Keeping Pace with Digital Transformation: Design, Application, and Evaluation of a holistic Digital Maturity Model

by
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Overview of research output

In the table below, all my publications are listed in chronological order. The dissertation includes the five papers shaded in light grey. In accordance with the requirements of the PhD program at ESCP Europe, they equal **3,5** points (a minimum of 2 points is required). The other papers listed are not considered as they are not directly related to the topic of the dissertation.

Title	Authors	Type of publication	VHB	Status	Points
How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models	Thordsen, T.; Murawski, M.; Bick, M.	**Proceedings** Lecture Notes in Computer Science (LNCS)	C	Published in 2020	0.5
A Decade of Digital Maturity Models - Much ado about nothing?	Thordsen, T; Bick, M.	**Journal** Journal of Information Systems and e-Business Management	C	Published in 2023	0.75
The Importance of Platforms to achieve Digital Maturity	Thordsen, T; Bick, M.	**Proceedings** European, Mediterranean, and Middle Eastern Conference on Information Systems (EMCIS)	C	Published in 2023	0.75
Towards a holistic digital maturity model (*Research In Progress Paper*)	Thordsen, T; Bick, M.	**Proceedings** International Conference on Information Systems (ICIS)	A	Published in 2020	-
A holistic digital maturity model for content publishers in the media industry	Thordsen, T; Bick, M.	**Journal** European Journal of Information Systems (EJIS)	A	Desk reject passed	1.5
Structural Requirements for Digital Transformation – Insights from German Enterprises	Murawski, M.; Thordsen, T.; Martensen, M.; Rademacher, C.; Bick, M.	**Journal** Journal of Competences, Strategy & Management (JCSM)	C	Revised and resubmitted	-
Organizational requirements for digital transformation – a first empirical investigation	Murawski, M.; Thordsen, T.; Martensen, M.; Rademacher, C.; Bick, M.	**Proceedings** International Conference on Competence-based Strategic Management	-	Published in 2017	-
The Role of Non-social Benefits Related to Convenience. Towards an Enhanced Model of User's Self-disclosure in Social Networks	Thordsen, T.; Murawski, M.; Bick M.	**Proceedings** Lecture Notes in Computer Science (LNCS)	C	Published in 2016	-

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List of abbreviations

CMM	Capability Maturity Model
COVID-19	Coronavirus Disease 2019
DCT	Dynamic Capabilities Theory
DMM	Digital Maturity Model
DSR	Design Science Research
DT	Digital Transformation
ECIS	European Conference on Information Systems
e.g.	exempli gratia (Latin, means: for example)
EMCIS	European, Mediterranean, and Middle Eastern Conference on Information Systems
EJIS	European Journal of Information Systems
et al.	et alii (Latin, means: and others)
LNCS	Lecture Notes in Computer Science
I3E	IFIP Conference - e-Business, e-Services, and e-Society
ICIS	International Conference on Information Systems
i.e.	id est (Latin, means: that means)
IS	Information Systems
IT	Information Technology
JCSM	Journal of Competences, Strategy & Management
SSKM	Symposium Strategisches Kompetenzmanagement
WI	Internationale Tagung Wirtschaftsinformatik

This collection of abbreviations solely applies to the dissertation at hand. It does not encompass abbreviations used in the attached research manuscripts (section 5). The same holds true for the list figures and tables respectively.

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"Digital maturity models are the key to unlocking the potential of digital transformation, allowing organizations to move from a status quo to a truly digital business."

(Chat GPT, 2023)

1. Introduction

In recent decades, globalization has increased the pressure on organizations to adapt to an increasingly dynamic business environment (Kraus et al., 2021). To not only stay alive, but to thrive in this ever-changing business landscape, organizations need to efficiently integrate digital processes and collaborative tools. In this context, the importance of *digital transformation* (DT) has increased (Vial, 2021). On a high level, DT refers to the substantial changes occurring in society and industries as a result of the usage of digital technologies. At the organizational level, DT refers to the combined effects of the implementation of new technologies, which fundamentally transform "business strategies, business processes, firm capabilities, products and services, and key interfirm relationships in extended business networks" (Bharadwaj et al., 2013, p. 471).

Recently, the event of COVID-19 served as a catalyst for DT, compelling businesses to accelerate their adoption of digital technologies and to reshape their operations in order to keep pace with the highly dynamic business environment (Burlea-Schiopoiu et al., 2023). The adoption of new technologies is defined as *digitalization.* With new technologies are meant social, mobile, analytics, and cloud technologies, as well as increased processing power, storage capacity, and communication bandwidth (Berger, 2018; Legner et al., 2017). Underlying this digitalization is the concept of *digitization* designating the process of converting analog information into digital data and automating activities using information technologies (Loebbecke & Picot, 2015).

In its entirety, DT eventually disrupts established corporate structures across all firm sizes and all sectors and thus causes high levels of uncertainty among managers. Disruptive changes in an organization and its business environment caused by the adoption of new technologies may possibly lead to the current business model becoming obsolete. DT thus threatens the existence of present organizations (Singh & Hess, 2017).

However, DT also bears new potentials for businesses to evolve and thrive in an increasingly digital world. It enables companies to stay competitive, deliver better customer experiences, optimize operations, and drive innovation and growth forward (Chanias & Hess, 2016b). DT is

an ongoing process, likely to have a lasting impact, as companies recognize the benefits of increased agility and efficiency, and resilience (Kane et al., 2017).

To harness the opportunities of this Information Technology (IT) induced phenomenon, managers need to formulate and prioritize concrete measures and investments to advance the transformation process (Menz et al., 2021). DT is an ongoing process, likely to have a lasting impact, as companies recognize the benefits of increased agility and efficiency, and resilience (Kane et al., 2017). Most of today's organizations are aware of the potentials of integrating new technologies in their business strategies (Eastmen & Sissons, 2016). However, the transformation of an organization is a long, time-consuming, and costly process with uncertain results taking time to manifest (Karimi & Walter, 2015). Consequently, there have been numerous recent examples of firms failing to efficiently distribute their resources. The inability to "keep pace with digital reality" may result in a sale or ultimately bankruptcy of an organization (Hess et al., 2016b, p. 124). Between 2022 and 2026, global investments in digital transformation are predicted to almost double, possibly reaching 3.4 trillion US Dollars (IDC, 2023).

In recent years, DT has as emerged as a significant research topic in the field of Information Systems (IS) (Robertsone & Lapiņa, 2023). Due to its high practical relevance, practitioners have increasingly set out to investigate on this topic (Gollhardt et al., 2020). To date, neither among researchers nor among practitioners, there is a consensus on the organizational key factors that must be considered for a firm's successful digital transformation endeavor (Hess et al., 2016a).

Managers in various sectors are looking for guidance to stay up with digital reality (Hillerström & Petersson, 2020). Their goal is to fully reap the benefits of digital transformation while diminishing the risk of their organizations becoming obsolete. Managers seek to make the right investments at the right point in time (Schallmo et al., 2020). Management consultancies have set out to cater exactly these needs by developing so-called digital maturity models (DMMs). DMMs are designed to identify success factors and reap the long-term rewards of digital transformation (Ochoa-Urrego & Peña, 2020). These models are intended to analyze an organization's present state of digital transformation, as well as to identify and prioritize measures to raise the level of digital maturity.

According to Chanias and Hess (2016a, p. 4), digital maturity designates "the status of a company's digital transformation". It indicates the progress a company has made in terms of transformation efforts. Efforts in this area include both operationally executed improvements and abilities obtained for mastering the organizational transformation process.

The design and use of DMMs is controversially discussed within the academic field of IS. Despite the widespread practical application and popularity among management consultancies and industry associations, several voices of the academic community question the quality and actual practical and theoretical value of these models (Berger et al., 2020; Rader, 2019; Teichert, 2019). This can be mainly traced back to the poor theoretical base and limited empirical evidence of DMMs. Nevertheless, various IS scholars underline the benefits of DMMs. Following a more pragmatic approach, according to these academics, it is expedient for a DMM to allow for a better overall understanding and direction in managing organizational digital transformation in order to add value to practice and theory (Carvalho et al., 2019; Gill & VanBoskirk, 2016; Ochoa-Urrego & Peña, 2020; Remane et al., 2017).

Research questions and goals of this dissertation

Despite their popularity and relevance, the theoretical and practical value of DMMs remains unclear. Consequently, the overarching research questions of this dissertation are:

1. Where lays the practical and theoretical value of existing DMMs?
2. What quality criteria can be derived for the design of DMMs?
3. How can a holistic DMM for a specific industry be designed, applied, and evaluated based on academic standards?

An explorative research design seems to be the most suitable approach, as it the aim of this dissertation to investigate on the underlying principles of the research object, as well as to get a more nuanced and deeper understanding of the phenomenon (Flick et al., 2005). In this context, the lack of precise conceptual definitions, as well as the absence of established quality standards for DMMs constitutes major challenges.

To structure the present scientific investigation, the following research aims have been defined for this dissertation.

1. Critical evaluation and discussion of present DMMs' theoretical and practical value
2. Establishment of quality criteria for the measurement of an organization's level of digitalization
3. Determination of essential building blocks for DMMs
4. Development of a holistic DMM based on academic standards
5. Application of a holistic DMM based on academic standards
6. Publication and presentation of the research papers and dissertation

In summary, by attaining the present goals, this dissertation seeks to find new solutions for the following practical problem: the great uncertainty for organizations that is caused by the effects of digital transformation.

Consequently, the research paradigm of this dissertation is design science research (DSR) (Hevner et al., 2004). DSR bridges the gap between theory and practice by designing and evaluating new solutions for practical problems (Baskerville, 2008). The ultimate objective of DSR is to generate and synthesize new knowledge that leads to meaningful improvements and actionable outcomes (Bisandu, 2016; Drechsler & Hevner, 2016).

This thesis, among others, follows the academic calls Schallmo et al. (2020) and Williams et al. (2019) for a more nuanced understanding of the phenomenon of DT. This dissertation is also in line with the academic calls of Becker et al. (2010) and Poeppelbuss et al. (2011) for a deeper analysis and differentiation of IS maturity models and their usefulness for practitioners. Ultimately, the scientific calls of Remane et al. (2017) for further empirical evidence, Nguyen et al. (2019) for closer investigation of the theoretical basis, as well as Gollhardt et al. (2020) for a better comparability of the DMMs will be met in the context of this doctoral thesis. These contributions are accomplished via both the respective research manuscripts, as well as by the integrated perspective of the dissertation at hand.

When engaging in maturity model research, particular rigor, accuracy, and documentation are essential to prevent reproducing the previously mentioned shortcomings of maturity models (Becker et al., 2009). Following this line of thought, this dissertation builds on the ideas of Becker et al. (2009) and de Bruin et al. (2005) who have defined concrete guidelines for the design and evaluation of maturity models in IS. In addition, this dissertation draws on the work of Solli-Sæther and Gottschalk (2010) who offer additional assistance for this undertaking.

The structure of this dissertation is as follows. The next chapter outlines the underlying theoretical concept of digital transformation and presents current approaches to manage organizational digital transformation – including the idea of DMMs. In section 3, the overarching research paradigm is presented. Then, in section 4, the dissertation structure as well as the five research manuscripts with their respective research objectives and questions will be briefly introduced. Subsequently, in section 5, these five manuscripts are presented in full. A discussion of the contributions, implications for theory and practice, respective limitations, and future research constitutes section 6. Finally, this dissertation draws a conclusion with final remarks.

2. Managing organizational digital transformation

In the academic literature, there are varying perspectives on the concept of digital transformation. In general, depending on the focus of the respective IS researchers, the typology of DT can be defined from an organizational perspective or from a holistic perspective concerning all aspects of human life (Bican & Brem, 2020). Van Veldhoven and Vanthienen (2022, p. 629) regard DT as a technological, organization and social change and thus "as an interaction-driven perspective between business, society, and technology". Westerman et al. (2011, p. 5) refer to DT from a solely business-centric point of view: "DT is the use of technology to radically improve the performance or reach of enterprises."

In this dissertation, an exclusively organizational perspective on the phenomenon of DT is taken.

2.1 Organizational digital transformation

Following (Bharadwaj et al., 2013, p. 471), organizational DT is defined as the combined effects of the implementation of new technologies "fundamentally transforming business strategies, business processes, firm capabilities, products and services, and key interfirm relationships in extended business networks". This IT-induced phenomenon can bring along significant advantages such as cost reductions and innovation and gains in productivity. It thus affects the way firms achieve competitive advantage and ensure their long-term success in an increasingly digital business environment (Menz et al. 2021). On the other hand, DT holds considerable risks for organizations when failing to keep pace with the challenges of the more and more digitalized market. A hostile take-over or, ultimately, bankruptcy may be the consequences for organizations (Hess et al., 2016a).

2.2 Different approaches to manage the transformational process

Both in theory and practice, there are different approaches and instruments seeking to provide guidance in this fast-paced business environment. The most prominent approaches for managing organizational digital transformation are the dynamic capabilities perspective (Karimi & Walter, 2015), the typology of digital transformation strategies (Matt et al., 2015), the ideas of digital readiness (Nguyen et al., 2019) and digital maturity (Aslanova & Kulichkina, 2021).

The concept of dynamic capabilities (Teece, 2014; Teece et al., 1997) is a theoretically well-founded concept and is closely related to the resource-based view and the evolutionary theory of the firm (Nelson, 1985). Dynamic capabilities are characterized as an organization's collection of distinctive processes or routines "enabling adaptations to external environments

characterized by rapid or discontinuous change" (Helfat & Winter, 2011, p. 1246). Teece (2018) expresses that these capabilities can be classified as sensing, seizing, and transforming activities. Where sensing refers to the identification and development of technological opportunities, seizing addresses the mobilization of an organization's resources to exploit these opportunities, and transforming describes the continuous renewal of the organization. Taken together, these capabilities qualify to "faithfully reflect and guide" firms' digital transformation processes (Yoo et al., 2012, p. 1405).

However, there is a lack of a profound understanding of the "specific capabilities needed, how those capabilities are developed throughout the digital transformation process, or how they interact with internal and external influencing factors" (Soluk & Kammerlander, 2021, p. 8). In addition, it is largely unclear which factors enable or hinder the development of such capabilities (Di Stefano et al., 2010). Concluding, the approach of dynamic capabilities does not provide managers with the respective means to fully reap the benefits of digital transformation. It does not help managers to derive and prioritize concrete investments to foster their organizational digital transformation.

Another established perspective on an organization's digital transformation is the typology of digital transformation strategies. This approach consists in designing and implementing management practices to govern this complex transformation (Hess et al., 2016a). From a business-oriented perspective, "these strategies focus on the transformation of products, processes, and organizational aspects owing to new technologies" (Matt et al., 2015, p. 339). Digital transformation strategies should not be mistaken for digital business strategies. Digital business strategies as described by Bharadwaj et al. (2013) lack insights on how to govern this organizational transformation. Typically, digital transformation strategies are formulated drawing on the four following dimensions: use of technologies, changes in value creation, structural changes, and financial aspects (Tekic & Koroteev, 2019). The four different dimensions must be closely aligned to guarantee the successful implementation of a digital transformation strategy and to fully realize its intended benefits. To facilitate this implementation, the four dimensions and their respective dependencies can be integrated into the Digital Transformation Framework (DTF) (Hess et al., 2016a).

However, to date, concrete guidelines for organizations regarding the formulation, implementation, and evaluation of digital transformation strategies are still ambiguous. Further research in this field needs to be done (Mitroulis & Kitsios, 2019). As for the previous approach of

dynamic capabilities, the typology of DT strategies does not enable practitioners to exploit the full potential of their organization's DT.

The so-called digital readiness concept is also among the prominent approaches to organizational digital transformation (Nguyen et al., 2019). Digital readiness is defined as the "inclination and willingness to switch to and adopt digital technology and readiness to create new innovative opportunities by using this technology in order to bring an individual, organization, industry, and country to achieve their goals faster and with greater results" (Nasution et al., 2018, p. 97). This concept draws on the literature of change management and organizational readiness respectively (Lokuge et al., 2019). Three components constitute the digital readiness construct: (1) digital assets, (2) digital capabilities, (3) commitment to digital transformation. In this context, digital assets refer to the digital infrastructure, digital human assets, and digital relational assets of the organization. The concept of digital capabilities is subdivided into digital pro-activeness and digital responsiveness. Finally, digital commitment is defined by managerial commitment and employee commitment (Nasution et al., 2018).

An analysis of the corresponding literature in the field of digital readiness shows that this idea is merely a construct that needs further empirical validation (Isaev et al., 2018). To this date, there seems to be only one single study to ground this conception on Thus, the concept of digital readiness does not provide managers with the required guidance (Nguyen et al., 2019).

The fourth concept focusing on organizational digital transformation has been largely designed and published by management consultancies and industry associations in a practical setting: digital maturity (Gollhardt et al., 2020). Digital maturity refers to "the status of a company's digital transformation" – it designates "what a company has already achieved with regard to transformation efforts" (Chanias and Hess, 2016a, p. 2). In this context, efforts include acquired operational capabilities as well as implemented changes with regards to managing the organization's digital transformation. Reaching digital maturity is commonly perceived as equivalent to exploiting the potentials of new technologies to promote organizational competitiveness (Lichtblau et al., 2015) and improve firm performance (Eremina et al., 2019). DMMs are designed to identify success factors and reap the long-term rewards of digital transformation (Teichert, 2019). These models are intended to analyze an organization's present state of digital transformation, as well as to identify and prioritize measures to raise the level of digital maturity (Williams et al., 2019). While doing so, they cater exactly the current needs of managers (Kane et al., 2017). However, due to the practical character of DMMs and the absence of external quality assessments such as peer reviews, the theoretical and practical value of DMMs remains

uncertain. Nevertheless, the popularity of DMMs has increased continuously over the last decade (Google Inc., 2021).

2.3 Digital maturity models

This section provides the general context and theoretical setting of this dissertation thesis by elaborating further on the concept of digital maturity and DMMs respectively. In this course, nature, specific components, and points of criticism regarding the existing models will be presented.

Even after over 50 years of maturity model research in general, there is still a terminology haze, making it more important to provide a common understanding of the subject at hand. *Framework*, *stages of growth model*, *stage model*, *change model*, and *maturity model* are examples of terms that are used interchangeably in the discipline of IS to describe this concept (Joerg Becker et al., 2010) Hellweg. Moreover, there is no general definition of digital maturity - several interpretations of this idea exist (Aslanova & Kulichkina, 2021).

In this dissertation thesis*, Digital Maturity* refers to the degree to which an organization has successfully integrated digital technology into its business processes, culture, and strategy. In this context, Westerman et al. (2014, p. 2) underline the importance of incorporating "organizational operations and human capital into digital processes and vice versa". Kane (2017, p. 1) further describe *Digital Maturity* as the ability of organizations to "systematically prepare to adapt consistently to ongoing digital change".

The notion at hand is rooted in psychology, where maturity refers to the learned ability to react to the environment in an appropriate fashion. According to de Bruin and Rosemann (2005), an organization's response to its external environment is often learnt rather than instinctual. Yet, an organization's maturity does not necessarily correlate with its age (Bititci, Garengo, Ates, & Nudurupati, 2015, p. 3065). The evaluation of a company's maturity is a crucial step in attaining a greater level of organizational performance (Pedrini & Frederico, 2018).

By defining and evaluating the maturity of various types of organizational resources, firms can assess their capabilities regarding various business areas. The maturity of organizational processes, artifacts or technologies can be at the center of such inquiry (Poeppelbuss et al., 2011). The link between organizational maturity and performance is well-understood, e.g., greater maturity results in greater performance (Dooley et al., 2001). Maturity models follow this principle as they are developed specifically to assess the maturity of organizational capabilities. Within the IS field, there are far more than 100 different maturity models, spanning all the major study areas and themes (Poeppelbuss et al., 2011): e.g., software engineering (Paulk et al., 1993),

business process management (Rosemann & de Bruin, 2005), inter-organizational systems (Ali et al., 2008), digital government (Gottschalk, 2009), and knowledge management (Teah et al., 2006). Recently, in the context of digital transformation, scholars and practitioners have engaged in assessing businesses' digital maturity (Chanias & Hess, 2016).

Digital Maturity Model refers to the normative reference models that firms use to assess their current degree of digital maturity and, therefore, of their status quo of their digital transformation across its building blocks and levels (Williams et al., 2019). DMMs are thus intended to guide businesses to overcome the challenges and reap the benefits of digital transformation (e.g., Teichert, 2019). The purpose is to identify and prioritize concrete actions that will accelerate the attainment of a target degree of digital maturity. Successive evolutionary stages indicate varying levels of maturation. Accordingly, maturity models, that are not considering the organization's digital transformation through a holistic perspective across its various levels, cannot be defined as DMMs. Among these are: IT maturity models, such as Nolan's stage model (Nolan & Koot, 1992), software maturity models, such as the capability maturity model (CMM) (Paulk et al., 1993), or business transformation models (e.g.,Venkatraman, 1994).

Assessing a company's maturity is thought to be a crucial step in obtaining a higher level of organizational performance (Bititci et al., 2015). Owing to the simplicity and usefulness of maturity models, a large number of DMMs have emerged during the past decade (Büyüközkan and Güler, 2020).

DMMs are mainly developed for the following areas of application in medium and large enterprises. The majority of the present frameworks serves a general business environment (Catlin et al., 2015; Westerman et al., 2011). Another essential share of identified DMMs covers the sectors manufacturing (Colli et al., 2018; Gajsek et al., 2019) and education (Đurek et al., 2018; Jugo et al., 2017). The remaining models are designed for a broad range of business contexts such as telecommunications (Ochoa-Urrego and Peña, 2020), services (Isaev et al., 2018), and government (Fath-Allah et al., 2014).

2.3.1 Dimensions of digital maturity

DMMs are characterized by their main feature of assessing an organization's digital status quo using a predetermined set of dimensions and evolutionary stages. Along these stages, DMMs provide guidance for the organization's transformation endeavor. This design strategy is referred to as a multidimensional orientation, which is appropriate given the complexity of the phenomenon DMMs aim to portray (Ochoa-Urrego and Peña, 2020). Once more, it is evident

that the concept of digital transformation goes beyond the simple integration of new technologies into organizational processes (Teichert, 2019).

Figure 1 shows an exemplary DMM, developed for telecommunication service providers (Valdez-De-Leon, 2016). Dimensions and evolutionary stages are immediately discernible.
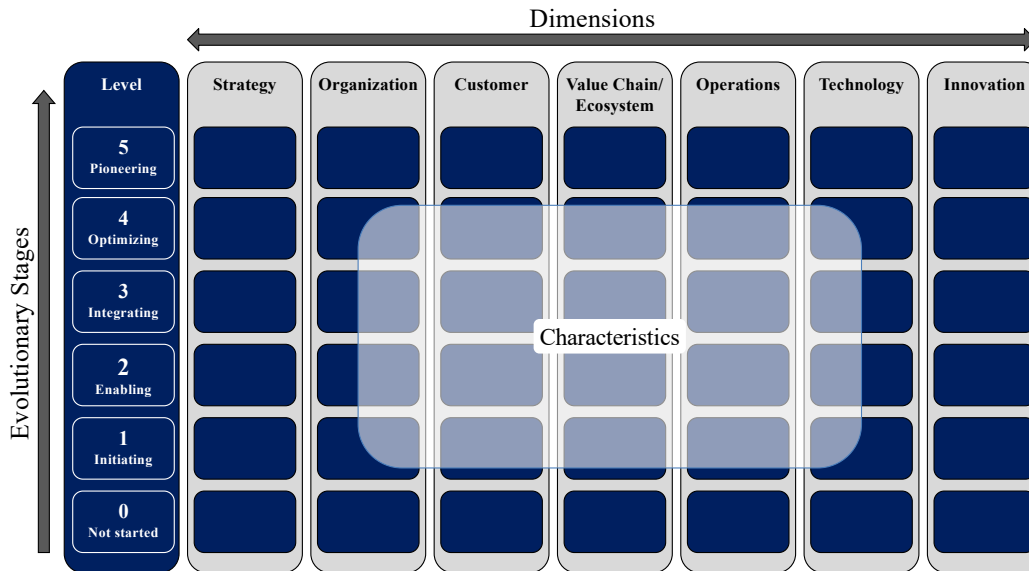
Figure 1: Exemplary DMM (Valdez-De-Leon, 2016)(adapted)

On average, DMMs include six dimensions spanning four to six evolutionary stages (Ochoa-Urrego and Peña, 2020). The following dimensions are the most prevalent in existing DMMs: *Digital Culture*, *Operational Processes*, *Technology*, and *Digital Strategy*. Additionally, the *Management* dimension is frequently mentioned.

The capability maturity model (CMM), initially established for software development by Paulk et al. (1993), serves as a blueprint for the building of new IS maturity models (Joerg Becker et al., 2010; T. Aguiar et al., 2019). In this way, it also serves as the primary source for fundamental terminology and vocabulary. In terms of the number and nomenclature of their evolutionary phases, DMMs also rely on this standard maturity model (e.g., Aguiar et al., 2019).

2.3.2 Stages of digital maturity

Indeed, there are major differences in the design and application areas of DMMs (Hizam-Hanafiah et al., 2020). Yet, notable similarities can be detected. In general, DMMs propose similar paths leading towards digital maturity (Ochoa-Urrego and Peña, 2020). The figure below reflects the typical path to a firm's digital maturity - as depicted by existing DMMs.
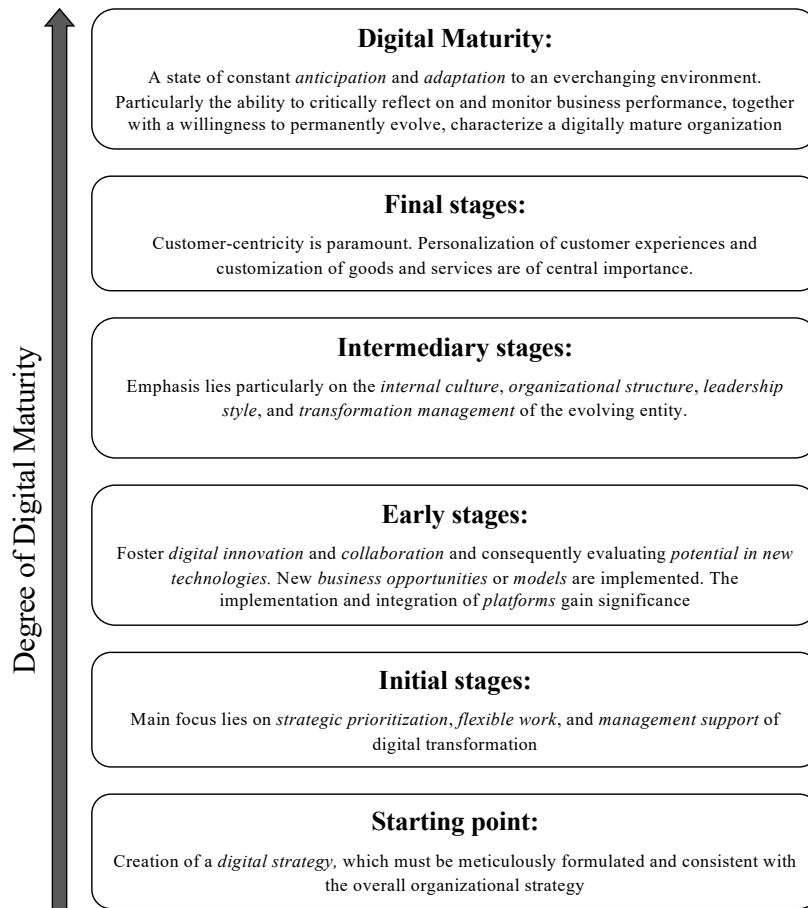
Figure 2: Synthesis of typical evolutionary stages of current DMMs

The starting point of a digital organization is the formulation of a digital strategy, which must be aligned with the company's overall strategy (Chanias and Hess, 2016b; Matt et al., 2015; Ochoa, 2016). Following, the initial stages of the frameworks focus on the strategic prioritization, flexible work, and management support of digital transformation (e.g., Berghaus and Back, 2016; Ifenthaler and Egloffstein, 2020). Early stages of digital maturity emphasize the strategic relevance of innovation. Present models underline the importance of fostering digital innovation and collaboration and identifying potential in new technologies. In this context, the implementation of platforms gains significance. A platform is a software or hardware architecture that allows individuals, organizations, and institutions to develop applications, services, and communities (Gawer, 2014). The integration of platforms into the organization's IT infrastructure, is widely considered as catalysts for data and knowledge sharing, collaboration, and fostering innovation (e.g., Berger et al., 2020; Catlin et al., 2015; Friedrich et al., 2011; Gill and Vanboskirk, 2016; Westerman et al., 2012). As a result of this process, new business opportunities or models gain importance.

Intermediate phases on the way to digital maturity encompass *organizational structure*, *internal culture*, *leadership style*, and *transformation management* of the evolving organization (Muehlburger et al., 2019; Nguyen et al., 2019; Salviotti et al., 2019). This crucial phase is fittingly depicted by Berghaus and Back as "commit to transform" (2016, p. 8). With this step comes a significant shift in the organization's culture, positions, and responsibilities. Key internal characteristics include a greater readiness to take chances and a proactive error culture.

On the final steps on the path to maturity, customer-centricity becomes paramount (Berghaus and Back, 2016; Catlin et al., 2015; Westerman et al., 2012). Particularly, personalization of customer experiences and customization of goods and services are defining characteristics of a transforming organization. This new focus on the consumer is made possible by the data-driven enterprise. The synchronization of operations and analysis of consumer data in real-time utilizing new technology gets the business closer to digital maturity. Finally, a digitally mature organization is characterized by its capacity to critically reflect on and evaluate business performance, as well as its ability to develop continuously. Digital maturity is thus a condition of ongoing anticipation and adaptation to an ever-changing environment, necessitated by the extraordinarily rapid pace of technology innovation and ever-increasing client demands (Ifenthaler & Egloffstein, 2019).

As previously outlined, the topic of DMMs is controversially discussed in the academic community. The frequently addressed lack of academic rigor and validity of the present models must be brought out in particular (Teichert, 2019).

Aiming at remedying the shortcomings of present models and ultimately developing and applying a new holistic DMM for a specific business field, this dissertation is committed to follow the established guidelines of design science (DSR) to bolster a rigorous design and application process.

3. Research paradigm

In the following section, design science research (DSR) as the overarching research paradigm of this dissertation will be portrayed. A link to the topic of DMMs will further be established.

3.1. Design science research

DSR is an iterative and problem-driven research paradigm that integrates research and design activities to produce actionable outcomes. By focusing on the construction and evaluation of artifacts, DSR bridges the gap between theory and practice. The goal is generating knowledge that can lead to meaningful improvements in various domains (vom Brocke et al., 2020). DSR is often employed in applied research settings, where the emphasis lies on solving specific problems and creating practical solutions (Drechsler & Hevner, 2016).

DSR exhibits two distinct types of contributions: *design science* and *design research (Winter, 2008)*. On a generic level, design science primarily focuses on the design research process and its evaluation. To guarantee the rigor of this process, design science aims at creating standards and guidelines. On a problem specific level, design research aims at creating so-called artifacts to solve concrete classes of relevant problems (Gericke & Winter, 2009).

The following illustration depicts the different contributions of DSR as overarching paradigm and design science and design research respectively.

Design Science Research

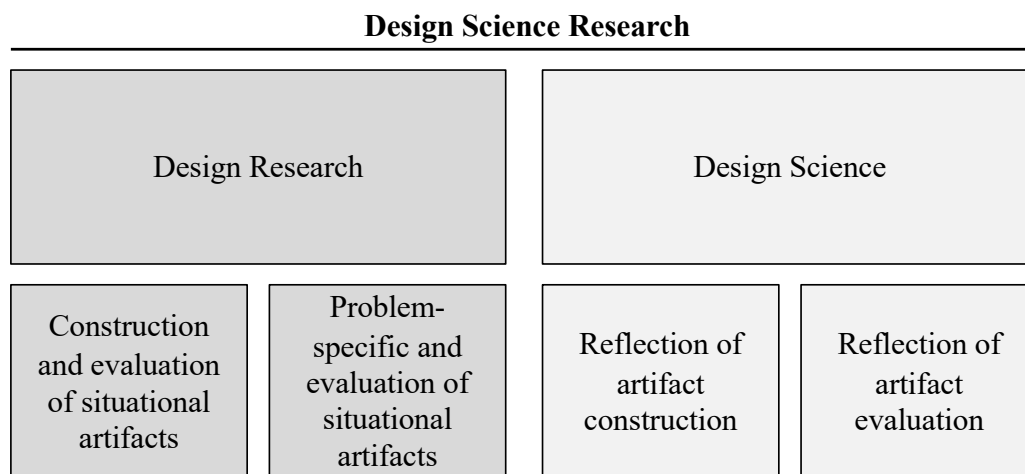| Design Research	Design Science
Construction and evaluation of situational artifacts / Problem-specific and evaluation of situational artifacts	Reflection of artifact construction / Reflection of artifact evaluation

Figure 3: Analysis framework for research (Winter et al., 2009)

Design research draws on the guidelines and standards of design science for the construction and evaluation process of these respective artifacts (Mettler, 2009).

March and Smith (1995)identify four different design artifacts: (1) constructs, (2) models, (3) methods, and (4) instantiations. Constructs provide the language to specify problems and solutions. Models make use of this language for the representation of the identified problems and future solutions. Methods constitute in the procedures which provide guidance on how to solve these problems and develop the solutions. Instantiations can be seen as problem-specific aggregates of the previously outlined constructs, models, and methods. This understanding has been broadly accepted (Hevner et al., 2004; Pfeffers et al., 2006).

Hevner et al. (2004, p. 82) have established widely accepted guidelines for design science. The purpose of the seven guidelines is to "assist researchers, reviewers, editors, and readers to understand the requirements for effective design-science research." In the following table, these seven guidelines for an iterative artifact construction and evaluation are further elaborated upon.

Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 1: Design science research guidelines according to Hevner et al. (2004)

DSR necessitates the construction of a viable artifact (Guideline 1) for a specified and important business problem domain (Guideline 2). The utility of the artifacts for the specified problem needs to be rigorously demonstrated and evaluated using established methods (Guideline 3). The artifact must be innovative. This means that the artifact needs to address a to date unsolved problem or a known issue in a more effective or efficient manner (Guideline 4). In this context, the artifact must also be "rigorously defined, formally represented, coherent, and internally consistent" (Guideline 5) (Hevner et al. 2004, p. 82). Consequently, the entire artifact construction process needs to follow rigorous methods appropriate to the problem

environment (Guideline 6). Finally, an effective presentation and communication of the design science research results both to a technical and to a managerial audience is necessary (Guideline 7) (Hevner et al. 2004).

Hevner (2004) underlines that each of the above guidelines should be considered for DSR to be complete and rigorous. These guidelines are thus designed to serve as an orientation for the construction process of a specific artifact. Based on these insights, different standard processes for the construction of maturity models have emerged (de Bruin et al. 2005; Becker et al. 2009).

3.2. Process for the design and evaluation of a DMM

As previously outlined, the concept of maturity models is often criticized due to a lack of validity, reliability, and generalizability. In addition, the poor documentation of the models' development process has been underlined (Rosemann & de Bruin, 2005)

Addressing these points of criticism de Bruin & Rosemann (2005) suggest a first design process for the development and evaluation of maturity models in their work. Becker et al. (2009) further refined this design process for IT maturity models. Solli-Saether and Gottschalk (2010) offer additional assistance for such an undertaking. Drawing on these works, the following design process for this dissertation has been developed.
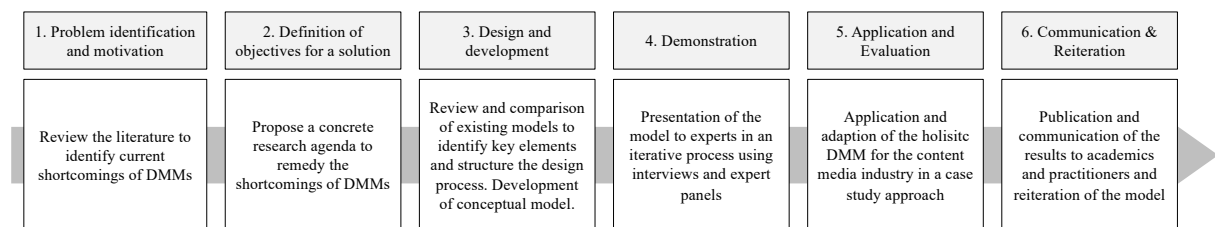
1. Problem identification and motivation	2. Definition of objectives for a solution	3. Design and development	4. Demonstration	5. Application and Evaluation	6. Communication & Reiteration
Review the literature to identify current shortcomings of DMMs	Propose a concrete research agenda to remedy the shortcomings of DMMs	Review and comparison of existing models to identify key elements and structure the design process. Development of conceptual model.	Presentation of the model to experts in an iterative process using interviews and expert panels	Application and adaption of the holisitc DMM for the content media industry in a case study approach	Publication and communication of the results to academics and practitioners and reiteration of the model

Figure 4: DSR Process of the present dissertation

Respecting the guidelines of Hevner et al. (2004), the first process step consists in identifying and defining a specific business problem with the goal of constructing a viable artifact for its solution. As a next step, concrete objectives for a solution of the problem are worked out. Then, in the *Design and Development* phase, key elements for a viable DMM are determined and the construction process is set up leading up to a first conceptual model. Subsequently, as a part of the *Demonstration* phase, the conceptual model is presented to both a technical and a managerial audience. The result is a refined DMM. In the *Application and Evaluation* stage, the model is then applied to a specific industry in a case study approach. Finally, in the sixth phase, the

results of the model's application are published in an IS outlet and communicated to academics and practitioners of this research field. Based on the feedback, the model is then again refined.

4. Outline of research manuscripts

This section introduces the five manuscripts constituting this dissertation. Here, the emphasis lies on highlighting the main features and qualities of each work. Table 1 provides a comprehensive overview of the manuscripts.

4.1. Research objectives and research questions

As previously outlined, DMM research is imprinted with several shortcomings (e.g.,Teichert, 2019). Especially the often-addressed lack of academic validity and rigor needs to be mentioned. To ensure a sound research approach and process, this academic investigation is based on established DSR guidelines. Accordingly, the five research manuscripts of this dissertation are aligned with these standards. The following process flow illustrates the respective steps of the DSR process.
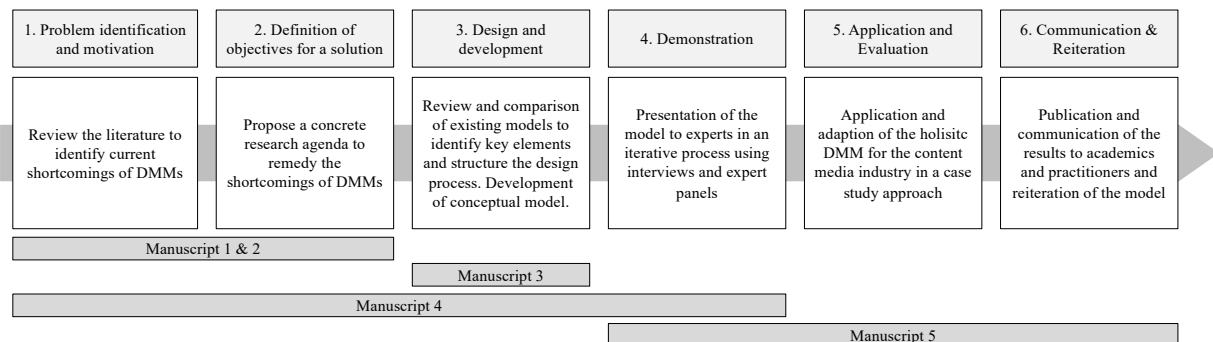
Figure 5: DSR Process of the present dissertation with respective manuscripts

Manuscript 1 & 2 lay the foundation of the present investigation in the field of DMMs. Primarily, these works contribute to the identification of current flaws in DMM research and to motivate the scientific inquiry and artifact creation. In this context, the two manuscripts identify and analyze the existing literature of this research field in order provide an overview – as comprehensive as possible. Furthermore, both studies question the theoretical and practical value of the present models, and each derives a research agenda – defining the objectives for solving the previously identified of issues.

Manuscript 1 entitled *"How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models"* raises the following research question:

> *To what extent do DMMs respect quality standards in their measurement of a company's degree of digitalization?*

This research question is answered using a systematic literature review with a subsequent deductive qualitative content analysis. Based on the results, manuscript 1 derives concrete quality criteria for the measurement of an organization's level of digitalization.

Manuscript 1 has been present at the *I3E 19th IFIP Conference - e-Business, e-Services, and e-Society 2020 in Trondheim, Norway* and published in the conference proceedings Lecture Notes in Computer Science (LNCS).

Manuscript 2 deals with the research question:

> *"What are the most prominent opposing opinions regarding Digital Maturity Models in the discipline of IS?"*

Manuscript 2 extends the scope of investigation on the research field at hand. This work seeks to provide the first comprehensive synthesis of the research field of DMMs since the emergence of the first model in 2011 (presumably Westerman et al., 2011). This aim is achieved by identifying and contrasting the main contentious opinions among IS scholars concerning DMMs. A systematic literature review in combination with a deductive qualitative content analysis is the method of choice. As previously outlined, a research agenda provides directions for future research. Manuscript 2 is expected to be published in 2024 in the *Journal of Information Systems and e-Business Management*.

Taking up one of the suggestions for future research derived from previous manuscripts and under the premise "*Design and development*" of the DSR process of this dissertation, manuscript 3 sheds light on a key building block of existing DMMs: the platform concept. The overarching research questions of this manuscript are:

1. *In the context of present DMMs, what are the different platform types addressed as relevant for an organization's digital maturity?*
2. *In the context of digital maturity, what definition of the platform concept can be derived?*

This study aims at presenting a well-founded overview of the differing platform types, which are deemed significant for an organization's digital maturity. A first working definition of

platforms in the context of digital maturity is deduced. Under the title "*The Importance of Platforms to Achieve Digital Maturity*" manuscript 3 has been presented at the *19th European, Mediterranean, and Middle Eastern Conference, EMCIS* in December 2022. It has been published as part of the proceeding by Springer Nature Switzerland in April 2023.

Manuscript 4 "*Towards a holistic digital maturity model*" is a research in progress paper and draws its origin from the insights and quality criteria for DMMs identified in all three previously mentioned manuscripts. By designing a holistic DMM based on recognized design science research standards, it addresses and remedies the shortcomings of existing models. The outcome is a conceptual DMM. This research in progress paper was presented at the *International Conference on Information Systems (ICIS)* in 2020. Manuscript 4 laid the theoretical foundation for manuscript 5.

Accordingly, manuscript 5 covers the design, the evaluation, and application of the holistic DMM relevant to the branch of content publishers in the German media industry along established DSR guidelines. Consequently, the research paper is entitled "*A holistic digital maturity model for content publishers in the media industry*". The conceptual DMM built in manuscript 4 is applied in a case study approach in four large organizations of the content publishing media industry. Manuscript 5 has passed the desk reject for a special issue titled "*Managing and Sustaining Digital Transformations*" of the *European Journal of Information Systems* (EJIS).

Table 2: Overview of research manuscripts

Manuscript No.	1	2	3	4	5
Title	How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models	A Decade of Digital Maturity Models - Much ado about nothing?	The Importance of Platforms to achieve Digital Maturity	Towards a holistic digital maturity model	A holistic digital maturity model for content publishers in the media industry
Authors	Thordsen, Murawski, Bick	Thordsen, Bick	Thordsen, Bick	Thordsen, Bick	Thordsen, Bick
Outlet	Lecture Notes in Computer Science (LNCS)	Journal of Information Systems and e-Business Management (ISeB)	European, Mediterranean, and Middle Eastern Conference (EMCIS)	International Conference on Information Systems (ICIS) (*Research In Progress Paper*)	European Journal of Information Systems (EJIS)
VHB Ranking	C	C	C	A	A
Publication Status	Published (2020)	Published (2023)	Published (2023)	Published (2020)	Desk reject passed
Research Type	Empirical; Research Agenda	Empirical; Research Agenda	Empirical; Conceptual	Empirical; Conceptual	Empirical Paper
Research Objectives	Evaluating existing DMMs regarding their conformity to the criteria of a valid measurement process of digital maturity. Thus, we ultimately seek to assess the theoretical value of DMMs. A research agenda is derived.	Painting a comprehensive picture of the research field of DMMs by identifying and contrasting the most prominent contentious opinions among IS scholars. Based on our experience in this field, we provide a first synthesis of eleven years of DMMs and derive a research agenda.	Providing a comprehensive overview of the differing platform types, that are deemed significant for an organization's digital maturity. To provide a foundation for future research at this point of intersection of the two research fields, we derive a first working definition of platforms in the context of digital maturity.	Remedy the shortcomings of existing DMMs and proposing a new holistic DMM based on established guidelines of design science research and additional empirical insights. The aim is to provide a transparent, scientifically validated instrument to assess and improve the organizational level of digital maturity.	Addressing the shortcomings of existing models, by designing a holistic DMM based on recognized design science research standards. This model is then applied in organizations of the highly dynamic German content publishing media industry to provide direction for key players of all branches disrupted by digital transformation.
Research Questions/ Aims	To what extent do DMMs respect quality standards in their measurement of a company's degree of digitalization?	What are the most prominent opposing opinions regarding Digital Maturity Models in the discipline of IS?	1. In the context of present DMMs, what are the different platform types addressed as relevant for an organization's digital maturity? 2. In the context of digital maturity, what definition of the platform concept can be derived?	1. Identify shortcomings of existing DMMs regarding IT maturity. 2. Remedy these shortcomings by developing a new holistic DMM for medium and large companies to assess and improve an organization's level of digital maturity based on academic standards and free-of-charge.	1. Design a holistic DMM for medium and large content publishers in the media industry 2. Apply the model to medium and large corporations of the German media industry to demonstrate its applicability, comprehensiveness, and validity.

4.2. Theoretical environments

In its entirety, this dissertation is organized based on the problem-solving paradigm of DSR. Further information on the overarching research paradigm of the present dissertation can be found in section 3 of this dissertation.

In general, manuscripts 1 to 5 build on the theories of organizational digital transformation and the framework of DMMs. As previously outlined, in the present investigation, a perspective on DT focusing on a solely business-centric point of view is taken. Here, DT refers to "a specialized type of business transformation where IT plays a dominant role. In the digital age, new business opportunities arise, and enterprises transform their strategy, structure, culture and processes using the potential and power of digital media and the Internet" (Uhl & Gollenia, 2014, p. 15).

In the context of this dissertation thesis, *Digital Maturity* refers to the degree to which an organization has successfully integrated digital technology into its business processes, culture, and strategy. Accordingly, *Digital Maturity Model* refers to the normative reference models that firms use to assess their current degree of digital maturity and, therefore, of their status quo of digital transformation across its building blocks and levels (Williams et al., 2019). DMMs are intended to guide businesses to overcome the challenges and reap the benefits of digital transformation (e.g., Teichert, 2019). The purpose is to identify and prioritize concrete actions that will accelerate the attainment of a target degree of digital maturity. Successive evolutionary stages indicate varying levels of maturation.

Within the overarching framework of DMMs, the five manuscripts focus on different characteristics of these models. As previously outlined, manuscript 1 focuses on the theoretical value and academic rigor of DMMs. In line with this scope, manuscript 1 sheds light on of the quality of measurement of DMMs regarding the concept of digital maturity.

The validity of a measurement determines its quality (M. Kane et al., 1999). The validity of measurement is defined by its proximity to the truth along with the complex net of arguments backing up the findings. The assessment of validity is thus made based on respective validity arguments. To ensure a certain level of validity in performance measurement, M. T. Kane (2006) has established five requirements. An updated version of these requirements has been suggested by Brühl (2015). The set of criteria for a valid measurement process in DMMs is: (1) Observation, (2) Generalizability, (3) Theory-based Interpretation, (4) Exploration, and (5) Implication.

Manuscript 2 is dedicated to four distinct fields of interest within the research area of DMMs: contribution to practice, contribution to theory, impact of digital maturity on firm performance, and DMM standards. Under these four fields, the main contentious opinions and perspectives in the academic community are represented and discussed. Ultimately, this procedure serves to identify shortcomings of the present models and to derive respective future areas of research for this research field.

Manuscript 3 investigates on a key building block of existing DMMs: the platform concept. This work stresses the fact that the concepts of digital maturity and platforms are de facto closely interrelated. Consequently, the theoretical fundament manuscript 3 is located at this point of intersection of the two research fields.

The term *platform* refers to software or hardware infrastructure that allows people, organizations, and institutions to develop applications, services, and communities (Gawer, 2014). Platforms are catalysts for data and knowledge sharing, collaboration, and innovation. These are key factors for achieving digital maturity (Pauli et al., 2021). Platforms can be observed at different levels and in various organizational settings: within a single firm, across supply chains, or across entire ecosystems. Gawer (2014) proposes an established integrative framework which suits the context of digital maturity perfectly. It defines three overarching platform types: *platforms with closed interfaces*, *platforms with selectively open interfaces* and platforms with *N-sided market infrastructure*. To provide a basis for future research a first working definition of the platform concept in the context of digital maturity is derived.

Ultimately, manuscript 4 and 5 build on the insights of the previously outlined works and engage in the development and application of a holistic DMM for a specific industry. Under these premises, the overarching paradigm is design science research (DSR) (Hevner, 2004). For the design and application of a maturity model, Becker et al. (2009) and de Bruin et al. (2005) suggest a catalogue of five phases grounded on the well-established DSR guidelines. Following these recommendations, shortcomings of present DMMs are identified. Findings suggest that DMMs are not exhaustive regarding organizational IT, which is deemed a key factor of digital maturity (Chanias and Hess 2016). In this context, to address this issue, the framework of IT maturity models (ITMMs) has been chosen, making up a complementary theoretical basis for this manuscript. With their unique focus on the dimension of organizational IT, ITMMs provide additional insights on this key factor of digital maturity and thus serve as a tool to remedy these concrete shortcomings of present DMMs.

4.3. Research type, design and methods

Seeking to design, apply, and evaluate a new holistic DMM, this dissertation, in its entirety, is organized based on the problem-solving paradigm of DSR. In this context, manuscripts 1-3 are conceptual papers, whereas manuscripts 4 and 5 complete this dissertation with empirical insights.

Conceptual research focuses on the analysis, critique or development of theoretical frameworks, concepts, or ideas (Meredith, 1993). It primarily involves the exploration and presentation of theoretical perspectives rather than the collection and analysis of empirical data. Conceptual papers typically provide an overview of the topic and identify research gaps or limitations. These aims are achieved by e.g., reviewing existing literature, critically analyzing, and synthesizing existing theories, or concepts related to the topic. Furthermore, they may propose new concepts or frameworks (Jaakkola, 2020).

Accordingly, the design, application, and evaluation of the conceptual DMM in manuscripts 4 and 5 respectively are of empirical nature. Empirical research relies on gathering evidence from the real world through systematic observations or experiments (Flick et al., 2005).

Manuscripts 1-4 follow a qualitative research approach, whereas manuscript 5 combines qualitative and quantitative research. Qualitative research is a method that focuses on understanding subjective experiences, meanings, and social phenomena. It involves collecting and analyzing non-numerical data to gain insights into human behavior, attitudes, and social contexts. Qualitative research provides in-depth understanding and interpretation of complex phenomena based on the collection and analysis of non-numerical data (Mayring, 2014). As previously mentioned, manuscript 5 furthermore engages in quantitative research when applying and evaluating the DMM. Quantitative research consists in the collection and analysis of numerical data to answer research questions or test hypotheses. It involves the use of statistical and mathematical techniques to derive objective and generalizable conclusions from the data (Flick et al., 2005).

Manuscript 1 critically evaluates 17 existing DMM, identified through a systematic literature review (2011–2019), regarding their validity of measurement. The systematic search encompasses 10 prominent IS journals, five major IS conferences, and two additional databases (Business Source Premier and Google Scholar) over an eight-year period (2011 to 2019). The chosen period is especially pertinent, considering that the first so-called DMM was published in 2011 by a consultancy (Westerman et al., 2011). The outlets and databases were chosen based on the findings of Poeppelbuss et al. (2011), who have reviewed existing IS maturity models. The

PICO criteria (Population, Intervention, Comparison, and Outcomes) were utilized to build the search terms for the systematic review (Aromataris & Pearson, 2014). In the medical area, these criteria are typically used as guideline to define the research topic by generating keywords and formulating search strings. Kitchenham and Charters (2007) believe that the PICO criteria are especially appropriate for conducting a systematic evaluation in the academic context of Information Systems . Synonyms and alternate spellings for these key words were identified by consulting both specialists and publications in this research field (Lasrado et al., 2015). The deductive qualitative content analysis of the models is based on established academic criteria, such as generalizability or theory-based interpretation. The findings indicate that most of the identified models do not respect academic evaluation criteria. Based on these insights, a detailed research agenda with respective research questions and strategies is derived.

To deepen the understanding of the research field of DMMs, manuscript 2 expands the scope of the in manuscript 1 performed systematic literature substantially. Eleven literature reviews of this research domain provided in total 15 additional catchphrases. As a result, the literature pool of manuscript 2 comprises 64 articles. Subsequently, the articles of the literature pool are investigated upon using a qualitative content analysis based on previously identified leading questions of the academic community of this research area. The supporting academic sources for these four deductive categories comprise more specifically eleven literature reviews of this research area (Bordeleau and Felden, 2019; Chanias and Hess, 2016a; Hizam-Hanafiah et al., 2020; Ochoa-Urrego and Peña, 2020; Ochoa, 2016; Remane et al., 2017; Schallmo et al., 2020; Teichert, 2019; Thordsen et al., 2020; Virkkala et al., 2020; Williams et al., 2019). Additionally, the feedback from reviewers and editors (2017-2022) from the journals Business Information Systems, Electronic Markets, MIS Quarterly, and Information Systems Frontiers and IS conferences ECIS, ICIS, EMCIS, I3E, WM, and SSKM respectively was considered. In this regard, informal conversations and discussions with IS scholars from e.g., Freie Universität Berlin, the Technische Universität Dresden, and the Ludwig Maximilian Universität München provided further insightful information regarding the opposing viewpoints in the field of DMMs. These insights were triangulated with the knowledge of practitioners (for example, C-Level Executives of a multi-billion Euro media firm) that were interviewed as part of the present research.

From the deductive qualitative content analysis, the most prominent controversies between IS researchers in this area are identified and a synthesis of the field of DMM is derived. Several research gaps have become clear as a result of the critical analysis of the main contentious opinions in the field of DMMs. Emerging from this investigation, a first research agenda, comprising concrete research questions has been assembled.

Taking up one of the suggestions for future research, the focus of manuscript 3 lies on the analysis of 24 DMMs that have been identified in the course of a systematic literature search based on the findings of the previous manuscript. The purpose of this research is to identify the various platform concepts addressed in current DMMs and hence deemed significant for an organization's digital transformation endeavor. Furthermore, the aim is to identify the differing business settings in which the various platform types are addressed. Finally, this work seeks to get a deeper understanding of the platform phenomenon and its various types in the context of DMMs, as well as to identify opportunities for future scientific research. An inductive qualitative content analysis following the guidelines of Mayring (2014) is the method of choice. Based on the findings of this study, a first working definition of the platform idea in connection to a firm's digital maturity is proposed.

Finally, manuscript 4 expands on the insights of the preceding manuscripts by developing a conceptual DMM. This DMM is then refined and applied as a holistic DMM for a specific industry in manuscript 5. The overall research paradigm for design and evaluation of the prescriptive framework is rooted in design science research (DSR). Becker et al. (2009) and de Bruin et al. (2005) propose a catalogue for the design and evaluation of a maturity model in Information Systems based on Hevner et al.'s (2004) well-established DSR guidelines. Drawing on the insights of these previous works, in manuscript 4, the first design process for a generalist DMM has been derived (Figure 6).
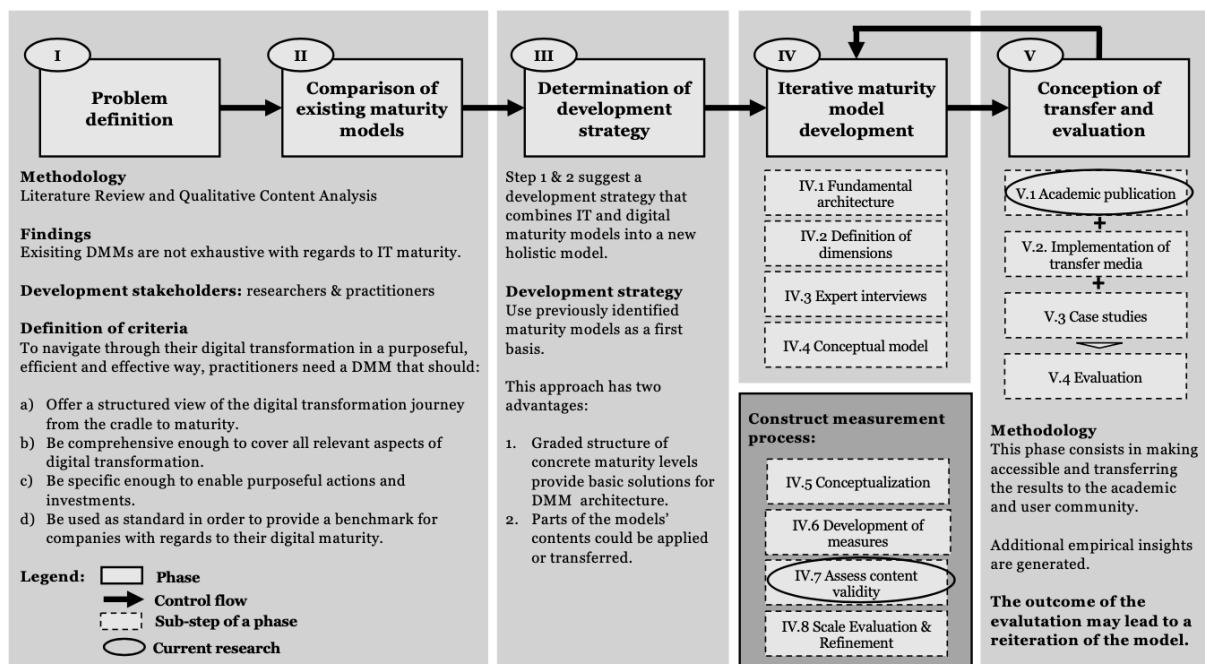

Figure 6: Design process for a generalist DMM based on DSR guidelines

The above figure depicts the new derived framework of five phases for developing a generalist DMM. Phases I-III are based on a systematic literature review according to the guidelines of vom Brocke et al. (2009) to provide a thorough and comprehensive overview of the existing literature on digital maturity and IT maturity. A literature search covering a period of a 45 years (1974–2021) in ten prominent IS journals, five significant IS conferences, and two supplementary databases (Business Source Premier and Google Scholar) is conducted. As a result, the literature pool encompasses 20 ITMMs and 33DMMs. The present models are then compared along three predefined dimensions: (I) organization, (II) management and (III) information technology. Each of these dimensions is in an integral part of the discipline of IS. They should always be taken into consideration when engaging in research of this field (Laudon & Laudon, 2020). The insights of the deductive qualitative content analysis suggest a design strategy that combines ITMMs and DMMs into a new holistic generalist model.

After a repeated review of the present models, a first conceptual DMM is designed (Phase IV.1 & IV.2). In Phase IV.3, seven German digitalization specialists were interrogated in semi-structured interviews (25 to 47 minutes) to assess the model's plausibility and practical value (Becker et al., 2009). In an iterative process, the conceptual generalist DMM is refined according to the findings of the interviews (IV.4). Then, relevant dimensions to be measured are defined. 40 statements are developed to capture the constructs' main aspects. A content validity study of two parts is performed (Rubio et al., 2003). First, a content expert panel is consulted to make sure that the generated statements fully represent the constructs. After having implemented the academics' feedback, practitioners were interrogated regarding the comprehensibility of the resulting item catalogue.

Under the premise of phase V.1 "Academic publication" Phases I-IV of iterative model development have been presented as manuscript 4 under the title "*Towards a holistic digital maturity model*" at the International Conference on Information Systems (ICIS) in 2020. The valuable academic feedback, especially regarding the application of the model through a pilot and a case study was implemented.

Consequently, in manuscript 5, the design process has been further refined with the aim of designing a DMM for content publishers in the media industry (Figure 7).
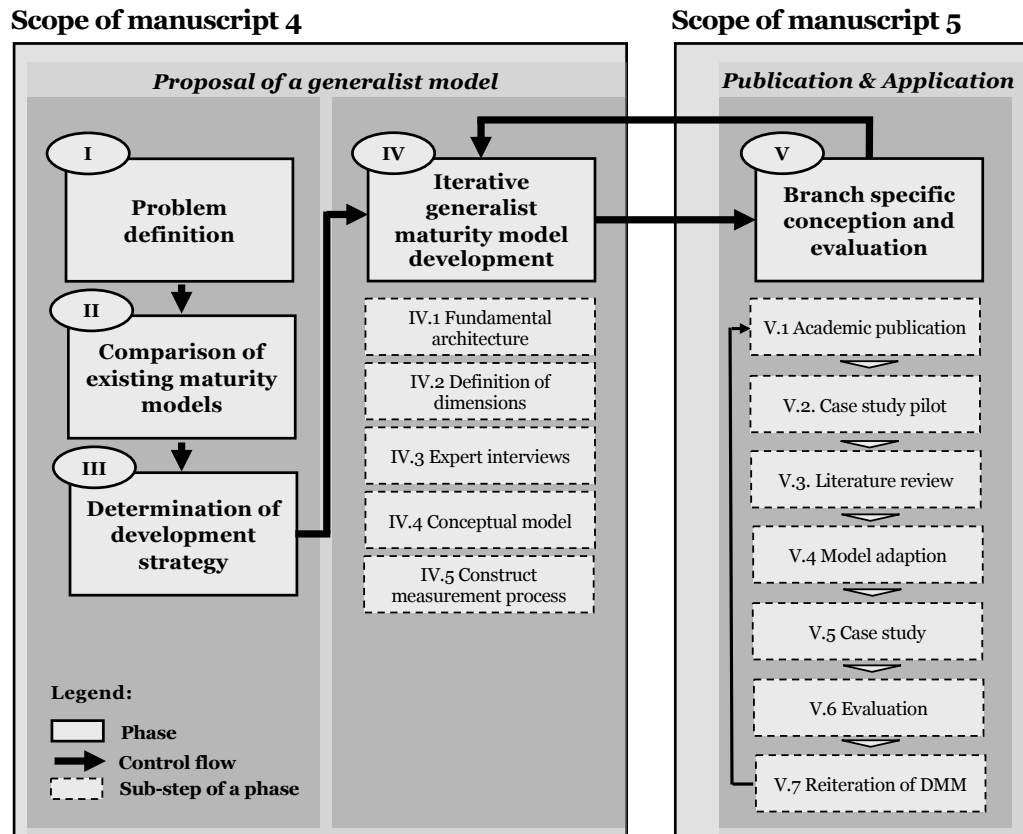
Figure 7: Refined design process for industry specific DMM

As previously mentioned, phases one to four encompass the development of a generalist DMM – grounded on extensive literature, existing models, and first empirical insights. In the fifth phase the generalist conceptual model is then refined into a branch specific model – among others through the practical application in the target industry. In this context, the application and adaption of the model in the content publishing media industry is essential. A case study approach is the method of choice. It is an established research technique in the field of IS, and it is ideal to shed light on the dynamics between IT related technologies and organizational settings. A case study approach is useful when a research topic is complex and a holistic, in-depth reflection is required (Darke et al., 1998). Our case study design involves a first exploratory, pilot case study, conducted in a German medium sized content publishing media organization, followed by a case examination in four large organizations of the same industry. The data is collected through interviews, quantitative surveys, observations, and complementary documents. Based on the findings of the pilot study, an incompleteness of certain dimensions of the DMM is identified. As a result, a renewed literature review is performed, the catalogue is extended. The DMM is again refined both in the course of its application in the four large organizations and after the evaluation of the results. The results of the study have significant

practical implications. Concrete and purposeful potentials to improve organizational digital maturity are derived.

Table 3: Theoretical frameworks and designs of the research manuscripts

RM	Theoretical framework	Research design and methods	
1	Digital Maturity Models / Criteria for a valid measurement process	Type	Conceptual
		Method	Literature review Qualitative Content Analysis
2	Digital Maturity Models	Type	Conceptual
		Methods	Literature review Qualitative Content Analysis
3	Digital Maturity Models/ Classification of Platforms	Type	Conceptual
		Methods	Literature review Qualitative Content Analysis Design Science Research
4 & 5	Digital Maturity Models/ IT Maturity Models/ Design Sciences Research	Type	Artifact Development; Design Science Research; Empirical
		Methods	Literature Review Qualitative Content Analysis Artifact construction and evaluation Expert interviews, expert panels Case study (application of DMM catalogue, including 15 interviews, analysis of internal documents, observations, pilot study, and four case studies)
		Data	Literature pool with existing ITMMs and DMMs Seven transcribed interviews with digitalization specialists Academic expert panel comprised of six graduated academics Practitioner's expert panel with seven digitalization experts 15 transcribed interviews and survey data (DMM catalogue) of professionals in the case companies (C-Level, middle management, and operational level) Internal documents (reports, financial sheets, minutes, etc.)

5. Research manuscripts

In this section, the four previously outlined research manuscripts are presented. The papers at hand are provided in their current version at the time of the submission of this dissertation. Two of the papers have been accepted and published. One paper has been accepted and will be published in 2024. The last paper is under review. The works are formatted according to the requirements of the respective publishers and outlets.

5.1. Manuscript 1: How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models

Manuscript No. 1

This manuscript is published as:

5.2. Manuscript 2: A Decade of Digital Maturity Models - Much ado about nothing?

Manuscript No. 2

This manuscript is published as:

5.3. Manuscript 3: The Importance of Platforms to achieve Digital Maturity

Manuscript No. 3

This manuscript is published as:

5.4. Manuscript 4: Towards a holistic digital maturity model

Manuscript No. 4

This manuscript is published as research in progress paper:

Thordsen, T., Bick, M (2020): Towards a holistic digital maturity model, *International Conference on Information Systems (ICIS) 2020 Proceedings,* https://aisel.aisnet.org/icis2020/governance_is/governance_is/5

5.5. Manuscript 5: A holistic digital maturity model for content publishers in the media industry

Manuscript No. 5

This manuscript was submitted at European Journal of Information Systems (status: desk reject passed) as:

Thordsen, Tristan; Bick, Markus: A holistic digital maturity model for content publishers in the media industry

Manuscript 5 is available upon request.

6. Discussion

In the first part of this section, the main contributions of this dissertation are discussed. Subsequently, the main implications for academia and practice are outlined. The following subsection 5.3 deals with the study's limitations and further research opportunities.

6.1. Key findings and major contributions

In the introduction the aims of this dissertation have been well defined:

1. Critical evaluation and discussion of present DMMs' theoretical and practical value
2. Establishment of quality criteria for the measurement of an organization's level of digitalization
3. Determination of essential building blocks for DMMs
4. Development of a holistic DMM based on academic standards
5. Application of a holistic DMM based on academic standards
6. Publication and presentation of the research papers and dissertation

These goals have been defined following a DSR approach combining knowledge from existing theories and research to design and develop new solutions for practical problems. DSR bridges the gap between theory and practice, while generating knowledge that can lead to meaningful improvements and actionable outcomes (Drechsler & Hevner, 2016). Even though the discipline of IS is an "applied" research discipline, the dominating research paradigms are descriptive. Only a small fraction of research papers published in renowned IS journals aims at producing artifacts of practical value (Pfeffers et al., 2006). To make IS research more relevant to practice, this dissertation seeks to provide solutions for one of the most prominent practical problems at the intersection of IT and organizations.

Answering prominent scientific calls in the research field of DMMs

The practical problem at hand can be described as a lack of understanding and guidance in both academia and practice regarding an organization's digital transformation. While investigating on this matter, this dissertation follows among others the call of Schallmo et al., (2020) and Bordeleau and Felden (2019) for further consideration of the entire spectrum of digital transformation. In this highly dynamic business environment, managers seek guidance to keep pace with digital reality. In this context, managers are focused on exploiting the potentials of DT, while avoiding its pitfalls. DMMs are established frameworks, designed to assess an

organization's digital status quo and prescribing concrete measures to increase the level of digital maturity. Despite the widespread practical application and popularity among management consultancies and industry associations, several voices of the academic community question the quality and actual practical and theoretical added value of these models (Teichert, 2019). As initially stated, there are numerous academic calls for further empirical evidence (Gollhardt et al., 2020; Remane et al., 2017; Teichert, 2019), for closer investigation of the theoretical basis (Chanias & Hess, 2016b; Nguyen et al., 2019; Remane et al., 2017; Teichert, 2019), practical value, as well for a better comparability of the DMMs (Hess, 2019; Rader David, 2019; Teichert, 2019).

Scientific calls for	IS scholars	Dissertation MAs
Better understanding of Digital Transformation	Bordeleau and Felden, 2019; Schallmo et al., 2020	MA 1 / MA 2 / MA 3 / MA 4 / MA 5
Research on the practical value of DMMs	Ochoa, 2016; Teichert, 2019; Valdez-De-Leon, 2016	MA 1 / MA 2 / MA 3 / MA 4 / MA 5
Research on the theoretical basis of DMMs	Chanias and Hess, 2016b; Remane et al., 2017; Teichert, 2019; Nguyen et al., 2019	MA 1 / MA 2 / MA 3 / MA 4 / MA 5
Research on differentiation and quality criteria of DMMs	Teichert, 2019, Hess, 2019; Rader, 2019	MA 1 / MA 3 / MA 4 / MA 5
Further Empirical evidence regarding DMMs	Remane, 2019; Teichert, 2019; Torsten, 2020	MA 4 / MA 5

Figure 8: Prominent scientific calls and corresponding dissertation manuscripts

The six aims of this dissertation have been derived carefully taking into consideration the above displayed academic calls. On that account, the five manuscripts of present dissertation focus on the different point of interest and answer the respective scientific calls.

Through explorative qualitative research consisting in the collection of non-numerical data, each manuscript provides valuable insights for the comprehension of the complex phenomenon of digital transformation from a distinct perspective. Relevant terms and definitions are carefully examined and interpreted.

In their entirety, based on systematic literature reviews, the manuscripts succeed in painting a comprehensive picture of the research field of DMMs and thus establish a first status quo. Furthermore, by identifying key factors for organizational digital transformation, the manuscripts of this dissertation are helpful to practitioners and researchers.

The present manuscripts also follow the call for additional research regarding the practical value of DMMs. The manuscripts of this dissertation offer valuable insights by discussing both the benefits and pitfalls of existing DMMs for managers. Furthermore, the architecture and contents of DMMs are carefully analyzed and compared to point out their respective advantages. Based on these findings and additional empirical insights, a holistic DMM for the content media publishing industry is derived and applied. In a practical setting, the usefulness of DMMs for practitioners is demonstrated by identifying of concrete measures to increase the level of organizational digital maturity.

The five papers of this doctoral thesis also investigate on the theoretical basis of DMMs by analyzing the central concepts and theories that the existing models are based upon. As previously outlined, central terms of the research field are discussed, interpreted, and defined. In this context, a theoretical basis for the development of a holistic DMM is derived.

Manuscripts 1 and 3 of this doctoral thesis focus on differentiation and quality criteria of DMMs by analyzing and comparing present models regarding their academic rigor, transparency, relevant factors, and documentation.

Finally, the call for additional empirical insights regarding the design and application of DMMs is answered by manuscript 4 and 5. These manuscripts offer a wide range of empirical evidence through the contention with both researchers and practitioners, as well as through the application and evaluation of a DMM in a case study approach.

During the present investigation new avenues for research were derived and concrete research questions defined. This dissertation thus strongly motivates further scientific investigations and contents in the area of DMMs.

Analysis of this dissertation form a DSR perspective

As already outlined in detail in section 3 of this work, this dissertation follows the overarching research paradigm of DSR. In the following, all manuscripts of the present work with will be analyzed through the lens of this problem-solving paradigm.

As described in section 3 of this dissertation, DSR entails two separate types of contributions (Winter, 2008): design science and design research. Design science primarily focuses on the design research process and its evaluation. To guarantee its rigor, design science aims at creating standards and guidelines, whereas design research aims at creating so-called artifacts to solve concrete classes of relevant problems (Gericke & Winter, 2009).

Design science can further be broken down into two activities: the reflection on the artifact construction and the reflection on the artifact evaluation (vom Brocke et al., 2020). This division is necessary as the design science process commonly separates the two phases of construction and reflection respectively (Venable et al., 2016). As depicted in the following illustration, design research can also be broken down into two separate fields of application: on one hand the construction and evaluation of situational artifacts, on the other hand, the problem specific adaption of situational artifacts.
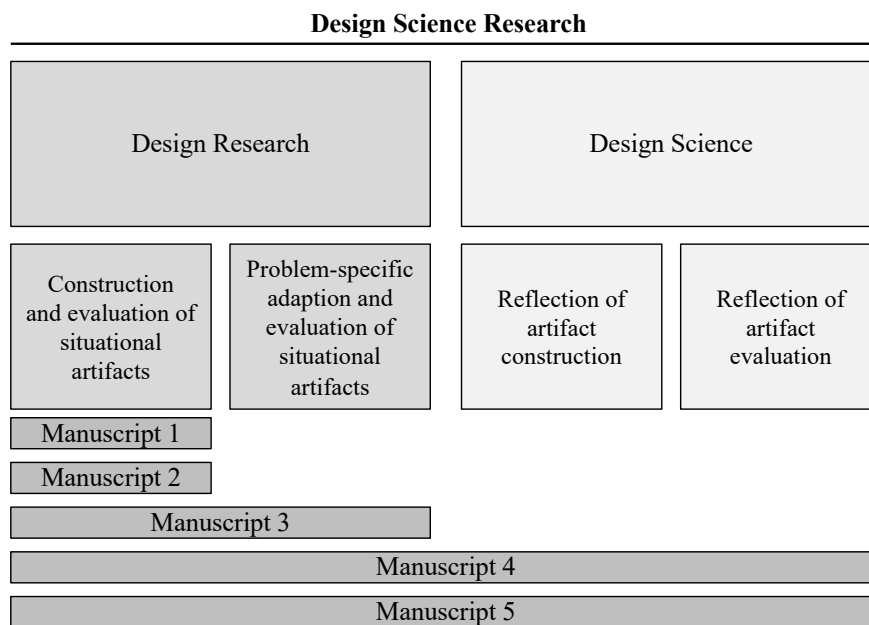
Figure 9: Contribution of manuscripts from DSR perspective

The above division of the research paradigm of DSR serves as an orientation and analysis framework for DSR related research. Making use of this framework, the focus of the each of the respective manuscripts of this dissertation will is mapped in Figure 4.

Manuscripts 1 and 2 investigate on the critical evaluation and discussion of present DMMs' theoretical and practical value and on the establishment of quality criteria for the measurement of an organization's level of digitalization. Thus, the two manuscripts focus on the construction and evaluation of situational artifacts within the overarching field of design research.

Manuscript 3 combines the two divisions of design research as it both evaluates DMMs as situational artifacts and problem-specific solutions.

Manuscripts 4 and 5 cover the entire spectrum of DSR based on the insights of the previous works. On the one hand, the two manuscripts encompass the construction, evaluation, application, and adaption of a holistic DMM. On the other hand, the two works emphasize on the design process as well as on its iterative evaluation phase.

Contribution of this dissertation from a design research perspective

One of the main contributions of DSR is the artifact construction and evaluation. March and Smith (1995) identify four different design artifacts: (1) constructs, (2) models, (3) methods, and (4) instantiations. Each type of design artifact bears a distinct contribution. Constructs provide the language to specify problems and solutions. Models make use of this language for the representation of the identified problems and future solutions. Methods constitute in the procedures which provide guidance on how to solve these problems and develop the solutions. Instantiations can be seen as problem-specific aggregates of the previously outlined constructs, models, and methods (i.e, Hevner et al. 2004; Peffers et al. 2006; Vahidov 2006). In this dissertation the artifact of interest is a holistic DMM for the content publishing industry. Based on the previous categorization, the present DMM will be assessed.

Digital maturity models (DMMs) have been designed to assess an organization's digital transformation status quo based on a set of specific dimensions and ascending maturity levels. In addition, they provide direction and recommendations for this digital transformation process (Williams et al., 2019). DMMs fulfill the requirements for the artifact type of a model as they reflect the current state of digital maturity and suggest an ideal target state. In addition, DMMs can also be seen as methods, as they specifically outline the procedures required to attain a higher level of maturity (Schallmo et al., 2020). Consequently, DMMs combine the two design artifact types of model and method of design research.
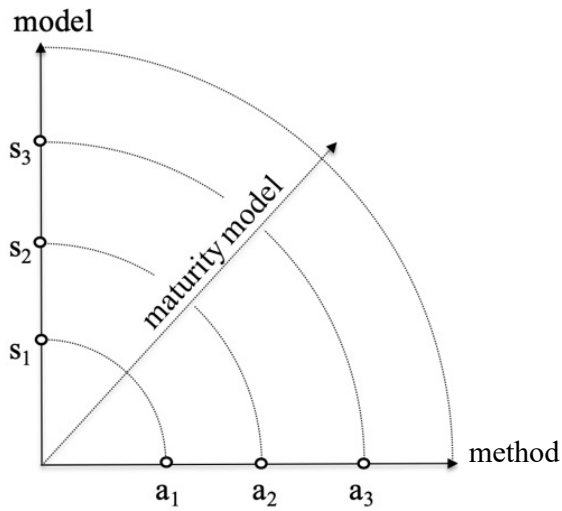
Figure 10: Positioning of maturity models in-between models and methods (Winter, 2008)

Contribution of this dissertation from a design science perspective

The other inherent contribution of DSR is the construction and evaluation process of an artifact. Depending on the artifact type, different processes for its construction and evaluation exist. In this context, de Bruin & Rosemann (2005) suggest a first design process for the development and evaluation of maturity models. Becker et al. (2009) further refined this design process for IT maturity models. Solli-Saether and Gottschalk (2010) offer additional assistance for such an undertaking. Drawing on these works, manuscript 4 suggests a first procedural model for the construction and evaluation procedure for a DMM. After careful evaluation, this procedural model was adapted and refined, and applied in manuscript 5.
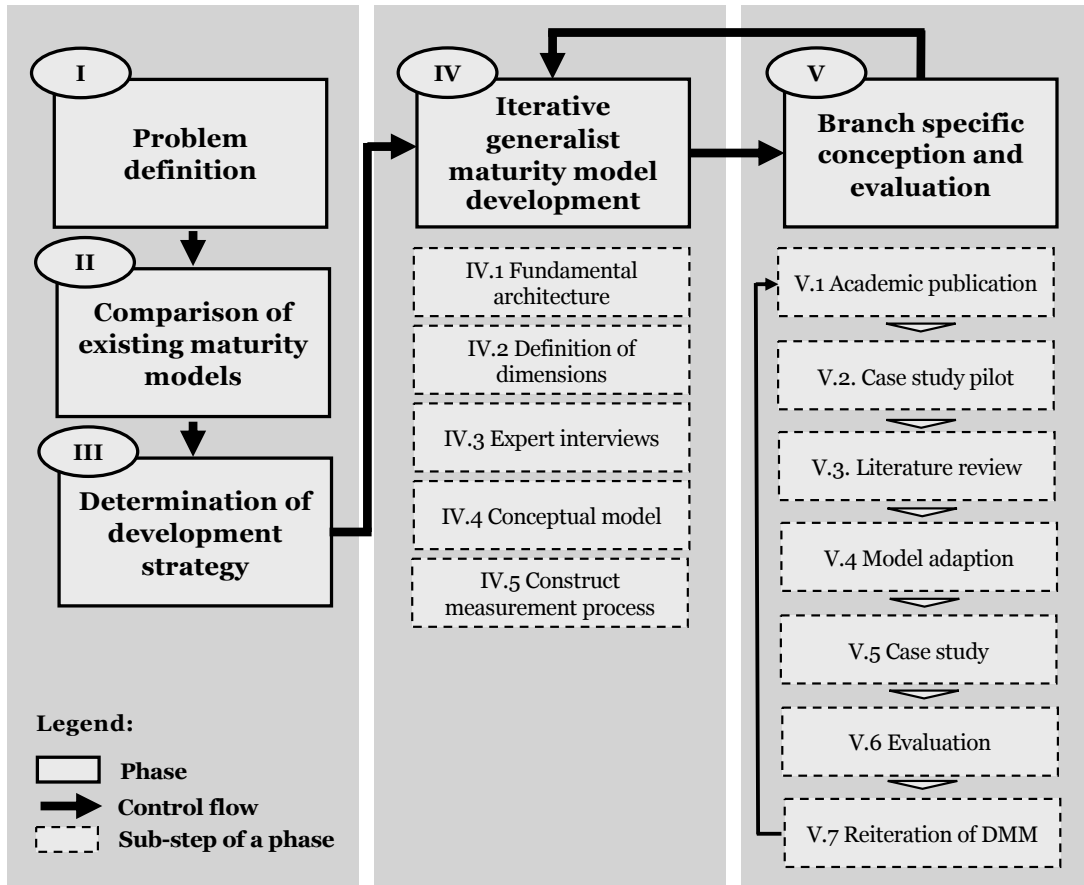
Figure 11: Final design process for industry specific DMM

The above illustration depicts the procedural model resulting from manuscripts 4 and 5. In comparison to the previously mentioned established design and evaluation processes for IS maturity models (i.e., Becker et al. 2009; de Bruin & Rosemann 2005; Solli-Saether and Gottschalk 2010) the new process offers more transparency, depth and guidance. In particular, phases IV and V are depicted in greater detail and provide more precise sub-steps, ultimately leading to a more rigorous research process according to design science standards. The present design process can serve as a blueprint for future endeavors in the field of DMM design. In this context, this process has to the potential to serve as a common standard and point of reference for additional accuracy, rigor and documentation.

6.2. Implications for academia and practice

The five manuscripts of this dissertation bear a variety of additional theoretical and practical implications that will be laid out in detail in the following paragraphs. When engaging in research in the field of digital maturity models, particular rigor, accuracy, and documentation are essential to prevent reproducing the previously mentioned shortcomings of the studies of this research field.

Manuscript 1 focuses on the theoretical value and academic rigor of DMMs. In the context of a systematic literature review followed by a qualitative content analysis, manuscript 1 identifies concrete flaws of the present models regarding their theoretical basis. Multiple understandings and definitions of the core terms hinders the development of a valid measurement model. Furthermore, the present study shows that the quality of the methods and approaches applied largely in current DMMs differs or cannot be evaluated at all. In general, the data collection procedure is not transparently explained. Based on the provided research agenda, along with concrete research problems and corresponding strategies, academics gain valuable insights regarding the research field of DMMs.

On a practical level, manuscript 1 provides managers with a much-needed critical evaluation of these popular practical instruments. They can refer to the present overview of 17 DMMs to identify a suitable tool for their organizational digital transformation.

Manuscript 2 is dedicated to four distinct fields of interest within the research area of DMMs: contribution to practice, contribution to theory, impact on performance, and DMM standards. Here, the main opposing viewpoints and perspectives in the academic community are represented and discussed. Finally, this approach serves to highlight shortcomings of current models and to deduce appropriate future research opportunities for the current research field. Scholars thus gain a comprehensive picture of the status quo of this field of research. Based on the provided directions for future research along with concrete research questions, a solid basis and point of reference for the development of a new DMM and ultimately the theoretical advancement of this research field is established. Finally, concrete solution approaches for current issues within the IS community are provided.

By generating transparency, clarification, and guidance for the organization's digital journey, manuscript 2 allows managers to examine the quality of a DMM's contents and interpret the results of a digital maturity assessment based on their own needs.

Manuscript 3 investigates on a key building block of existing DMMs: the platform concept.

Platforms are catalysts for data and knowledge sharing, collaboration, and innovation. These are key factors for achieving digital maturity (Pauli et al., 2021). Platforms can be observed at different levels and in various organizational settings: within a single firm, across supply chains, or across entire ecosystems. The present study provides a first comprehensive overview of the differing types of platforms relevant to an organization's digital transformation. Based on these insights a valid first working definition of the platform concept in relation to a firm's digital maturity is derived. From a theoretical point of view, along with a more nuanced understanding

of one the key building blocks of organizational digital maturity, researchers gain a first point of reference for future research in this field.

From a practical standpoint, the findings of manuscript 3 help managers in the interpretation and application of DMMs while taking the platform phenomenon into account. Practitioners are thus enabled to increase their organization's level of digital maturity by deploying an appropriate platform type from the offered overview.

Ultimately, manuscript 4 and 5 build on the insights of the previously outlined works and engage in the development and application of a holistic DMM for the content publishing industry. Manuscript 4 paper defines the research process for this endeavor. In this study shortcomings of present DMMs are identified and a first comprehensive conceptual DMM is designed. The conceptual model has practical and theoretical implications. Drawing on a systematic literature analysis and empirical evidence, the designed model is considered the first conclusive DMM that goes beyond the narrow scope of existing instruments. Practitioners are thus supplied with all relevant organizational dimensions necessary for a successful digital transformation. In addition, the conceptual DMM is one of only a few DMMs that conforms to academic standards and rigor and thus makes up a sound theoretical basis for manuscript 5.

As previously outlined, in manuscript 5 the conceptual DMM is then refined and applied as a holistic DMM for content publishers in the media industry. This study extends the understanding of digital transformation in the context of the content publishing media industry. It defines all relevant aspects for organizations seeking to reap the benefits of this transformation in the long-term.

Through an in-depth analysis of the relevant literature and a subsequent application of the DMM in the pioneering content publishing media industry, a solid basis for future research in this field is laid. Furthermore, manuscript 5 advances the comprehension, analysis and distinction of information system maturity models and their use to practitioners.

From a practical point of view, due to the holistic character of the DMM, managers can derive and prioritize concrete investments and practical measures to further increase their organization's digital maturity. Accordingly, these actions ultimately increase the firm's performance and competitiveness (Eremina et al., 2019); for example, higher levels of process maturity lead to higher levels of performance (Bititci et al., 2011; Le Chen & Fong, 2012; Dooley et al., 2001).

6.3. Limitations and future research

In this section, the limitations of the present manuscripts are acknowledged. Furthermore, directions for future research are derived.

All the manuscripts of this dissertation make use of literature reviews to collect relevant data for analysis based on previously defined parameters such as keywords, catchphrases, as well as databases, outlets, and timeframe. The area of interest is the research field of digital maturity and digital maturity models respectively. As previously outlined, in this field, there is no consensus on the definitions of underlying terms - resulting in a weak theoretical foundation in the relevant literature. In addition, due the highly dynamic setting of organizational digital transformation there is a need for a constant stream of publications with new concepts and approaches through various outlets. Due to the high practical relevance, in addition to the peer reviewed academic outlets such as conferences, journals, books etc., also so-called grey literature encompassing among others publications by industry associations and management consultancy firms needs to be considered to portray a comprehensive picture of the research field.

Given these circumstances, the literature reviews of the present studies can only be seen as excerpts of a status quo of DMM research at a certain point in time. Therefore, drawing on the insights of previous studies, future literature reviews should further extend the scope of the inquiry regarding keywords, catchphrases, as well as databases, outlets, and timeframe. A continuously updated pool of relevant literature could be highly beneficial to ensure the quality of research.

In contrast to manuscript 1 and 3, manuscript 2 complements the data collected via a literature review by empirical insights to sketch a comprehensive picture of the research field of DMM. For example, comments by reviewers and editors (2017-2022) from established IS journals and conferences, and informal talks and discussions with IS researchers from renowned German universities and the expertise of practitioners that have been interviewed along the field of work.

As mentioned earlier, in manuscript 4 a first conceptual holistic DMM is designed based on the results of a systematic literature review and empirical data collected through seven semi-structured interviews with digitalization experts and the feedback of two expert panels.

The scope of the empirical data collection in manuscript 2 and 4 is limited to the respective sample sizes of the interviews and discussions. Further empirical insights, e.g., expert interviews, group discussion, or Delphi studies could generate additional value and representativeness.

In manuscript 1-3, several research gaps have become obvious. Emerging from these, specific research areas and questions have been derived. To visualize and structure the evident research opportunities concrete research agendas have been proposed in the respective papers. Naturally, research agendas bear great potential for future research; however, they can only portray a fraction of the avenues for future research.

In manuscript 5, in a case study approach, the conceptual DMM is refined and applied to four large organizations within the highly dynamic content publishing media industry. This study has some limitations, several of which point to intriguing areas for further research.

First, due its exploratory approach, this case-based study is not statistically generalizable. The sample organizations represent only a fraction of the entire German content publishing media industry. Given the aim to portray a comprehensive picture of the status quo of organizational digital transformation of this particular sector, additional case studies in other organizations of the same industry need to be carried out. These further empirical insights could ultimately lead to a refinement of the model. Nevertheless, the holistic DMM could be used in similar industries due to its applicability along with a high face validity. Naturally, the model could also be applied to organizations outside of Germany, which would increase the representativeness of the results.

As already pointed out, using the DMM, the current status quo of an organization's digital maturity can be assessed and practical measures with the aim to enhance this level can be derived and implemented. Longitudinal case work (e.g.,Langley, 1999) is required to record the potential repercussions of these actions, as well as the ongoing progress of the digital transformation process in the respective organizations.

Given the rapid pace of breakthrough technology innovation and the resulting the highly dynamic business environment, the holistic DMM needs to be continuously refined. Ultimately, a continuous update of the relevant data used in the beforementioned manuscripts could add value to future research.

7. Conclusion

For organizations of all sizes and all sectors, DT currently is and will be both a major challenge and opportunity. Even though DT is an established phenomenon, the dynamics and implications of organizational digital transformation are still widely uncharted. This dissertation aims at contributing to theory and practice by offering new insights on how to identify and exploit the potentials of digital transformation while avoiding its pitfalls.

This doctoral thesis succeeds in developing, applying, and refining a new holistic DMM for the content publishing media industry in Germany through systematic literature review, analysis of present models and the identification of shortcomings and key factors for organizational digital transformation, combined with new empirical insights. While doing so, this dissertation follows established DSR guidelines and contributes to theory and practice by providing new standards for the design process of DMMs. In addition, each of the five manuscripts of the present dissertation answers various scientific calls in the field of DMMs and thus advances IS research considerably.

The complexity of organizational digital transformation still causes great uncertainty and instability for firms; however, this dissertation provides orientation and guidance for managers in this highly dynamic business environment. I am confident, that this dissertation will further stimulate valuable discussions at this point of intersection between theory and practice.

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Appendix

Learnings of the pilot case study

Process step	Encountered issue	Learning
Kick-Off meeting	- Aversion of executives to take part in an assessment that could be potentially negative - Questioning of value of scientific research for the practical business context	- Engage in an open discourse - Provide motivation and transparency - Emphasis on the organisational benefits – without individual consequences - Anonymization of survey and interview data - No sharing of data - Comprehensive NDAs
Acquiring of suitable interview partners	- Proposal of unsuitable interview partners	- Precise communication with responsible executives - Clear definition of suitable interview partners based on the organisations company structure and organigram
Completion of survey and complementary interviews	- Strong criticism concerning the underlying statements or wording of the survey during the interviews	- Engaging in open discourse - Maintain professional distance and objectivity - De-escalation - Adaption of wording
	- Perceived incompleteness (by researchers) of the dimension IT Automation, Integration and Security	- Need of a renewed literature regarding the scope of the statements of the assessment catalogue concerning data/ information security
	- Two of the items raised additional questions due to high complexity	- Split two existing items into two less complex statements
	- Clear trend to provide only positive answers	- Addition of check-up questions and statements - Adaption of wording - Reorganisation of the order of the survey statements - Inversion of questions and Likert scale
Presentation of DM score for verification	- Limited interest in the results of the assessment - Questioning of assessment quality	- Maintain professional distance and objectivity - Underlining potential benefits for the organisation
Derivation of practical measures	- Questioning of suitability of practical measures	- Maintain professional distance and objectivity

Detailed case study protocoll

Process step	Aim	Realisation	Participants
Initial application	1. Obtain participation of suitable organisations 2. Identification of suitable contact persons	- Review of publicly accessible information (annual reports, newspaper articles, etc.) - Review of digital strategy of the last 10 years - Individualized cover letter with one-pager, outlining benefits of DMM assessment	2 Researchers
First contact	1. Introduction of research, benefits, and motivation 2. Defining relevant parameters 3. Scheduling of Kick-off meeting	- Short overview of research - Motivation for choosing this corporation - Getting to know each other - Refinement of assessment catalogue and glossary	2 Researchers, CTO and chief of staff of parent corporation
Preparation of research project	1. Gathering background information on the parent corporation and subsidiaries 2. Additional information on business models 3. Background information of all potentially involved executives	- Review of digital strategy - Review of CVs via LinkedIn/ Xing etc.	2 Researchers
Kick-off meeting (*in person*)	1. Establishing common ground 2. Obtaining participation and cooperation 3. Presentation of motivation of the board of board of the parent corporation to scientifically assess DM of subsidiaries 4. Defining ideal interview partners 5. Scheduling of timeframe	- Presentation of the researcher, the research model, and excerpts of the assessment catalogue - Definition of central concepts and terms - Outlining added value and benefits of DM assessment (one-pager) - Short discussion of the executives' opinions	5 participants - CTO of the parent corporation & one chief executive of each of the respective subsidiaries, 2 Researchers
Scheduling of interviews	1. Ensuring conformity to timeframe 2. Ensuring the suitability of interview partners – 3 interviewees per subsidiary with strong connection to implantation of digital strategy - for triangulation	- Contact via email and telephone - Adaption of suggested interview partners	12 participants - All potential interview partners, 2 Researchers

Conduction of interviews and data gathering for assessment catalogue (*via video conferencing*)	1. Ensuring interview standard for comparability 2. Audio- recording of interviews 3. Respect the timeframe of max. 1.30h 4. Gather additional information concerning DM 5. Encourage open communication	- Presentation of the researcher and motivation of the parent corporation to assess DM - Completion of assessment catalogue - Individual weighting of DMM dimensions - Explanations for survey answers - Open discourse	12 participants - All interview partners 1 researcher
Follow up of interviews (weighting of dimensions & complementary documents	1. Ensure the receiving of complementary documents	- Complementary documents concerning digital initiatives, innovation, and products	12 participants - All interview partners 1 researcher
Transcription of interviews	1. Rigorous and precise transcription of interviews	- Transcription of interviews using Trint transcription software	2 Researchers
Triangulation, Evaluation & Determination of DMM Score	1. Evaluation of the three interviews/ completed surveys for each subsidiary under consideration of personal impression 2. Evaluation of provided complementary documents 3. Calculation of DMM score for each subsidiary	- Review of transcripts and survey results - Definition of outliers - Review and analysis of all complementary documents - Review and evaluation of collected data for the assessment catalogue	2 Researchers
Interpretation of score and derivation of practical measures	1. Evaluation of collected data for each subsidiary under consideration of personal impression of the researcher	- Evaluation and interpretation of data	2 Researchers
Presentation of results	1. Comment and Verification of the results and measures	- PowerPoint presentation of results and derived practical measures	5 participants - CTO of the parent corporation & one chief executive of each of the respective subsidiaries,

Digital maturity assessment catalogue (German)

#	Pillar	Dimension	Dimension Criteria	Assessment Item
1	Broader Organisation	Business Model	Digital Business Model	Wir bewerten regelmäßig neue digitale Geschäftsmodelle und integrieren sie ggf. in die Unternehmensstrategie.
2	Broader Organisation	Business Model	Diversification into digital business fields	Zusätzlich zum Hauptgeschäftsmodell investieren wir in neue digitale Geschäftsmodelle.
3	Broader Organisation	Collaboration	Best Practices	Erfahrungen und Erfolge aus internen Projekten werden abteilungsübergreifend im Unternehmen kommuniziert und angenommen.
4	Broader Organisation	Collaboration	Use of collaborative technologies	Digitale Technologien zur Zusammenarbeit (wie z.B. Google Docs, Slack, Trello, Asana ...) sind Teil der täglichen Arbeit und werden vom Unternehmen bereitgestellt.
5	Broader Organisation	Collaboration	Working remotely	Mitarbeiter, für die es sinnvoll ist, können jederzeit mobil und ortsgebunden arbeiten.
6	Broader Organisation	Culture & Expertise	Assessment of digital competencies	Uns ist das digitale Kompetenzlevel jedes Mitarbeiters bekannt.
7	Broader Organisation	Culture & Expertise	Assessment of digital competencies	Wir prüfen das digitale Kompetenzlevel jedes Mitarbeiters regelmäßig auf wissenschaftlicher Basis.
8	Broader Organisation	Culture & Expertise	Assessment of digital competencies	Die Bewertung der digitalen Kompetenzen der Bewerber erfolgt nach wissenschaftlichen Kriterien.
9	Broader Organisation	Culture & Expertise	Culture of mistakes	Wir kommunizieren und werten Fehler und Lehren aus Projekten ohne negative Konsequenzen für die Mitarbeiter aus.
10	Broader Organisation	Culture & Expertise	Employee commitment to digital transformation	Unsere Mitarbeiter bringen sich aktiv in digitale Initiativen ein.
11	Broader Organisation	Culture & Expertise	Employee commitment to digital transformation	Unsere Mitarbeiter begrüßen die stetige Digitalisierung des Unternehmens und erkennen die Chancen an.
12	Broader Organisation	Culture & Expertise	Propagation of digital competencies	Wir investieren kontinuierlich durch Fort- und Weiterbildungen in die digitalen Kompetenzen unserer Mitarbeiter.
13	Broader Organisation	Culture & Expertise	Propagation of digital competencies	Digitale Kompetenzen sind ein entscheidendes Kriterium bei der Einstellung neuer Mitarbeiter.
14	Broader Organisation	Customer Experience	Customer Data Analytics	Wir werten Kundendaten regelmäßig und gezielt in großem Umfang aus.
15	Broader Organisation	Customer Experience	Customization of digital offerings across channels	Über alle Kanäle hinweg individualisieren wir unsere digitalen Angebote.
16	Broader Organisation	Operational Processes	Adaptability of processes	Wir passen unsere Prozesse kurzfristig an, um auf interne und externe Veränderungen zu reagieren.
17	Broader Organisation	Operational Processes	Continuous reevaluation of business processes	Unsere unternehmensspezifische Geschäftsprozesse erfasst und sich mit deren Verbesserung befasst.
18	Broader Organisation	Operational Processes	Process efficiency	Unser Unternehmen verfügt über effiziente Geschäftsprozesse.
19	Information Technology	IT Automation, Integration and Security	Data Security	Wir verschlüsseln sensible Daten nach den höchsten Industriestandards.
20	Information Technology	IT Automation, Integration and Security	Data Security	Wir haben strenge Data Policies und schulen alle Mitarbeiter regelmäßig.
21	Information Technology	IT Automation, Integration and Security	Data Security	Wir verfügen über strenge Access Control Richtlinien.
22	Information Technology	IT Automation, Integration and Security	IT Integration	Unsere gesamte Wertschöpfungskette wird durch verbundene IT-Systeme abgedeckt.
23	Information Technology	IT Automation, Integration and Security	IT Integration	Unsere IT-Systeme verfügen über externe Anbindungen an z.B. Lieferanten/ Kunden.
24	Information Technology	IT Automation, Integration and Security	IT Security	Wir kennen unsere unternehmensspezifische Gefährdungssituation bzgl. Cyberattacken und prüfen das Cyberrisiko regelmäßig.
25	Information Technology	IT Automation, Integration and Security	IT Security	Wir verfügen über eine über eine Cyberrisiko Versicherung.
26	Information Technology	IT Automation, Integration and Security	IT Security	Wir verfügen über aktuellste Intrusion Detection Systems (IDS).
27	Information Technology	IT Automation, Integration and Security	IT Security	Unsere IT- und Datensicherheit ist an dem unternehmensspezifischen Cyberrisikolevel angepasst.
28	Information Technology	IT Automation, Integration and Security	Process automation	Wir verfügen über voll-automatisierte Geschäftsprozesse.
29	Information Technology	IT Usability	Functional IT support	Jeder Mitarbeiter erhält zeitnah IT Support.
30	Information Technology	IT Usability	Intuitive and easy-to-use software	Von 0-5 : Welche Rolle spielen Nutzerfreundlichkeit und intuitive Anwendung beim Einkauf bzw. der Entwicklung von Software?
31	Information Technology	Requirements Management	Continuous evaluation of IT infrastructure	Wir haben ein Gremium, das die Güte der IT Infrastruktur des Unternehmens prüft.
32	Information Technology	Requirements Management	IT satisfies requirements imposed by business	Wir haben Bedürfnisse und Anforderungen des Unternehmens an die IT identifiziert.
33	Information Technology	Requirements Management	IT satisfies requirements imposed by business	Die IT erfüllt die Bedürfnisse und Anforderungen unseres Unternehmens vollumfänglich.
34	Information Technology	Requirements Management	Software monitoring	Unser Unternehmen verfügt über Qualitäts- und Produktivitätsstandards für Software-Anwendungen.
35	Information Technology	Technology Change Management	Identification and evaluation of new technologies	Wir haben ein Gremium, das regelmäßig neue Technologien auf deren Nutzen für das Unternehmen prüft.
36	Information Technology	Technology Change Management	Transfer of technologies into the organization	Wir haben Standards zur Einführung neuer Technologien in das Unternehmen.
37	Management	Designated Roles	Designated roles	In den letzten 5 Jahren haben wir mit Bezug auf die digitale Transformation neue Berufsbilder eingeführt (e.g. Chief Digital Officer, Chief Data Officer, Data Scientist, IOT Engineer, Cloud Integrator, User-Experience Designer).
38	Management	Designated Roles	Designated roles	Wir haben Verantwortlichkeiten im Unternehmen unter Berücksichtigung der Digitalen Transformation definiert.
39	Management	Designated Roles	Clear reporting structure	Wir haben klare Hierarchiestrukturen innerhalb unseres Unternehmens.
40	Management	Digital Strategy	Adequacy of available resources	Unser Unternehmen verfügt über ausreichende Ressourcen für die Digitale Transformation des Unternehmens.
41	Management	Digital Strategy	Commitment to digital transformation	Von 0-5 : welchen Stellenwert nimmt die digitale Transformation in der Unternehmensstrategie ein?
42	Management	Digital Strategy	Communication of strategy	Wir informieren unsere Mitarbeiter regelmäßig digital und analog über die aktuelle Unternehmensstrategie.
43	Management	Digital Strategy	Identification of strengths	Wir haben die Stärken und Schwächen unseres Unternehmens in Bezug auf die Digitale Transformation identifiziert.
44	Management	Digital Strategy	Implementation of strategy for digital transformation	Die für die Digitale Transformation erforderlichen Maßnahmen werden implementiert.
45	Management	Digital Strategy	Strategy for digital transformation	Wir haben einen Maßnahmenplan, der alle relevanten Themenfelder der Digitalen Transformation adressiert und priorisiert.
46	Management	Management Support	Middle Management Support	Unser mittleres Management treibt die Umsetzung von digitalen Projekten voran.
47	Management	Management Support	Top Management Support	Führende Organe unseres Unternehmens treiben die Digitale Transformation voran und stellen entsprechende Ressourcen zur Verfügung.
48	Management	Management Support	Top Management Support	Steuerung und Verantwortung für die Digitale Transformation liegt auf oberster Führungsebene.
49	Management	Performance Measurement	Definition of KPIs	Wir haben erfolgskritische Kennzahlen unter Berücksichtigung der Digitalen Transformation definiert und kommuniziert.
50	Management	Performance Measurement	Evaluation and improvement of KPIs	Wir überprüfen erfolgskritische Kennzahlen regelmäßig und passen sie ggf. an.
51	Management	Performance Measurement	Incentivisation of employees	Wir haben erfolgskritische Kennzahlen im Zusammenhang mit der digitalen Transformation in der Zielvereinbarungen der Mitarbeiter verankert.
52	Management	Product Innovation	Digital offer complementation	Zur Ergänzung unserer Produkte und Dienstleistungen bieten wir digitale Begleitangebote an.
53	Management	Product Innovation	Digital offer development	Wir ziehen Kundenfeedback bei der Entwicklung neuer Produkte und Dienstleistungen mit ein.
54	Management	Product Innovation	Digital offer development	Wir ziehen Mitarbeiterideen bei der Entwicklung neuer Produkte und Dienstleistungen mit ein.

Digital maturity assessment catalogue (English)

#	Pillar	Dimension	Dimension Criteria	Assessment Item
1	Broader Organisation	Business Model	Digital Business Model	We regularly evaluate new digital business models and integrate them into the corporate strategy where appropriate.
2	Broader Organisation	Business Model	Diversification into digital business fields	In addition to the main business model, we are investing in new digital business models.
3	Broader Organisation	Collaboration	Best Practices	Experiences and best practices from internal projects are communicated and implemented across departments in the company.
4	Broader Organisation	Collaboration	Use of collaborative technologies	Digital collaboration technologies (such as Google Docs, Slack, Trello, Asana...) are part of the daily work and are provided by the company.
5	Broader Organisation	Collaboration	Working remotely	Employees for whom it makes sense can work mobile and unrestricted at any time.
6	Broader Organisation	Culture & Expertise	Assessment of digital competencies	We know the digital competence level of each employee.
7	Broader Organisation	Culture & Expertise	Assessment of digital competencies	We regularly test the digital competence level on a scientific basis.
8	Broader Organisation	Culture & Expertise	Assessment of digital competencies	The evaluation of the digital competence of the applicants is based on scientific criteria.
9	Broader Organisation	Culture & Expertise	Culture of mistakes	Our employees are actively involved in digital initiatives.
10	Broader Organisation	Culture & Expertise	Employee commitment to digital transformation	Our employees welcome the steady digitalization of the company and recognize the opportunities.
11	Broader Organisation	Culture & Expertise	Propagation of digital competencies	We communicate and evaluate mistakes and lessons learned from projects without negative consequences for employees.
12	Broader Organisation	Culture & Expertise	Propagation of digital competencies	We continuously invest in the digital skills of our employees through training and development.
13	Broader Organisation	Culture & Expertise	Propagation of digital competencies	Digital skills are a decisive criterion when hiring new employees.
14	Broader Organisation	Customer Experience	Customer Data Analytics	We regularly evaluate customer data on a large scale and in a targeted manner.
15	Broader Organisation	Customer Experience	Customization of digital offerings across channels	Across all channels, we individualise our digital offerings.
16	Broader Organisation	Operational Processes	Adaptability of processes	We adapt processes at short notice to respond to internal and external changes.
17	Broader Organisation	Operational Processes	Continuous reevaluation of business processes	We have a committee that captures business processes and addresses their improvement.
18	Broader Organisation	Operational Processes	Process efficiency	Our company has efficient business processes.
19	Information Technology	IT Automation, Integration and Security	Data Security	We encrypt sensitive data according to the highest industry standards.
20	Information Technology	IT Automation, Integration and Security	Data Security	We have strict data policies and train all employees on a regular basis.
21	Information Technology	IT Automation, Integration and Security	Data Security	We have strict access control policies.
22	Information Technology	IT Automation, Integration and Security	IT Integration	Our entire value chain is covered by connected IT systems.
23	Information Technology	IT Automation, Integration and Security	IT Integration	Our IT systems have external connections to e.g. supplier's/customers.
24	Information Technology	IT Automation, Integration and Security	IT Integration	We are aware of our company-specific risk situation with regard to cyberattacks and regularly review the cyber risk.
25	Information Technology	IT Automation, Integration and Security	IT Security	We have cyber risk insurance.
26	Information Technology	IT Automation, Integration and Security	IT Security	We have the latest intrusion detection systems (IDS).
27	Information Technology	IT Automation, Integration and Security	IT Security	Our IT and data security is adapted to the company-specific cyber risk level.
28	Information Technology	IT Automation, Integration and Security	Process automation	We have fully automated business processes.
29	Information Technology	IT Usability	Functional IT support	Every employee receives IT support within 24h.
30	Information Technology	IT Usability	Intuitive and easy-to-use software	From 0-5 - What role do user friendliness and intuitive application play in the purchase or development of software?
31	Information Technology	IT Requirements Management	Continuous evaluation of IT infrastructure	We have a committee that reviews the quality of the IT infrastructure.
32	Information Technology	IT Requirements Management	IT satisfies requirements imposed by business	We identified needs and requirements of the company for IT.
33	Information Technology	IT Requirements Management	IT satisfies requirements imposed by business	IT fully meets the needs and requirements of our company.
34	Information Technology	IT Requirements Management	Software monitoring	Our company has quality and product ratify standards for software applications.
35	Information Technology	Technology Change Management	Identification and evaluation of new technologies	We have a committee that regularly reviews new technologies for their benefit to the company.
36	Information Technology	Technology Change Management	Transfer of technologies into the organization	We have standards for introducing new technologies into the company.
37	Management	Designated Roles	Designated roles	In the last 3 years, we have introduced new job descriptions with reference to digital transformation (e.g. Chief Digital Officer, Chief Data Officer, Data Scientist, IoT Engineer, Cloud Integration, User-Experience Designer).
38	Management	Designated Roles	Designated roles	We have defined responsibilities in the company with digital transformation in mind.
39	Management	Designated Roles	Clear reporting structure	We have clear hierarchy levels within our company.
40	Management	Designated Roles	Adequacy of available resources	Our company has sufficient resources for the digital transformation of the company.
41	Management	Digital Strategy	Commitment to digital transformation	From 0-5 - how important is digital transformation in corporate strategy?
42	Management	Digital Strategy	Communication of strategy	We regularly inform our employees digitally and unambiguously about the current corporate strategy.
43	Management	Digital Strategy	Identification of strengths	We have identified the strengths and weaknesses of our company with regard to Digital Transformation.
44	Management	Digital Strategy	Implementation of strategy for digital transformation	The measures required for digital transformation implemented.
45	Management	Digital Strategy	Strategy for digital transformation	We have an action plan that adds cases and prioritizes all relevant topics of digital transformation.
46	Management	Management Support	Middle Management Support	Our middle management drives the implementation of digital projects.
47	Management	Management Support	Top Management Support	Leading bodies of our company are driving forward the Digital Transformation and providing the appropriate resources.
48	Management	Management Support	Top Management Support	Control and responsibility for digital transformation lies at the top management level.
49	Management	Performance Measurement	Definition of KPIs	We have defined and communicated key performance indicators that are critical to success, taking digital transformation into account.
50	Management	Performance Measurement	Evaluation and improvement of KPIs	We regularly review key performance indicators that are critical to success and adjust them if necessary.
51	Management	Performance Measurement	Incentivisation of employees	We have anchored key performance indicators that are critical to success in connection with the digital transformation in the employees' target agreements.
52	Management	Product Innovation	Product complementation	To complement our products and services, we offer digital companion services.
53	Management	Product Innovation	Digital offer development	We take customer feedback into account when developing new products and services.
54	Management	Product Innovation	Digital offer development	We incorporate employee ideas when developing new products and services.