Practical Application of Maturity Models in Healthcare: Findings from Multiple Digitalization Case Studies

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Abstract: Maturity models (MMs) are widely applied means for describing a current status of development across numerous domains, but also within the healthcare sector. They offer orientation for systematic development and improvement regarding the aspect examined. However, experience from the practical application of MMs is scarcely described. Within this article two projects in which MMs were used in collaboration with practitioner groups from hospital environments are presented. The general project intentions, motivation for incorporating MMs and generated results are described. By deriving observations across the two cases, general tensions between healthcare practice and research concerning maturity modelling are identified. Additionally, the suitability of existing MMs to support especially hospitals in coping with the challenges of the digital transformation is discussed. This study's findings may be incorporated into development and refinement of MMs and may thus contribute to increasing practical value created by such means.

1 INTRODUCTION

Manufacturing industries all over the world are facing the challenges of the digital age: a change of production, services as well as business models itself is required (Bauernhansl, 2014). The same challenge applies to healthcare provision: the increased availability of electronically held information and data offers new ways of providing healthcare. Digital interfaces between care providers, sectors, divisions, wards and functional areas offer a seamless availability of information, but also require new ways of organizing and steering the health provision process. The peculiarity of the digital transformation is the prospective designation as an industrial revolution, what has usually been named as such in historical review. Regardless of whether the scope was correctly anticipated, this withholds the opportunity and the burden for societies, industry, research, but also healthcare providers to actively shape the future (Hermann et al., 2016). Hitherto, practitioners and researchers pursued the systemization of change processes, in order to constitute a phenomenon, and to be able to structurally evolve it (Meister et al., 2019). The shaping of this as a revolution labelled future working world requires the disruptive rearrangement of processes according to a constantly developing vision (Deiters et al., 2018).

Up to this point, maturity models (MMs) have been widely established as tools for describing a specific development status, circumstance or condition of an organization, a process or a structure (Wendler, 2012). At the same time, they usually offer a path of evolution for systematic development and improvement with regard to the assessed aspect (Pöppelbuß et al., 2011; Pöppelbuß & Röglinger, 2011). Current research efforts focus on the development of increasingly rigorous MMs particularly addressing the challenges of the digital transformation in various domains. An increasing number of MMs is dealing with digitalization aspects in healthcare settings. At the same time, there is little narrative about the implementation and effectiveness of applying MMs in highly complex environments like hospitals (Waring & Currie, 2009). However, such experience should have sustainable impact on the development of such models itself (Blondiau et

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al., 2016). Barret and Oborn describe the division between practice and research as twofold: on the one side researchers are "lost in translation" struggling in explaining the relevance of theories to practice. On the other side research is "lost before translation" developing practically irrelevant theories (Barrett & Oborn, 2018). In order to bridge the mentioned research-practice-division, within this article we present experiences from applying MMs as means for achieving specific practical purposes in two separate research projects. According to Braa & Vidgen (Braa & Vidgen, 1999) the studying of IS artefacts in-context is able to contribute to understanding the "organizational laboratory", the artefact itself and integration mechanisms. We thus endeavour to contribute to answer the following research questions by investigating two practical applications of MMs:

1) *What challenges does the practical field face when applying MMs as tools for structured development of healthcare provision?*
2) *What challenges arise from using MMs as means to structurally cope with the digital transformation in healthcare?*

For this purpose, we firstly outline the relevant conceptual background regarding maturity modelling and modelling digital maturity in the healthcare domain. Secondly, we present the research approach and data collection methods, as well as the two projects we derive our findings from. Subsequently, we depict the project results and the observations made from incorporating MMs into practice. We conclude with a summary of the contributions, limitations and potential for future research.

2 BACKGROUND

2.1 Maturity Modelling

The concept of modelling maturity originates from the classification of software development processes (Humphrey, 1988) within the Capability Maturity Model (CMM) (Paulk et al., 1993). Since then, a continuously rising number of publications with regard to MMs have been made (Lee et al., 2019; Wendler, 2012).

The modelling of maturity distinguishes between general approaches and domain specific descriptions of maturity aspects (Wendler, 2012). This is due to the challenge of distinctive MMs of on the one hand addressing individual challenges and generating a hands-on benefit for the assessed organization, and at the same time provide general expressiveness and abstraction, for which the research community is striving (Becker et al., 2009; Blondiau et al., 2016). MMs mostly categorize a defined context in discrete stages (Gottschalk, 2009; Schuh et al., 2017), and differ in their degree of descriptivity and prescriptivity (de Bruin et al., 2005).

Most of the existing measurement means were developed following a top-down approach, which led to the criticism regarding relevance and rigor of these procedures. Following that, bottom-up methods and tools have been proposed (Lahrmann et al., 2011; Rönkkö et al., 2008).

Within this paper the focus lies on the depiction of maturity with regard of general healthcare provision, institutions and processes, and in particular regarding digitalization aspects within this domain.

2.2 Digital Maturity in Healthcare

Healthcare provision substantially differs from providing conventional services, or from production in the manufacturing sector. This is obvious in the requirements dynamics, interdisciplinarity and human-centred process control (Söylemez & Tarhan, 2016). Furthermore, and contrary to other organizations, actors in healthcare organizations are not subordinate to a central strategy, but follow diverging aims (e.g. different aims in different clinics, conflicting economic and medical aims). For this reason, the healthcare domain puts its trust in domain specific models rather than adopting general models from industry.

In 2016 Carvalho et al. identified 14 maturity models dealing with information systems technology in healthcare (Carvalho et al., 2016), and since then others have been added (Gomes & Romão, 2018; Kolukısa Tarhan et al., 2020).

The probably most widely applied MM approach regarding digitalization in healthcare is the Electronic Medical Record Adoption Model (EMRAM), developed and provided by the Healthcare Information and Management Systems Society (HIMMS Analytics, 2017). EMRAM measures the degree of the integration of an electronic health record (EHR) of hospitals. This model was first introduced in 2005, revised in 2018 and categorizes hospitals in eight levels of maturity from 0 (no digitalization) to 7 (paperless hospital) (Stephani et al., 2019).

Other exemplary approaches in the hospital sector dealing with digitalization aspects set a focus on the maturation and evolvability of PACS (van de Wetering & Batenburg, 2009) or digital imaging

(Studzinski, 2017), the adoption of data analytics (Sanders et al., 2013), the degree of correspondence of the IT architecture with strategic goals (Mettler et al., 2014; Mettler & Pinto, 2018), or the ability to implement IT innovation (Esdar et al., 2017).

While a considerable number of methods operationalize and measure particular maturity aspects of healthcare institutions, Carvalho et al. in their literature review remark, that no identified model covers all organizational areas and systems of healthcare organizations. This notation is e.g. picked up by the regularly published "IT Healthcare Report" (Hübner et al., 2015; Hübner et al., 2018; Hübner et al., 2020), which points out one particular aspect per issue. One of these aspects is the clinical information logistics, operationalized in the workflow composite score (WCS) (Liebe et al., 2015). The score breaks down the availability of data along and across clinical processes.

Most of the mentioned approaches neglect the dependence of healthcare processes on interaction (purely social as well as socio-technical) and commitment of human actors. Krasuska et al. i.e. identify multimodal capabilities relevant for "digital excellence" in hospitals (Krasuska et al., 2020). Pak & Song (Pak & Song, 2016) explicitly address the human interaction aspect, while Burmann et al. suggest a combination of technical and human factors (Burmann et al., 2019).

However, successful implementation and deployment in practice is scarcely described (Blondiau et al., 2016). Mettler et al. addressed this issue by discussing experiences and pitfalls from the translation of their intervention-cycle into application (Blondiau et al., 2016; Mettler, 2010). They conclude that implementation of maturity assessments in practice requires especially in hospitals a high level of support (Blondiau et al., 2016; Caldwell & Atwal, 2003; Conwell et al., 2000).

3 METHODOLOGY

The presented research methodologically builds on a structured literature review (SLR) and case study research (CSR). The SLR provides a comprehensive overview of the current status of research and application. Thereby, substantial developments of maturity modelling in general and particularly in the healthcare domain were identified. The findings presented in this article are based on the retrospective analysis of two projects, which were conducted from 2017 to 2020. Both projects followed the assumptions regarding case study research made by Yin (Yin, 1987). The presented analysis combines aspects from the pragmatism and interpretivism paradigms in IS research as explained by Goldkuhl (Goldkuhl, 2012). The "data generation" followed the former since the two projects were carried out in joint teams with representatives from research and practice, while the retrospective "data analysis" can be merely assigned to interpretivism. The SLR served as a continuous knowledge basis for both of the presented case studies.

3.1 Literature Review

In order to gain an overview of the literature in the field of maturity modelling, a structured literature review, as suggested by Webster and Watson (Webster & Watson, 2002) and vom Brocke et al. (vom Brocke et al., 2009) was conducted. This search was carried out accompanying both projects and updated regularly. Since literature in the field of Information Systems (IS) is gathered across a large number of databases, a combination of search sources is advised (Levy & J. Ellis, 2006). The databases Scopus, AIS eLibrary and IEEEXplore were chosen in order to incorporate the leading journals and conference proceedings. Firstly, the authors aimed at collecting the conceptual foundation of maturity models in general and therefore used the search string "maturity model" OR "maturity assessment" OR "maturity measurement". Subsequently, languages other than English and were excluded, and the results were limited to secondary sources. From initially over 6800 identified publications 118 documents remained, of which 4 sources referred to digitalization MMs. Via a backward and forward search of the relevant literature we identified the major works and contributions to general maturity modelling and modelling the status of digitalization. Additionally, a summary of activities with particular regard to maturity modelling in the healthcare domain was generated by combining the search string above with AND "Hospital" OR "Healthcare" OR "clinical workflow". This search lead to a total number of 146 results, which were subsequently screened for actual models presented. The total number of maturity models particularly for the healthcare domain rose from around 30 in 2017 to more than 60 in 2020 (Kolukısa Tarhan et al., 2020). In order to also incorporate approaches which might not be described on a peer reviewed research level, but are part of practical application, the search was conducted in GoogleScholar as well. The identified maturity models served as a knowledge basis for solving domain problems within several projects related to

hospital digitalization since 2017, and particularly the two referred to in this article. Section 3.4 describes the two cases in further detail.

3.2 Case Study Research

In order to derive general findings associated with the practical application of MMs in healthcare context and contribute to answering the formulated research questions the recent project past of the authoring working group was screened for cases suitable to be included into this analysis. Since we aimed at breadth and generalization across different practical scenarios, we identified two projects as heterogenous as possible regarding timely distance to each other, data collection means, combination of applied MMs, type of action (intervention or description) and number of maturity assessments. Both projects were assigned to the field of case study research. A case study generally analyses a real-world phenomenon, and contributes to understanding a complex problem (Yin, 2003). The investigation is defined in time and location, and follows a specific research question (Baxter & Jack, 2008; Ridder, 2016)., related to the description of digitalization of healthcare processes, were carried out under the CSR notion. Both projects were carried out and analysed separate from each other (Gustaffson, 2017). Section 3.4 describes the adduced projects, while Table 1 compares the case's parameter.

3.3 Data Collection Means

Within the two projects primary qualitative data collection methods were used. That encloses in-depth interviews and focus groups (Gill et al., 2008) with designated experts as well as guest visits and observations of the daily working environment by one of the researchers (shadowing) (Quinlan, 2008). The in-depth interviews followed a predefined semi-structured guideline, and were conducted by phone and documented by the interviewer (Longhurst, 2010). The focus groups were carried out with healthcare representatives and scientists from the research institute on the site of the respective project partner. Focus groups strengthen the relevance as they enable joint problem-oriented research activity with practitioners (Gill et al., 2008). Within these focus groups processes were modelled and analysed with regard to the current status of digitalization and optimization potentials. Therefore, tools such as the Business Process Model and Notation (BPMN) (Allweyer, 2010), group discussions or the Digital Imaging Adoption Model (DIAM) (Studzinski, 2017) were used. The focus groups were documented by the research representative (doctoral candidates in the subject area) with whiteboards, flipcharts and protocols.

3.4 Case Description

The two mentioned cases were driven by user needs and aimed for different purposes. Common ground is that both incorporated the application of maturity modelling concepts into practice. They were carried out independently and included into this analysis retrospectively. The projects were initiated from institutions of healthcare provision and can be assigned to two specific and disparate functional areas: diagnostic imaging (DI) and oral and maxillofacial surgery (OMS). The project objectives are summarized in the following, and the project parameter relevant for this article are comparatively depicted in table 1.

3.4.1 Case 1: Diagnostic Imaging

The scope of Project 1: Diagnostic Imaging was to support the substitution of an analogue radiology imaging system with a digital workplace solution and to assess the impact of an increase of the degree of digitalization on workflow efficiency. In order to achieve that, six radiology departments (four within hospitals and two in resident practice) were identified, all of which were just about to upgrade from an analogue to a digital imaging system. in a first step the initial workflow and the stage of development with regard to digitalization were modelled. Therefore, as MM means parts from the EMRAM were combined with aspects from DIAM. Additionally, the classic process modelling notation BPMN (Allweyer, 2010) was used. By using these means, the initial process was modelled and assessed regarding workflow and status of digitalization. Additionally, workflow efficiency was monitored by a person from the research team in a time frame of two days of shadowing the everyday work routine. Following that, the current workflow was analysed regarding optimization potential through digitalization. Based on this a digital imaging system was selected according to the customers' needs and configured correspondingly to the greatest possible extent. The respective imaging system was then integrated into each of the six departments, and the department teams were trained on the system. Following an initial familiarization phase of 6-8 weeks, the new workflow was assessed again with regard to process flow by applying the same means as

used in the initial analysis (two days of shadowing). Both assessments were comparatively examined and changes in workflow efficiency were identified.

3.4.2 Case 2: OMS

Within Project 2: Oral and Maxillofacial Surgery the goal was to describe the current status of digitalization in this particular medical discipline, with the goal to describe and share this with the medical community. This description was supposed to reveal fields of action, structural internal and external barriers as well as best practices. In order to achieve that goal, in a first step the standard procedures and information flows of the discipline were modelled along the intersectoral patient pathway. Additionally, the literature review with regard to modelling digital maturity in healthcare settings was updated. Therefrom, suitable aspects of MM tools were identified and merged into an interview guideline, which was supposed to extract the relevant information from direct interaction with medical professionals from the discipline. The interviews were restricted to a timeframe of 40 minutes. Subsequently, the interview protocols were pseudonymized and confirmed by the person interviewed. Following that, a combination of open and axial coding protocol as suggested by Wiesche et al. (Wiesche et al., 2017) was carried out. The coding and grouping of text passages led to a content classification and analysis. The analysis was split into general findings about process bottlenecks of the discipline, the digitalization status of the field OMS

Table 1: Categorization of the two projects implementing MM means.

Name	Diagnostic Imaging	Oral and Maxillofacial Surgery
Project goal	Assess the initial radiology workflow based on an analogue imaging system. Integrate a digital imaging system and adapt customizable settings suitable to an envisaged digital workflow. Assess efficiency changes between workflows.	Assess the current status of digitalization of the medical discipline “oral and maxillofacial surgery”. Identify internal and external barriers remarkable structural achievements and easily accessible adjusting screws for leveraging the potential of digitalization for the discipline.
Scenarios investigated	3 overall: 1st in hospital, integration of a mobile imaging system, 2nd in hospital, stationary imaging system, 3rd in resident practice, stationary imaging system	2: 1st in resident practice, 2nd in hospital
MM goal	Assess, improve MM level, reassess, display improvement	Assess, interpret, suggest actions
MMs used	EMRAM, DIAM	WCS, DHMI, EMRAM
MM proceeding	Identification of meaningful parameter from the mentioned models, reduction and fusion of the models into a project specific set of maturity assessment points	Identification of meaningful parameter from the mentioned models, reduction, fusion, and transfer to the relevant data points and interfaces in OMS
Type	intervention	description
Assessing person	External (researcher), in close collaboration with the participants	External (researcher), in close collaboration with the participants
Data collection method	Focus groups and guest visit (shadowing)	In-depth interviews
Number of participants	number of participants according to team size and availability with alternating line-up, according to roster: 2 departments per scenario, leading to a total number of 6 departments	8 in total, 4 per scenario
Profile of participants	Mainly medical technical radiology assistants (MTRA), and radiologists	Medical specialists categorized by years of working experience (>10, <10), medical assistants (at least one representative of each role per scenario)
Data collection points	3 per intervention: “before” (focus group and shadowing), “during” installation (shadowing) and “after” replacing an analogue with a digital radiology system (shadowing)	1 interview per participant
Project Year	2017	2020

and best-practices in both respects. Additionally, external and internal influencing factors on successful digitalization were clustered.

3.5 Retrospective Analysis

The two described projects were retrospectively analysed with regard to the formulated research questions. In a first step the project content, its goals and the applied means and methods were summarised. Following that, the conducted steps and tools were comparatively displayed on a timeline. The project documentation (interview transcripts, focus group documentation and notes, workflow analysis and notes from the shadowing sessions) was then inductively analysed by a coding protocol combining open and axial coding as suggested by Wiesche et al. (Wiesche et al., 2017). The axial grouping led to 5 classes of findings observed in both cases associated with the formulated research questions. The findings are described in section 4.3.

4 RESULTS

The project's timelines of steps and methods conducted showed a common proceeding of the following steps: 1. to assess the specific user goals, 2. To narrow down the object that was to be described, 3. to identify a suitable tool to depict the respective field of interest, 4. to adapt available tools to the specific need, 5. to translate this into a real application, 6. to derive knowledge from this application and optional (only for the diagnostic imaging project) 7. to integrate an intervention in order to increase the digital maturity, and 8. to reassess and examine efficiency differences between the initial and final workflow. The application of MMs was thus not an end in itself, and not particularly scope of the observation, but served as a tool for achieving a practical goal. However, the translation of formalized MMs into practice is still a field of research these projects contribute to. Therefore, the following sections briefly outline the two project's results regarding their general scope, and present central findings from the application of MMs in these two healthcare contexts.

4.1 Case 1: Diagnostic Imaging

The efficiency of diagnostic imaging workflows in resident practice as well as in hospitals based on an analogue imaging system was assessed. Following the replacement of the analogue with a digital imaging system, the efficiency of the old workflow was compared to the new workflow in the same setting. In the resident practices a stationary imaging system and in the hospital environment stationary and mobile systems were examined. For each scenario, two systems from differing manufacturers were compared to a digital system from one manufacturer (who also fabricated one of the initial systems in each scenario). The digital workflow was found to be more efficient compared to the analogue workflow to a varying extent in all the scenarios. The comparison of two different manufacturers of the initial system showed no significant divergence by contrast with the digital systems for none of the scenarios. Since this project was commissioned by the digital system's manufacturer and the results intended for internal purposes only, the study has not in all its details been made available to the community.

4.2 Case 2: MOS

Based on the conducted interviews, the general workflow, involved parties and actors, interfaces, data and transfer points were described. The digitalization status of the working environment, workflow and the organizations was modelled based on the set of maturity parameter merged from WCS, DHMI and EMRAM for each interviewee as well as abstracted across all participants. General digitalization hurdles like literacy and sovereignty in handling digital services and workflows, or the lack of integrated process support were identified. Particularly within hospitals, the competition of disciplines for investment budgets was mentioned as an inhibiting factor. The development status of digitalization especially between resident practices was highly heterogeneous. The close interrelationship with the field of diagnostic imaging was identified as a driver for development: innovations often diffuse from this area to the discipline of OMS. The comprehensive analysis was made available to the medical discipline and the scientific community in a separate article (Meister et al., 2020).

4.3 Retrospective Findings across Cases

Only sparse experience from practical application of MMs in healthcare has been reported thus far. Blondiau et al. (Blondiau et al., 2016) made their experiences available, based on the intervention-cycle presented by Mettler (Mettler, 2010), differentiating between findings related to MM design and implementation. Referring to the latter, the

authors brought MMs into application, and identified challenges exceeding the ones addressed by the experiences and suggestions by Blondiau et al. In this section the authors present and formalize 5 observations noted in both of the two case studies with regard to translating MMs into real-world application in healthcare context. The observations are as follows:

1) *Continuous Translation between Research and Practitioners is Required.*

Not only the knowledge of the relevant state of the art regarding MMs was found to be fairly limited on the practitioners' side (which is understandable since it is a huge field and not particularly the core business of the hospitals' representatives). At the same time, although the interest to be involved and contribute to the arrangement was present, the comprehensibility of the available literature seemed rather formalized and impractical to the user groups. This led to the necessity of intensive collaboration between research and practice for identification, extraction and merging of suitable means into a depiction protocol. Also during the protocol execution, a close guidance and affirmation was asked for. This emblematically shows the misunderstanding between research and practice. Researchers are striving for abstraction and formalization and not necessarily provide an overview of explicit technical or processual innovations and best practices. On the other hand, practitioners are hoping for precise details and guidance. The interface in our two projects was bridged by human efforts. Both sides need to move towards each other by the means of education and simplification.

2) *Implementation of MMs and Taking Actions based on This Requires Support of All Affected Professional Disciplines and Hierarchy Levels.*

In Hospitals we have the special situation, that managerial and medical leaders work detached from each other in terms of content and are not authorized to issue instructions to each other with regard to the specific professional matters handled by the respective division. Since interests between these areas not always fully overlap, joint efforts require the involvement and support of all affected stakeholders. Vice versa, that implies that MMs which explicitly target a particular profession, while the object of examination (or especially the evolution of it) affects areas or actors beyond the included group, are hardly able to contribute to mutual interests. While there are reasonable intentions of addressing an explicit profession with a MM (e.g. for tailoring the language or conceptual level for the needs of the user group (Blondiau et al., 2016), or strengthening the negotiation position of individuals), the concomitant non-consideration of other interest groups may even affect the implementation of measures adversely.

3) *Structural Development of Hospitals Requires Modular and Holistic MMs.*

Numerous MMs with differing level of detail and focus exist, some of which were found suitable for depicting a project-relevant aspect of maturity within very specific boundaries. However, neither a conceptually holistic and encompassing MM nor one suitable approach for that very specific project goal could be identified. This can of course vary in conjunction with the respective area or goal one wants to examine or achieve. Nonetheless, for the two projects we had to extract different aspects from different MMs and combine them into a presentation appropriate for the respective group of practitioners. We certainly did not expect to identify a perfectly suitable MM able to model the two specific medical disciplines, workflows or data exchange points. Addressing the conducted effort in both project of merging suitable modules of existing MMs into a project-specific set of parameters by the development of a modular and holistic MM can significantly reduce the application hurdles for representatives from practice. From a scientific point of view the focus on depth rather than breadth in MMs makes sense: comparability and schematization of similarly parameterizable aspects naturally leads to narrowing the observation field. At the same time, it impairs practical application, since seldom only one particular aspect is part of a real-world project. In order to increase value creation for the hospital domain multivariate and modular analysis means, or an integration of specialized solutions are required.

4) *A Differentiation between "Visible Result" and Necessary Action to Achieve That Result is Required.*

MMs usually offer a path of evolution with regard to the specific aspect of examination. This presentation suggests necessary actions for achieving a higher level of maturity by displaying the required characteristics for the next stage. However, especially MMs dealing with digitalization tend to derive a maturity model from a set of "checkable characteristics". This seems intuitive since digitalization becomes obviously technologically verifiable. At the same time, it neglects that the digital transformation requires processual and organizational action, which eventually leads to a technological

status. So checkable maturity parameter and evolutionary actions not necessarily need to be the same. Most MMs do not clearly distinguish between these "checkable characteristics" and necessary actions to achieve such a state. The development of an organization like a hospital is multivariate and complex itself. Correlation and causation remain largely undescribed. Especially MMs with a focus on data flows and degree of information integration suggest a rather technical approach to developing a state of digital maturity. From our experience, the depiction of such "measurable" indicators may be mistaken by practitioners for the necessary actions required to achieve the next level. Especially in such an interprofessional environment this outcome may not in all cases be achieved by "just" implementing technological requirements for the next maturity level. E.g. in rather technical MMs the processual, organizational and human prerequisites are necessary to shape the digital transformation successfully and encompassing. We suggest a stronger emphasis on the differentiation between measurable maturity level parameter and evolutionary actions required to achieve the next stage.

5) The Static Definition of Maturity States in Times of Disruptive Change Needs to be Questioned.

Some MMs provide a firm definition of maturity levels, and some comprise a certain degree of dynamics and adaptability to future developments. The general concept of maturity modelling in the past decades was mainly intended to support incremental development. Today, great uncertainty engages the healthcare provision domain on how to shape the disruptiveness of the digital revolution. A clear and encompassing vision of the future digital hospital is neither by practice nor by research formulated yet. This is also reflected in the respective definitions of high sophistication in existing MMs. Therefore, the depiction of the current status of maturity of a certain skill, process or organization seemed capable within the two applications. On the other hand, the evolutionary paths provided by the selected MMs could not cope with the expectations regarding disruptive reorganization of healthcare provision. Some of the selected MMs even acknowledge this uncertain target state and leave the room for future definition. That certainly reflects the current situation of the domain in a sufficient way from the research perspective. At the same time, it leaves practice alone with the empty room the anticipated disruptiveness of the digital revolution provides. Statically defined maturity states are only able to describe our current knowledge and imagination. However, they set boundaries when they are used as means to prospectively shape disruptive change. It could be incorporated explicitly that current depictions only reflect current knowledge, and that the digital transformation requires solutions and arrangements exceeding that. Nonetheless, in order to increase value creation for practitioners in the future, this uncertainty needs to be addressed by joint efforts to foster clarification (this probably exceeds research and practice and also requires politics and society) of how healthcare delivery should be transformed in the digital age.

5 CONCLUSIONS

With this article we intend to support building the bridge between the developers and implementers of MMs. The growing number of publications with regard to maturity models emphasizes developments and discussions of design methodologies rather than reports on practical application and efficacy of that implementation itself and potential change efforts (Blondiau et al., 2016).

The need for application guidance, as described by Caldwell and Atwal as a result of the interdisciplinary organization "hospital" (Caldwell & Atwal, 2003), was found to be still very high.

In both depicted cases, the definition of an envisaged digital target state required a joint effort between practitioners and researchers. A systematic uncertainty within the domain of how exactly the "digital hospital" as a maturity status can be defined remains. For the purpose of guiding through the disruptiveness and dynamics of the digital transformation, existing MMs were perceived as too focused on incremental development and static states. With this prevailing design the capability of MMs of guiding the healthcare domain through the prospectively postulated and not yet fully described digital revolution is arguable. However, applying MMs with the aim of monitoring progress as described in case 1 was found appropriate.

5.1 Contribution

The presented article provides various practical and managerial implications. The observations derived from projects applying MMs in practice may serve practitioners and collaborative implementing teams in their decision making when it comes to reflecting the practical capabilities and expectations with applying MMs. Furthermore, insights into challenges to expect in the process of identifying, adapting and

implementing suitable means for a specific maturity purpose are provided.

At the same time, the observations presented are equally suited to be taken into account by the developers of MMs. The consideration of these during the creation of MM solutions may contribute to the practical applicability and thus on the value creation for the practitioner's scope of application as well as the structural development of healthcare organizations in general.

5.2 Limitations

At this stage, however, it is necessary to also share the limitations of the presented study. This particularly refers to the generalizability of the results. Firstly, the findings result from two case studies from very delimitable medical disciplines, and the transferability to other fields or wider scopes is not necessarily given. Secondly, the observed implications arose from the interaction of humans during the projects. We acknowledge the theory formulated by Walsham, that the enquirer's interaction with the study object or environment and the perception of all involved parties not only influences the sensing of events, but also the reality itself (Walsham, 1995). Perception and interaction impact the reality created within a situation and such observations are thus not compulsory applicable to other social settings or general environments.

5.3 Future Research

Prospectively, it will be essential to invest further research into the determination of success factors and capabilities a hospital must have to be able to collaboratively shape the change for the benefit of the patient. The expert organization itself is only partially described and can thus hardly be evolved structurally. Therefore, further knowledge about the underlying causal relationships of communicated and subliminal aspirations of individuals and professional groups in this special setting of an expert organization is required.

Besides, further invest is needed in the definition of a common ground of a potential "target state" of the digital hospital.

Furthermore, since the transferability of the presented observations is limited due to the two cases, insights into the work of other research or practitioner groups with regard to practical application of MMs would be beneficial in the future.

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