even in the context of maturity assessment and digitalization [39–44]. Waterman et al. [38] claim that organizational change is only effective and successful if all relevant dimensions of an organization are considered. These 7S dimensions can be summarized as follows: *Strategy* describes all strategic actions in interdependence with external circumstances, which are essential for the business ability of the organization. *Structure* is the visible and formalized skeleton in the form of departments, teams, and tasks of an organization. *Systems* of an organization consist of the technical infrastructure as well as formal and informal processes that support other activities within the other dimensions. *Staff* includes all activities that impact the *Structure* and culture of the workforce and that shape the employee skill set. *Style* of an organization is affected by the leadership style and all related activities and behavior of managers and employees. *Skills* are understood as all skills, competencies,

and knowledge that exist on an individual, team, and organizational level. *Superordinate Goals* shape the corporate culture and act as a guideline for daily work. [38] When having the complete list of organizational characteristics after reviewing the articles' full-texts, we derive concepts according to Webster and Watson [37]. We aggregated duplicate or similar characteristics and finally assigned them to an appropriate dimension of the 7S. The decision process of assigning took place in workshops among the authors.

Our resulting theoretical framework was then empirically validated and refined using the Delphi method in the second phase. To do so, anonymous expert opinions were obtained in several rounds. In general, the Delphi method can be used for answering complex questions and for elaborating future directions [45]. It is an iterative approach in which multiple surveys are conducted until a consensus among experts is reached [45]. Delphi studies are well established in IS research [46] and have been successfully used in maturity model research [47, 48]. At the beginning of a Delphi study, a panel of experts is established, who can provide information about the topic area [45]. According to the literature, the expert panel is appropriate with a number of 10–18 participants, and the experts must remain anonymous among themselves. This is to prevent conflicts within the group as well as peer pressure [46]. The experts then evaluate the given topics in several rounds. After each round, the results of all participants are consolidated. On this basis, iterative adaptions are made, which are finally approved by the experts. A broad sample increases the chance of capturing different impressions in the data [49]. Therefore, we selected twelve experts with different fields of expertise, backgrounds, ages, and professional experience for our Delphi study. Participants worked either in academia (3) or practice (9) in Germany. Those working in academia qualified for our survey by conducting their research in the field of DT and/or having already developed maturity models. The participants working in companies have either practical experience in the area of DT, in the realization and development of digitization projects, in developing maturity models, or are working in an IT division. Our sample contains a broad spectrum of working experiences and ages of the participants. Professional experience varies from five or fewer years up to 16–20 years. A similar pattern can be noted regarding the age of the participants, which is between 21 and 50 years. In the four rounds of our Delphi study, 9–12 experts participated in each round. After the experts were determined, the study was conducted in four rounds. Each round consisted of a questionnaire provided through an online survey tool. The findings of the previous literature review served as the basis for the surveys in the form of aggregated dimensions and characteristics. Each round started with relevant background information. Rounds 1 and 2 focused on the dimensions, while rounds 3 and 4 dealt with the characteristics of the respective dimensions. **Round 1** began with definitions of DT and DMM to achieve a common understanding among all experts. The experts were asked to evaluate the seven dimensions, which were defined based on the literature review, and summarize all relevant aspects of an organization in a very abstract way. Each dimension was presented using a definition. For each dimension, the experts could choose to *Retain* (the dimension should be kept exactly as it is presented), *Adapt* (the dimension should be changed or extended), or *Drop* (the dimension should be completely removed from the framework). For this purpose, a selection box was provided for the experts to click on. In a separate field, the experts were allowed to make additional comments, which they should use if they had adaptions and/or additional

requests. In addition, the experts were asked whether the bundle of dimensions were complete or whether dimensions should be added. In preparation for the next round, necessary adaptions were made based on the results from the first round. A dimension is considered to be confirmed if it has a retention rate of at least a two-thirds majority. For a dimension to be completely dropped, a drop rate of at least a two-thirds majority is required. If these rates are just not met, it will be decided on a case-by-case basis which changes are necessary according to the experts' change recommendations. The adapted dimensions were presented to the experts for validation in **round 2**. The experts again had the three selection options *Retain*, *Adapt* and *Drop* as well as a comment field available. Additionally, the experts were asked to weigh the dimensions according to relevance. A maximum of 100 points was available, which had to be assigned to the individual dimensions by the experts. The sum of all the points awarded had to total 100. In **round 3**, the focus was on the characteristics of the dimensions that were assessed by experts. Within each dimension, a decision had to be made for each characteristic, whether it should be retained, adapted, or dropped. Again, the selection fields, including a comment field, were available. The results from round 3 were evaluated analogously to the first rounds, and the necessary adaptations of the characteristics were made. Finally, in **round 4**, the adapted characteristics were presented to and evaluated by the expert panel. After this round, the Delphi study could be concluded as a consensus was reached among the experts. Thus, the last minor adaptions were made, resulting in the finalization of the dimensions and characteristics.

4 Results

Due to the conducted systematic literature review in our first phase, we initially could extract a sum of 698 DT-related organizational characteristics from 39 relevant articles. These could be completely assigned to at least one dimension of the 7S. All articles addressed at least one 7S dimension. However, it is noticeable that most articles (35) have the dimension *Systems* under consideration, followed by *Strategy* (29) and *Style* (26). Three articles cover all seven dimensions, two of which aim at a state-of-the-art and one on a literature-based development of a DMM. Regarding the articles' research focus, it is striking that most of the literature (28) is to develop a DMM, whereas only a few DMMs are applied (5) or validated (4). In addition, articles with a focus to elaborate a state-of-the-art (3) were identified. Of the 698 characteristics, we aggregated duplicates and similar ones into a total of 48 different characteristics. This results in the design of a literature-based framework that we empirically revised in our second phase. The holistic approach of our framework was positively welcomed by the expert panel of our Delphi study. According to the expert panel, it covers the main facets of DT to map its complexity and impacts on practice within organizations. Our framework provides a sufficient overview of relevant aspects, which in turn leads to an optimized decision-making process. Nevertheless, "the model covers a lot, but there can be added more facets, which might be partly subordinated to other dimensions" [Delphi study]. The expert panel points out that it was difficult to delineate individual dimensions and characteristics because of their close relationships that are expressed intentionally by the 7S's definitions. Due to losses in terms of understanding of the dimensions and clarity

about the completeness, the literature-based framework was subjected to revision. The empirically-revised framework is introduced in *Table* 1 and substantial revisions are described below.

Table 1. Socio-technical framework for DT (literature-based and empirically-revised).

Dimension and characteristics	Literature basis
Strategy: Existence of clearly defined digital vision | Organization synchronized with digital vision | Existence of systematic developed digital strategy | Holistic execution of digital strategy | Development and offering of digital services or products to strengthen the existing business model or to enable new business models | Internal integration of digital technologies | Budgeting for digital innovation considering potential qualitative and quantitative benefits | Focus on customer value; Involvement of customers in the innovation process | Cooperation with business partners in a digital ecosystem | Conducting technological trend analysis | Corporate governance providing standards, ensuring ethics and compliance with laws	[3, 18, 50–76]
Structure & Process: Tasks, responsibilities, and competencies defined to support staff in execution | Coordination of centralized and decentralized digitalization efforts | Adequate resource allocation for digitization and transformation activities | Decentralized approach resulting in an extensive scope of action for divisions, departments, and working groups | Agile and flexible organizational configuration | Exchange across departments, business units, and organization borders | Collaboration in multidisciplinary teams | Data-driven product and service development in line with strategy | Data-driven resource planning processes | Digitally-modeled operations resulting in higher process transparency | Automated operational processes	[3, 18, 50–63, 65–83]
Technology & Data: Harmonized and resilient technology landscape | Communicating and interoperable equipment and installations | Interoperable and data-driven mobile devices & embedded systems | Automated and customizable application and service systems | Automated and expedient data acquisition and storage | Ensuring high data quality | Intra- and inter-organizational data integration and sharing | Ensured data security, protection, and ownership | Data analysis for operational and strategic purposes	[18, 53, 55–59, 61, 62, 64, 65, 67, 68, 70, 72, 75, 77–80, 82, 83]

(*continued*)

Table 1. (*continued*)

Dimension and characteristics	Literature basis
Culture: Innovative ideas are contributed by the entire staff | The risk of failure is taken to realize new ideas | Willingness to learn from errors | Organizational knowledge is shared and preserved internally | Openness to intra- and inter-organizational collaborations | Existence of transformational leadership style | Information is shared within the organization | Participative interaction between staff | Awareness of new digital developments | Openness to new technologies	[18, 52, 54–60, 62, 64, 65, 68, 69, 71, 72, 75, 79–81, 83–86]
Skills: Ability for teamwork | Ability to learn continuously | Ability to use digital tools | Technical knowledge is available | Data are handled | Staff is hired based on needed expertise | Analyzes show whether the necessary skills are sufficient | Staff is trained	[18, 51, 52, 54, 56–59, 62, 64, 68, 69, 72, 74–76, 80, 82, 84, 86]

The first dimension ***Strategy*** comprisses all activities that align the vision, the guidelines, and the business model with the political-legal, economic, social, and ecological circumstances of the business environment. In the origin 7S, a distinction is made between *Strategy* and *Superordinate Goals*. Many practitioners and even some scientists in our Delphi study had difficulties in differentiating the *Superordinate Goals* from the concept of *Strategy* and *Culture* and therefore pleaded for a merger. We have followed these suggestions as we pursue the goal of an application-oriented and user-friendly framework and separated the *Superordinate Goals* into *Strategy* and *Culture*. *Superordinate Goals* shape on the one hand the corporate culture and act as a guideline for daily work, and on the other hand, they give "notions of future direction" [38]. These notions are particularly shaped by aspects like the vision and corporate governance, which in turn is strongly linked to the strategy as many participants noted.

The second dimension called ***Structure & Processes*** comprises all visible and measurable components and activities concerning the organization's internal processes as well as its structure, such as hierarchies, departments, and teams. This dimension is a merger of *Structure* and a component of *Systems* belonging to the initial framework based on the 7S [38]. The *Structure* is the visible and formalized skeleton of an organization. Employees are aggregated into departments and tasks are divided into subtasks [38]. *Systems* includes partially formal and informal processes that support other activities within the other dimensions [38]. The original term *Systems* was misleading and required a separation of the technological and process component. According to the expert panel, a process component was not sufficiently clear, although especially value creation processes play an essential role in ensuring organizational alignment at a strategic and operational level. Because they saw a close relationship between internal processes and structure, these were therefore merged.

The dimension ***Technology & Data*** has been reformulated by the stated separation of *Systems* as well as by the emphasis of the expert panel on the importance of data

management in the context of DT. Thus, the dimension comprises the composition, interaction, and functionalities of technical resources required for processing information and data, as well as all activities within the scope of data management. Technical resources are hardware, software, and communication networks whose aggregation represents the technology landscape of an organization.

Culture comprises the overall values, norms, mindsets of the workforce, and leadership styles of management that determine behavior at an individual, team, and organizational level. This dimension was called *Style* in the underlying 7S. However, the expert panel disagreed with this designation and required a renaming. The adapted term was confirmed in the second round with a high retention rate. The characteristics of the initial dimension *Style* were simply transferred to *Culture* in the first step. The characteristics of the initial dimension were all confirmed by the experts. However, characteristics had to be added based on the results of the Delphi study.

The dimension ***Skills*** comprises the availability, preservation, and development of knowledge, competencies, and experience at an individual, team, and organizational level. In the underlying 7S, a differentiation is made between *Skills* and *Staff*. However, the expert panel identified strong overlaps between the two dimensions, which should not be considered separately at all. Within *Skills*, "[…] strong overlaps with the item *Staff*" [Delphi study] were seen, while within *Staff* the experts also found it "not quite clearly distinguishable from *Skills*" [Delphi study]. Thus, the two dimensions were combined overarchingly into *Skills.* The adapted dimension was confirmed by the experts in the round 2 so that the characteristics of the dimension were focused on in the third and fourth rounds. The characteristics of the initial dimensions were first combined and adaptions were made after the experts' evaluations in round 3.

In sum, two dimensions were merged, one dimension was split, and assigned to two other dimensions respectively in rounds 1 and 2 of our Delphi study. Concerning the weighting of the dimensions, the expert panel achieved an average of almost equal weighting. *Strategy* took rounded 22%, *Structure & Processes* 15%, *Technology & Data* 22%, *Culture* 22%, and *Skills* 19%. During rounds 3 and 4, out of a total of 48 characteristics, 18 were retained, 26 were adapted, four were dropped and six were supplemented. Thus, we obtained an empirically-revised framework consisting of five dimensions to which we link a total of 50 characteristics.

5 Discussion and Conclusion

The starting point of our research was the need for an application-oriented DMM that takes into account the holistic and socio-technical nature of DT [13, 16, 18, 21]. Thus, we aimed to provide a framework that improves DT management by serving as a pattern for (re)designing DMMs. Existing DMMs convey an incomplete picture of DT's complexity by only addressing a few dimensions [17, 18, 20]. This limits generalizability, which is why we ensure holism by viewing organizations as socio-technical systems [6], so we take a perspective on social and technical implications [87].

We chose a two-phase methodological approach consisting of a literature review and a Delphi study. First, we built a preliminary theoretical framework based on important findings from previous IS research. Existing DMMs and further research on DT and

digital maturity provided a suitable basis for this purpose [33, 34]. To classify DT-related characteristics extracted from the literature, we used a holistic organizational model. The 7S [38] is an appropriate basis that helps in mapping a complex subject area, such as DT. In addition, related research indicates that the 7S can also be adapted and used in distinct actual topics in the context of maturity assessment and digitalization [39–44, 88]. By using the 7S as a pattern in the literature review, the stated research need was confirmed. We identified only one developed DMM that covers all dimensions. Still, this model is at a theoretical level and has not yet been empirically validated. In terms of validity and the required application orientation [19], we went one step further and had our interim results tested and refined by an expert panel in a Delphi study. The anonymous nature of the Delphi study provided creative input and enriched our theoretical framework [46]. The method showed us that formulated dimensions and characteristics were able to be refined. The 7S was compressed into five dimensions and *Technology & Data* were given a stronger role by name than before. This might be due to the 7S's age as well as the driving character of technologies for a DT [2–5]. Moreover, characteristics that were not depicted in the literature were added by the expert panel. With our two-phase methodology accepted in IS research [48], we achieved to develop a socio-technical framework. While DDMs in IS research do not yet map the holistic and socio-technical nature of a DT, our framework provides a comprehensive composition of technical and social dimensions and characteristics. Thus, a socio-technical perspective is taken and the organization is understood as a socio-technical system [6]. This perspective considers both technical and social implications of DT and means that emerging changes are a result of the interactions between the two [87]. By using a two-layered framework architecture, we keep the recommended architecture for maturity models [23] to ensure the balance of representing the complexity of DT, on the one hand, and simplicity for reuse, on the other hand. In addition, adherence to proven development procedure models [23, 34, 35] supports further research. The containing dimensions and characteristics considered in interaction and dependence, our framework reflects the necessary socio-technical view on a DT [5, 7, 8]. The expert panel's weighting supports this perspective with its appraisal that equal attention should be given to all dimensions for a DT.

Nevertheless, our research has limitations. It remains to be emphasized that our socio-technical framework is not a complete DMM. The review of the small number of identified DT- and DMM-related articles only gives an excerpt of all developed DMMs in the literature. Extending the search field by replacing the term *digital transformation* by *digit** to include all other concepts in the digital context could provide more comprehensive results. Nevertheless, this would avert the necessary research focus on DT. Moreover, our design decision process of assigning and aggregating extracted characteristics might have a subjective character due to the common professional background of the authors. Involving an interdisciplinary and larger group in this process could lead to more objective results here, as well. We aimed to dissolve these limitations by empirically testing our preliminary and theoretical results with a 12-member expert panel from academia and practice. This approach is also beset with limitations that are rooted in the nature of Delphi studies. The framework's refinements and coding procedure are based on the perceptions of a group of experts which reduces representativeness [89].

Still, our framework helps facilitate the normalization of DT [13] and accelerate DT in practice by building an understanding and awareness of DT managers for key characteristics in their organization when dealing integrally with DT. Our results guide where DT can progress and suitable actions can be taken in organizations. Further, there is no universal answer to the research questions for an IS problem. Thus, our socio-technical framework reflects one contribution to the ongoing research and is a starting point for a community-wide discussion. A refinement of the framework within for example an iterative maturity model development phase [34] or, more systematically, within a design science research cycle [90] is also feasible. We invite researchers to evaluate, adapt, or extend our framework in further research. In particular, our socio-technical framework should be tested in the context of a DMM design. At this, a methodological basis can also be design science research as previous work around maturity models have done [91, 92]. In addition, reference models such as the Capability Maturity Model Integration that has proven itself in IS research [82] can serve as a suitable basis for integrating our framework. In this way, the holistic and socio-technical nature of DT will be represented in maturity models, so digital transformation maturity models will be supplemented.

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