Digital Transformation in Swiss Hospitals: A Reference Modeling Approach

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Abstract. Through various approaches such as the eHealth Switzerland 2.0 strategy, the Swiss healthcare system aims to digitally catch up with other industries and drive the industry into the digital future. To enable hospitals to transform their business model and prepare for the future, this paper presents an approach for the implementation of the digital transformation in Swiss hospitals. Thus, a metamodel consisting of nine elements was created as a base. The focus of the metamodel and the later reference model lay on the central activity elements, which are each embedded in a phase and are directly or indirectly connected to all the other elements in the metamodel. For the reference modeling, the metamodel serves as a structural template, while an existing roadmap from the literature on the digital transformation was used as a content-based starting point. The final reference model consists of 30 activities within six different phases.

Keywords: Healthcare · Transformation · Model

1 Introduction

The digital transformation in the healthcare industry is gaining momentum, and new digital transformation trends are continuously emerging and are slowly establishing themselves. These trends include progresses in several areas of health services and innovations such as an increase in patient engagement through technology, artificial intelligence in health, health apps, big data and 3D printing [15]. To unleash the enormous potential behind these technologies and allow them to prosper, a solid digitized base is required [6, 26]. Compared to other business sectors, healthcare organizations remain at a significantly lower degree of digitization and record far lower investments in their digital future [2, 10, 24]. A positive indicator of the digitization in healthcare is a proportionate increase in investments compared to previous years [24].

Despite that, Switzerland, among other north European countries, scored highest in the digital evaluation index in 2017 [8]. Harvard Business Review created this index to analyze the digital evolution of 60 countries. Among other things, the index analyses the countries' pattern of digital evolution, evaluates the digital competitiveness and assesses the changes since the last publication. Even though Switzerland, Denmark, Sweden, and

X.-S. Yang et al. (eds.), *Proceedings of Fifth International Congress on Information and Communication Technology*, Advances in Intelligent Systems and Computing 1183, https://doi.org/10.1007/978-981-15-5856-6_2

Norway lead the digital evolution index, they score below two of a maximum of four points regarding their rate of change in digital evolution between 2008 and 2015 [8]. This result reflects the challenges of sustaining growth and offers chances to facilitate existing maturity, scale and network effects to advance the digitization. A study published by PricewaterhouseCoopers, and Google Switzerland analyzed the degree of digitization in various industries [12]. The degree of digitization is based on a self-assessment of participating companies. The survey evaluates the digital maturity in four areas: process and infrastructure, digital sales, customer involvement and people and culture. The questions were answered on a four-point scale. The industries energy and utilities (1.78) and healthcare (1.84) lag the furthest behind. However, [12] mentions that the implementation of the eHealth Switzerland 2.0 strategy could advance the digital maturity in Swiss healthcare. This strategy was introduced in 2018 by the Swiss Confederacy and cantons to increase the digitization within the healthcare sector [11]. One of the suggested reasons for the lagging digitization in the healthcare industry is the focus for human interaction that often stands in the way of digital advancements [12]. Additionally, [12] states the strict regulations as another reason for the slow-progressing digitization in healthcare.

Several technology and consulting companies published reports with various views and explanations about the current state of digitization in the healthcare industry in Switzerland [16]. Barriers obstruct the digital transformation from the inside (e.g. the absence of relevant knowledge) and outside (e.g. strict regulations) of an organization. These impediments have led to the current digital deficit compared to other industries. Therefore, special attention must be given to the barriers when approaching future digitization projects.

As a result of the above-described slow digital transformation and the identified factors supporting it, this paper presents a reference model for the digital transformation of Swiss hospitals that address the mentioned issues and allow a simplified and guided transformation process. In the next chapter, the metamodel will be elaborated, and the deduction of the reference model described. Chapter 4 presents the outcome of the reference modeling approach and provides examples showing how the model is applied in practice. The fifth chapter reflects the results, discusses the findings, and describes the limitations. The final chapter concludes the paper, provides an outlook, and proposes approaches to reduce the impact of the previously discussed limitations.

2 Problem Statement

Medical institutions, specifically hospitals, face various challenges in connection with the digital transformation. Continuous pressure to decrease costs and increase efficiency is forcing hospitals to promptly address the digital transformation. However, the hospitals are diverse, and tailor-made solutions do not yet exist or are too specific. Therefore, they do not fit the specific organizational needs [16]. Hence, a reference model is defined to exploit these industry-specific drivers and barriers. The goal of the model is to create a generic approach where organizational characteristics are not considered, and the drivers are used to support the specific strengths of a company while at the same time removing and overcoming barriers. The result is a reference model, which is instanced

based on an organizations unique characteristics and requirements. Therefore, the model uses only generic elements which are adopted by the management or project lead to specific entities within the target organization. This approach addresses the different organizational settings of the various players within the hospital system. This paper will answer the following primary research question:

- What does an ideal approach for implementing the digital transformation in the Swiss healthcare system look like?

In order to answer this main research question, the following subordinate research questions are approached first:

- Which framework serves as a suitable foundation for the reference model?
- Which elements, components, and the corresponding relationships between them have to be taken into account in a reference model for digital transformation in Swiss hospitals?

The answers given in this paper only consider the hospital organizations within the Swiss healthcare industry. In case, the same sector in a different geographic region has similar drivers and barriers, and the reference model may be suitable as well. The reference model is a generic guideline and needs to be instantiated upon utilization according to an organization's specific requirements.

3 Metamodeling

In order to answer the previously defined research questions, a reference modeling approach was selected. This approach was applied on the base of a previously created metamodel. Below, the details of this research design are explained and where necessary, more profound statements are delivered in order to present a conclusive procedure.

3.1 Metamodel

The first step of creating a reference model for the implementation of the digital transformation in Swiss hospitals is establishing and defining the applicability of the reference model in the targeted domain using a metamodel as a blueprint. In the metamodeling process the overall depth, scale as well as the syntax and structure of the reference model are determined by charting its elements, components, and the corresponding relationships between them [13, 23, 27]. Hence, the metamodel facilitates the conceptual modeling and allows a more intuitive and practical view on the model based on it [13]. This helps users and implementors to better understand its complexity and extent when evaluating or making use of it.

The previous description shows that various modeling levels and abstractions exist. The guidelines followed in this research regarding multi-level modeling are presented in the paper by [14] and further described in [23]. As shown in Fig. 1, the mentioned guidelines are differentiated into four hierarchies. Apart from M0, each layer conforms

to or is implemented according to the adjoining layer above it and additionally (except M3) defines or abstracts the layer underneath it [14, 23]. Therefore, the metamodel describes the notation of the metamodel, while the metamodel describes the structure of the model. This research only includes the M1 and M2 layers. The first layer (M0) is not formally carried out and thereby is only briefly described in the following paragraph. In the final layer, the reference model is adapted to a Swiss hospital (layer M2) and consequently takes place in practice.

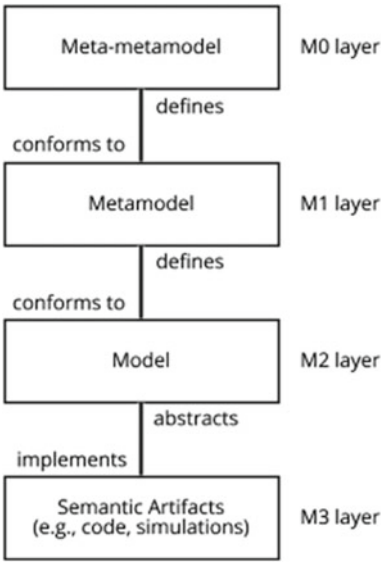

Fig. 1. Four-layer metamodeling architecture as described by [1]

The metamodel in this project was created using a simplified adoption of the UML class diagram notation. This notation, along with its elements, was chosen because it represents and aligns well with the main purpose of the metamodel, which is the listing of the allowed and necessary constructs within the reference model [13]. The mentioned simplification contributes to a better understanding by non-experts and increases the clarity of the model. Moreover, since the metamodel is not a model to a software artifact, using the notation to the full extent is not feasible and would not be appropriate. The following elements were used in the metamodeling process: the class element, the navigability, the multiplicity, and the generalization. The class element is used to model the single components that make up the reference model. Displayed with a rectangular outline, these components stand in an associative navigability to one another [19, 22]. The navigability gives additional information to the association and can either be unspecified, navigable or not navigable in both directions of the associated components [19, 22]. Additionally, the multiplicity or cardinality of the associations specifies the allowable number of instances of the described component in nonnegative integers [19, 22]. Lastly, associations can also occur in the form of a generalization. This form of

association structures classes into hierarchies of inheritance, where the subclasses specify the parent in a more detailed manner but are essentially already covered in the parent class. To allow the creation of a complete metamodel, the metamodeling process was not undertaken completely uncoupled from the reference modeling process. Rather, the first version of the original metamodel was used as a base for designing the reference model. Elements of one or the other model where then added or removed if necessary, in order to perfectly match the models to the targeted domain. This iteration between the meta- and reference modeling process resulted in complete and well-aligned models.

3.2 Reference Model

After completing the metamodel, the reference model was created according to the prior defined elements and relations discussed above. A definition that is universally accepted for "reference model" cannot be found. Consequently, to use a broadly accepted definition of the term in the context of this paper, common denominators in different definitions by [5, 7, 18, 21, 25] were combined. For example, [25] describes reference models as a universal tool using "recommendation character" to construct and derivate other (enterprise-specific) models while [5, 7] call it a "normalized description of key concepts of a given domain" and [21] describes a reference model as a construction with recommended universal elements and relationships that create a point of reference. Resulting from the combination of the mentioned definitions, a reference model in this paper is defined as a universally applicable and reusable best practice framework for a certain domain, which in this case are Swiss hospitals.

As displayed in the metamodel (Fig. 2), the reference model (and its phases) was derived from an existing roadmap. This serves as a solid base to ensure the completeness of the approach presented in this paper. Thereby, it offers a fully accompanying guideline using established and proven methods to better address the hospitals lagging regarding digitization, when compared to organizations of other industries [4, 9]. However, the single activities and phases as well as other elements of the underlying roadmap were modified, adjusted, removed, replaced or extended to fit the specific application domain of this research when necessary.

For this purpose, the model by [20] was selected. Schallmo and colleagues present in their book a high-level, comprehensive roadmap with five phases starting with the digital reality phase and ending with the implementation phase. The roadmap by [14] met several key factors to serve as a template, which is why it was selected. Firstly, their model not only shows a certain procedure, but is also a well-documented roadmap for the digital transformation and business model innovation. The second key factor is the combination of the objectives "digital transformation" and "business model innovation." This allows to keep a customer-oriented view during the major digital changes. In addition, the roadmap by [20] is based on existing "digital transformation" and "business model innovation" approaches as well as on best practices and therefore suggests an established procedure. Lastly, the roadmap is divided into five phases, where the implementation does not take place until the last step. Thus, this ensures a solid base with a thoroughly developed framework, inclusion of all stakeholders, and organizational characteristics plus a carefully designed organizational fit.

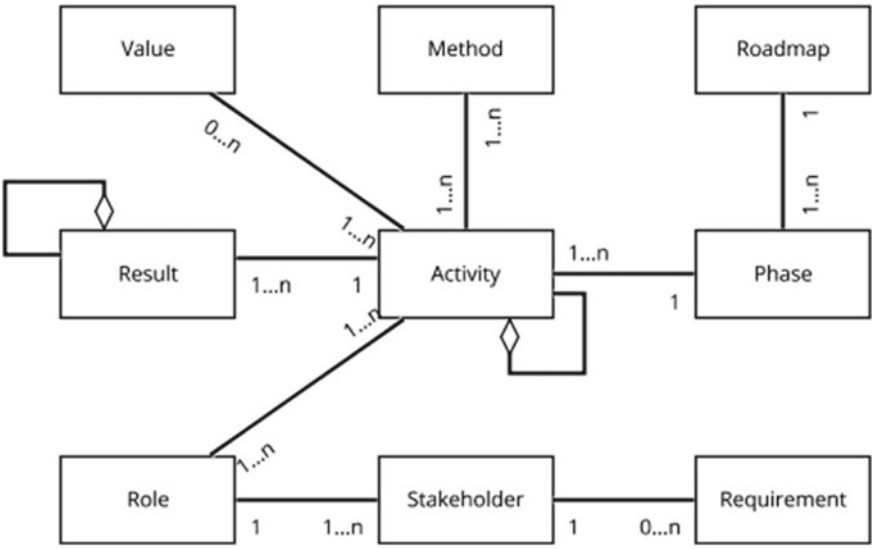

Fig. 2. Metamodel

In addition to the above-mentioned adjustments of the single parts of the selected approach by [20] to the specific domain, modifications of the superordinate phases were also discussed. Every phase of the original roadmap was critically analyzed concerning its value, contribution, and necessity to the digital transformation of a hospital. A phase was only used if it was required or added value to the purpose of this project. As a result, none of the original phases were removed; however, a final review phase as suggested by [1, 17] was added to the reference model. This reflection of the implementation of the digital transformation and the resulting business model innovation takes place iteratively with the previous implementation phase and assures an appropriate and proper transformation process. The review phase insures that the digital transformation takes place as it was planned and envisioned during the digital ambition phase by monitoring the progress and if necessary, rectifying the individual steps to reach the intended outcome. By reflecting the strategic and organizational implementation, potential conflicts and sources of error can be encountered early. As a result, the potential impact of discrepancies on the outcome and success of the digital transformation in an organization can be reduced or avoided altogether.

4 Results

The results of the metamodeling and reference modeling process are shown and explained in more detail in the following chapter. Two examples of activities from within the reference model are also presented in depth to give a better understanding.

4.1 Metamodel

The term metamodel is used when a model describes another model [3]. In this case, the metamodel is used to describe and define the reference model. The metamodel was developed in iterating workshops among the authors involving in-depth literature. As a result, nine different and interdependent elements were defined for the metamodel (cf. Fig. 2).

The activity is specified as the central element of the metamodel and can contain several sub-activities. At least one outcome results from each activity, whereby a result itself as a whole can also arise from the combination of multiple results. A role describes a function of a person within an organization and specifies which activities are performed by the employee. A stakeholder represents a party or person of interest, whereby it is possible that a stakeholder is also a role. Further, a stakeholder's need is recorded as a stakeholder specific requirement. A method for working out the objectives of an activity is also proposed, although these are not final. Since the reference model for the digital transformation contains an extensive number of activities and stretches over a considerable time period, the impact or contribution of every activity is also mentioned in order to keep an overview and creating additional transparency. Furthermore, an activity is assigned to a certain phase, which has arisen from an established roadmap or process model that can be found in the literature.

4.2 Reference Model

The reference model is created using the metamodel as a base, where the different elements are drawn up. This means that the different constructs are described in relation to the activity at the center.

As described in Chap. 3, the roadmap by [20] was selected as the initial basis for deriving the specially adapted reference model. This process model combines the best elements of the existing approaches by Bouée and Schaible, Esser and Pricewaterhouse-Coopers, among others, as well as existing business cases and best practices, consolidating them into an advanced process model. This process model is comprised of the five phases of [20], with an addition of a sixth phase, the review phase, which can be seen more clearly in Fig. 3.

In the first phase, the digital reality phase, the existing business model of a company is sketched out, the analysis of the value chain with associated actors is carried out, and the customer requirements are ascertained. Hence, the activities of this phase examine and document the actual state. This provides an understanding of the digital reality in different areas. Noticeably, in this phase the element "stakeholder" is represented by the management. This is because the current state of the processes and procedures is already known to the employees; therefore, there are no immediate changes for the employee. That is why the outline of the existing business model is mainly interesting for the management.

Based on the previous phase, the digital ambition defines the objectives with regard to the digital transformation. These relate to time, finance, space, and quality. The digital ambition states which objectives apply to the business model, its elements and how they

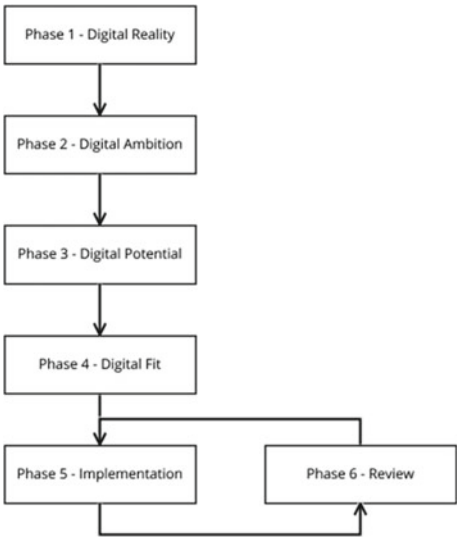

Fig. 3. Phases of the model

are prioritized. From the ascertainment of corporate objectives for the digital transformation, a digital vision is created as a result. By defining the priorities for the business model dimensions, a priority overview is created for the management.

In the third phase, best practices and enablers for the digital transformation, which serves as a baseline for the prospective digital business model, are identified. For this purpose, different digital options are derived for each business model element and logically combined with each other. To ensure that those responsible know why an activity needs to be carried out, the output and contribution of each activity in regard to future activities are listed. Thus, the main value of the activities to collect best practices and enablers for digital transformation can be adapted from activity "3.3.1 Development of the digital business model and associated options, taking into account enablers, disablers and best practices." Furthermore, this activity itself has the benefit of creating combinations of options on how the digital transformation could be implemented.

In the digital fit phase, the options for designing the digital business model are evaluated. Assuring the fit with the existing business model, the fulfillment of customer requirements and the achievement of goals are crucial. The evaluated combinations can be prioritized according to these factors. By suggesting methodical approaches for each activity, an important indication on how the activities can be implemented to achieve the desired result is given to the organizations. For example, information consolidation can be used to create combinations of options. It is proposed to use a decision-making method for the evaluation and selection of the combinations, because the responsibility for the right selection lays in the hands of the respective project management team.

The fifth phase contains the finalization and implementation of the digital business model, i.e., the combination of the compiled options from the previous phases that are pursued further. This means that created artifacts, processes, and workflows are transferred to the operative business. The digital implementation also includes designing

the digital customer experience and the digital value network with partner integration. Resources and capabilities required for digital implementation are also considered. A large number of roles are involved in this phase, as it is a very comprehensive and cross-departmental phase with influence on different areas of the company. For this reason, many different stakeholders and roles are involved in the activities.

In the sixth phase, the implemented actions are examined, and the project plan and action plan are further adapted to the situation. In order to successfully implement the developed options, it is necessary to obtain comprehensive information. Project management methods are suggested to be used to adjust the project and action plan. The management as a stakeholder is primarily interested in a meticulous review phase, but the employees are as well, because this could have considerable impact on the future work activities and processes.

4.3 Activities

For all six phases mentioned, corresponding activities were elaborated, in order to comprehensively describe the digital transformation, make the process more tangible, and deliver an accompaniment to the application of the reference model. For each activity, the dependent elements according to the metamodel were defined. These include roles, stakeholders, results, benefits, methods, and the linked phase.

Depending on the phase, a different number of activities were assigned in order to be able to fulfill these activities as best as possible. Eleven activities were assigned to phase 1, the digital reality phase. Only two activities were assigned to the second phase and seven to determine the digital potential phase. Two activities are needed for the digital fit phase and five for the digital implementation phase. Finally, there are two activities in the review phase. An overview over the number of activities in each phase is shown in Table 1.

Table 1. Number of associated activities per phase

Phase	Associated activities
Phase 1—Digital Reality	11
Phase 2—Digital Ambition	2
Phase 3—Digital Potential	7
Phase 4—Digital Fit	2
Phase 5—Implementation	6
Phase 6—Review	2

In order to better demonstrate the understanding of the individual activities, two fully elaborated activities will be selected and explained in more detail in the following. Firstly, activity "2.1.1 Survey of company objectives for digital transformation" from the digital ambition phase will be exemplified in depth. This activity comprises the collection of business objectives on the basis of four categories: time, finance, space, and quality.

The result of this survey is a digital vision for the organization. In order for employees to know what the activity is being carried out for, the impact on future activities is shown. Thus, the result of this activity will be useful for activities "3.3.1 Development of the digital business model and related options taking into account enablers, disablers and best practices" and "4.1.2 Evaluation and selection of combinations." The project manager, the CEO, a business model expert and a digitization expert are the required roles to carry out the activity. These roles were defined using the Responsible, Expert, Work, Approver (REWA) matrix and the assignments can be more closely examined in Table 2. REWA is a variant of the RACI model and has a similar significance. Since many people and groups are involved in the digital transformation, a final list of the parties to be informed is difficult to compile and ultimately not very informative. Thus, in this case the letter "I" (informed) from the RACI model is of little use. Therefore, the REWA variant is more suitable due to the pragmatic and meaningful naming. After all, with "E" for expert and "W" for work, it is evident who carries out the task and who provides professional assistance.

Table 2. REWA matrix for activity 2.1.1 Survey of business objectives for digital transformation

	R	E	W	A
Project manager	×		×	
CEO		×		x
Business model expert		×	×	
Digitization expert		×	×	
Steering committee				x

Furthermore, stakeholders of activity "2.1.1 Survey of business objectives for digital transformation" are the management, the board of directors or executive board, a representative member of the parent company, the trade union, political regulators and interest groups as well as investors. The methodology of a strategic analysis and objectives is recommended for the processing of the activity.

Activity "3.3.1 Development of the digital business model and associated options, taking into account enablers, disablers and best practices" is to be carried out on the results, among other things, of the activity described above. Based on the collected best practices, enablers, and disablers, all options for the future design of the individual business model elements are now derived. Apart from their listing, they are not yet evaluated. The business model elements are evaluated to determine if digitization is needed. If applicable, the form of digitization will then be defined. It is also examined how the enablers can be used to improve the business model elements. The result is a list of options for the intended digital business model. In regard to the entire transformation process, this result lays the foundation for activity "4.1.1 Creation of combinations of options." As shown in the REWA matrix in Table 3, the roles project manager, business model expert, and digitization expert are necessary to complete activity 3.3.1.

Table 3. REWA matrix for activity 3.3.1 Development of the digital business model and related options taking into account enablers, disablers, and best practices

	R	E	W	A
Project manager	×			x
Business model expert		×	×	
Digitization expert		×	×	

As stakeholders, the management, the client, the partners, the trade unions, political regulators, interest groups and investors are listed. In addition, goal setting, strategic analysis and information consolidation are the suggested methods to cope with the activity.

5 Discussion

The following paragraphs will discuss and further explain the results described in the previous chapter. The difference between the roadmap by [20] and the approach described in this paper are presented and the additional value created explicated. Despite not having applied and validated the reference model in practice, the representability and validity of the model in the targeted domain are justified. Also, the possible impact of the created reference model on other domains is mentioned and the importance of this contribution is highlighted. Lastly, the research questions listed at the beginning of this paper are addressed.

As described in the prior chapter, the reference model uses six different phases to guide the digital transformation process, starting at the current state and finishing with an iterative implementation and reflection of the developed digital business model. Noticeably, many of the 30 total activities take place in the first phase, while other phases such as digital fit phase consist of a smaller number of activities. Importantly, a large number of activities do not necessarily reflect the time needed to finish a phase or its complexity. For instance, the examination and documentation of the digital reality phase which consist of eleven activities can be considered a relatively short phase compared to other phases, such as the implementation phase, where individual activities can take up to several months or even years. Furthermore, to offer a complete process model that offers the highest possible degree of support, important factors and influences on the digital transformation process, such as stakeholders and their requirements as well as suitable methods for individual steps, were listed. However, this additional information is neither conclusive, nor does it represent the only correct way. It is intended primarily as a guidance and food for thought. The effective application of the model and design of the digital transformation process depends on the respective project manager. The reference model supports the business model innovation and should be seen as a guideline, yet the design of the practically implemented procedure depends on the preferences of an organization and how they adopt it.

The reference model was derived from the roadmap of [20], and therefore, similarities between the two are implied. The common themes do not result from a simple replication

of the underlying roadmap, but symbolize the uniformity of the superordinate purpose, which is the digital transformation. Therefore, certain activities, elements, instances, or parts of the digital transformation can be found in any approach. However, due to the very specific application domain of this reference model, none of the activities in [20] were identically replicated. The more general phases on the other hand were transferred after being carefully checked regarding their suitability. With the addition of the last iterative review phase, the base structure of the reference model now deviates from the one in [20] too. In addition, the degree of detail of the reference model created here is more profound and could only be realized by choosing a specific application domain. Despite not going into detail of each step of every activity, by defining the methodology, possible stakeholders, roles with the help of the REWA matrix, results, and the contribution of a single activity within the transformation process, considerably more content, transparency, and higher comprehensibility is established. As a result, the digital transformation in a Swiss hospital becomes more tangible and realistic, especially where such objectives pose blackboxes. Representing a seemingly small difference, the additional content creating an instructional guiding concept that not only talks about, but also shows and allows a successful implementation of the digital transformation, rather than a shallow roadmap.

In order to create a relevant and rigorous digital transformation approach, the reference modeling process was guided by well-established best practices and existing models. However, to increase representativeness and confirm the universal applicability of the reference model in practice of the Swiss hospital environment, additional input and adjustments in exchange with health and digital professionals in the targeted domain would be appropriate. Despite the positive effects in the context of this work, it was refrained from having the result validated by individual experts. Validation within the limited timeframe of this project risks that the general model is negatively manipulated based on personal subjective assessments and thus no longer corresponds to the original purpose. Due to the development based on practice-proven approaches, the presented reference model can be classified as representative and valid despite the lack of exemplary validation. Nevertheless, to create a full and well-aligned digital transformation approach to be used in a large number of digital transformation projects in Swiss hospitals, an extensive practical validation is crucial. Hence, as suggested in the following conclusion and outlook, objectively validating the reference model should be considered as one of the most important steps.

While this reference model was specifically created for the digital transformation in Swiss hospitals and took certain characteristics of the targeted domain into account, it does not rule out the (partial) applicability on organizations from other areas of the healthcare system or even outside the industry. This means that the presented approach's benefits are not limited to the very narrow domain but could also expand and trigger or encourage the digital transformation in other business sectors. Undeniably, pushing digital advancements in one sort of organizations within one industry (healthcare) promotes new digital solutions, a digital thinking, interorganizational digital processes and hence a much more extensive advancement of digital mature enterprises. Being the first specifically targeted contribution in a digitally restrained industry can therefore also serve as a basis for further research in this or related fields. Moreover, by taking this reference

model and further evolve and improve it, one or more approaches for multiple domains can result. Therefore, this paper does not only contribute to the digital transformation of Swiss hospitals but also to the possible digital advancements of an entire industry and lays a foundation for more advanced and sophisticated specific and cross-industrial approaches.

The defined main research question at the beginning of this paper focuses on an ideal approach for the implementation of the digital transformation in Swiss hospitals. By developing a reference model based on best practices and established approaches, the research question was attempted to be answered. Considering the previously mentioned omitted validation and possible further developments in an iterative setting with healthcare professionals, the presented approach would require additional input as well as practical experience to be described as ideal. Nevertheless, the created output can be considered a valid reference model and starting point for the implementation of the digital transformation in Swiss hospital. Hence, it is a step in the right direction and as described previously, having a foundation can also trigger a digital evolution on a larger scale. In the context of the first subordinate research question, an analysis was conducted to determine which existing model can be used as a template for a reference model in the chosen application domain. As explained in the previous chapters, [20] model is highly suitable for adaptation in this specific context. In combination with [1], who suggests a reflection phase, a solid and proper foundation was established. As mentioned before, to create a reference model a previously designed metamodel was required in order to set and define the key elements and components as well as their relationship. Consequently, the answer to the second subordinate research questions was given by modeling the metamodel.

6 Conclusion and Outlook

Although the digitization of the healthcare sector has gained momentum, investment remains significantly lower compared to other sectors. One approach to make up for this deficit is the eHealth Switzerland 2.0 strategy, which was introduced by the federal government and the cantons in the fall of 2018. Medical institutions, in particular hospitals, are currently facing various challenges in the digital transformation. Therefore, the aim of this paper is the development of an ideal approach for implementing the digital transformation in the Swiss healthcare system. In this generic approach, drivers and best practices were used to push the digital transformation and overcome the barriers.

The first step was to create a metamodel which served as the basis for the reference model. As part of this project, the metamodel was created with a simplified UML class diagram notation to provide a simple understanding of the necessary constructs. Finally, this metamodel consists of nine different elements, which have several dependencies on each other. The activity serves as the central element. In addition to the activity, the further elements are “result,” “value,” “method,” “roadmap,” “phase,” “role,” “stakeholder,” and “requirement.”

Following the completion of the underlying metamodel, the reference model was created according to the previously defined elements and relationships. Within the selected application domain, the reference model can be regarded as a universally applicable and

reusable best practice framework for Swiss hospitals. A high-quality and comprehensive template from [20] serves as the basic roadmap. This roadmap was reviewed in the course of a critical analysis and extended with an additional review phase. Thus, the roadmap consists of six phases: Digital Reality, Digital Ambition, Digital Potential, Digital Fit, Implementation, and Review. The implementation and review are carried out as iterative phases to ensure an appropriate and correct transformation process.

The individual phases consist of a varying number of activities with an overall of 30 activities listed. The various elements according to the metamodel were defined and assigned to the individual activities. In addition to the roles, a REWA model was created to show the responsibilities for each activity.

This paper and the presented approach for the digital transformation were created using extensive insights from different literature sources. So far, no practical feedback has been integrated into the work, which could be done in a future step. For example, experts from hospitals could examine the approach and suggest improvements through constructive feedback. However, additional inputs by selected experts are not solely contributing to more representative results but could also have a subjective impact on the otherwise generalized and objective reference model.

As mentioned above, the fact that no validation of the metamodel or reference model has taken place by professionals from the Swiss hospital system can be seen as a weakness as well as a strength of the work. It is possible that required elements have been forgotten due to the lack of involvement of experts from this industrial sector or that too little attention has been paid to some of the key factors. On the other hand, objectivity is guaranteed. This means that when validated by a hospital, subjective influences from this particular hospital automatically result from the feedback. Since not all hospitals are organized and set up the same way, this could lead to distortions of the work and individual opinions can be misinterpreted as generally applicable. Therefore, such a validation has to be carried out extensively and the gained feedback has to be critically analyzed, in order to take into account only suitable and value-adding objections.

Further, this model could now be used in cooperation with a hospital to create an individually broken-down approach specific to the selected hospital. Thus, this approach would be broken down from the theoretical level to the practical level, and a concrete use case would be developed. Additionally, the reference model offers not only the possibility for further specification but also generalization. As a result, it can serve as a guideline not only for hospitals, but also for other areas of the healthcare industry or even companies outside this sector.

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