Introduction of Actor-Focused Digital Building Blocks into Enterprise Architectures of Hospitals

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Abstract. As the digitalization progresses, enterprises, such as hospitals, are in need to utilize the advantages for their performances. Given that the sector is one of the lesser digitalized, this research seeks to define a reference architecture as an artifact, which enables experts to seamlessly implement, adapt or remove digital building blocks (e.g. systems or applications) in enterprise architectures of hospitals. Therefore, a systematic literature review about the current digitalization approaches as an overview for the determination of the status quo is necessary. Afterwards, objectives for the artifact will be designed that include needs of the physical actors within a hospital. To verify the artifact, a demonstration will be conducted, as a digital building block will be implemented, adapted or removed. In connection, the demonstration will be evaluated and the results communicated to the community within the sector as well as the scientific community interested in enterprise architecture management.

Keywords: Enterprise Architecture Management, EAM, Digital Transformation, Digital Building Block, Actor-Based Enterprise Modeling

1 Introduction

In times of the ongoing digitalization, enterprises face challenges in terms of flexibilization and consequently new phenomena emerge continuously, e.g. methods for process improvement or decision models for working activities. One approved method to handle these challenges and to structure digitalization efforts is the Enterprise Architecture Management, as it provides "methods and tools to establish a more holistic perspective on enterprises which includes systematically capturing and developing the different architectural layer of an enterprise (e.g. business, application and technology architecture)" [18]. However, especially the healthcare sector still lacks digitalization efforts [4, 5]. According to digitization indexes, such as the McKinsey Global Institute industry digitization index [23] or the DIGITAL Economy Monitoring Report [24], the healthcare branch is one of the least digitized. In terms of the digital usage that is specifically relevant for this research and contains transactions, customer and supplier interactions as well as internal business processes, only the construction as well as the

agriculture & hunting branch perform worse [23]. Thus, the healthcare sector is in need of smart and appropriate services to improve the digital usage, whereas Enterprise Architecture Management is a suitable concept for the development [1, 2]. In connection, cost-related and time-consuming activities to improve the digitalization efforts are the most critical barriers that inhibit digitalization [6]. The improvement of customer communication using digital channels, the enhancement in the quality of services or the range of services and the reduction of costs through the digitalization of internal processes, workflows and resources could provide huge advantages for the sector's enterprises [6]. In connection to the aforementioned most critical barriers, it is necessary to design an initiative plan for the implementation, adaption and removal of digital entities that integrates all relevant stakeholders, as this approach is considered to be the most promising one [21, 22]. To further define the digital entities, the term *digital building block* is used, as it helps teams to deliver services faster and to comply with regulation. Digital building blocks offer well-defined capabilities that can be used in digitalization of internal operations and delivery of patient-oriented services in hospitals. They encompass organizational, technical and economic aspects adaptable to individual hospitals. Furthermore, some of the basic capabilities of those blocks can be reused in any other project to facilitate the delivery of digital services across the stakeholders [12]. Therefore, this research investigates a possible solution for managing the digitalization in hospitals by designing a reference architecture that is dedicated to seamlessly implement, adapt or remove digital building blocks as the assumption is that such a reference architecture could gain the aforementioned advantages for a hospital. Furthermore, this research should answer the main research question:

RQ: How could a hospital benefit from a reference architecture that is dedicated to seamlessly implement, adapt or remove digital building blocks?

2   Problem Investigation & Research Progress

This section provides a detailed explanation of the individual steps of the research as well as the definition of sub research questions that are necessary to answer the main research question. As the first step of the research, an overview about the current approaches for digitalization in hospitals and their repercussions on the respective enterprise architectures is necessary. Furthermore, limitations are important and have to be documented as they could function as provider for ideas. Consequently, the first sub research question is:

S-RQ1: What is the current state of the art concerning enterprise architecture modeling in hospitals and what are the main difficulties to be resolved by implementing new digital building blocks?

The *S-RQ1* seeks to define the research problem and to justify the value of a solution. The problem shall be atomized to gain information and to determine if the problem is of special or general interest. The latter is necessary, so that the reader is able to validate

the research's finding, to accept the results and to understand the reasoning, which is associated with the researcher's understanding of the problem [3]. To realize this purpose, a systematic literature review shall be conducted.

As the second activity, the research's scope has to be sharpened. Since several stakeholders in terms of digitalization of hospitals exist, the first step is to predefine the target group for the research. Whereas the definition of internal and external stakeholders in hospitals depends on certain views, such as the key output [10], the research would become too complex by considering external stakeholders, as they vary from country to country, e.g. the *Medicaid* [8] program in the USA or the *Medical Advisory Service of the German Association of Statutory Health Insurance Funds* [9] in Germany. Since it is possible that patients are determined as external stakeholders due to that fact that they do not operate in hospitals and by contrast are the necessity that a hospital can function [11], this research intends to investigate the physical actors within a hospital, which includes the patient as an internal stakeholder. Thereby, different and very important needs emerge, as it is conceivable that the alteration of a digital building block could affect several actors in a hospital, regardless of whether they operate in a hospital (e.g. physicians, nurses) or not (patients, relatives). Therefore, a determination of the actor group is essential, which leads to the second sub research question that is divided in three parts each concerning one of the aforementioned aspects:

S-RQ2.1: Who are the physical actors in a hospital?

S-RQ2.2: What are their needs?

S-RQ2.3: How do they interact with the corresponding enterprise architecture and the digital building block(s)?

By answering those questions, the objectives for the solution shall be gathered and determined, by what is possible and feasible. As a new artifact shall be developed that is a desirable solution, which is better than the current one, there should be qualitative and quantitative goals. Additionally, the solution should fulfill the actors' needs [3]. To assure that, the necessities have to be ascertained, which could be realized by the Digital Innovation and Transformation Process [13]. This process is particularly well-suited for the present research as it supports the digital architect to moderate modeling sessions, regardless of the level of knowledge the local experts in the hospital exhibit concerning enterprise architecture modeling.

The first phase of this process is called *Focus Your Intention* as presented in figure 1. It is dedicated to collect information about the actors' needs as it asks for: *What has to be digitalized?*, *How does it have to be realized?*, *Who is involved?* and *What is the value of the solution?* [13].
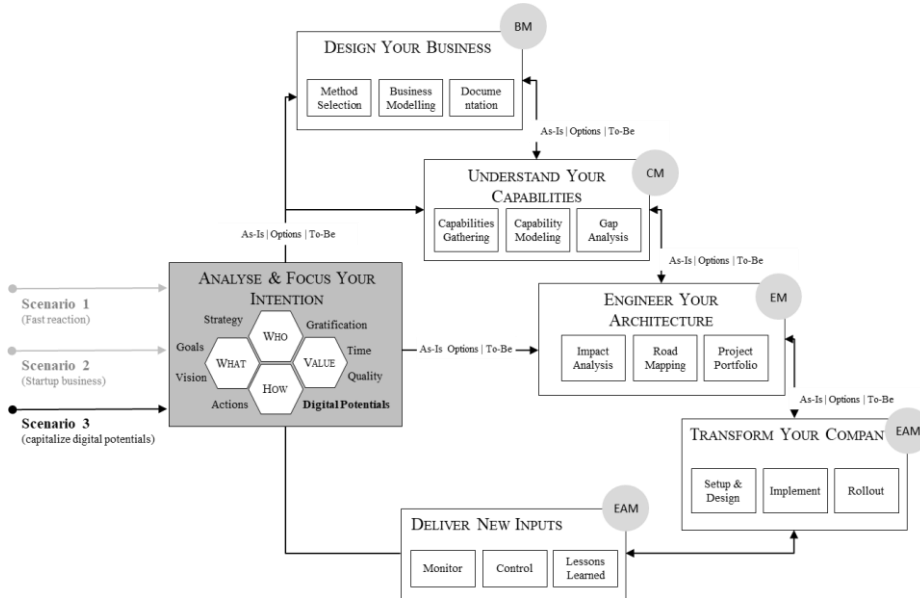
Fig. 1. The Digital Innovation and Transformation Process by Wißotzki et al. [13]

Consequently, those information as well as the information gathered by *S-RQ1* and the qualitative and quantitative goals lead to the third phase of the research – the creation of the artifact. Typically, such artifacts are models, methods, constructs or instantiations [3]. For this research, a reference architecture is envisaged that satisfies the actors' needs and enables IT specialists within the hospitals to implement, adapt or remove digital building blocks in the respective enterprise architecture with seamlessly conditions. Therefore, the third sub research question reads as follows:

S-RQ3: How is it possible to seamlessly implement, adapt or remove digital building blocks into the enterprise architecture of hospitals?

The next step of the research requires the demonstration of the developed artifact. This could be an experiment, simulation, case study, proof of concept or other appropriate activities [3]. By now, a conceivable case study could be the implementation of sensor-based indoor positioning [14] into the enterprise architecture of a hospital, as called the CliNav project. It would provide a digital mobility solution to navigate people through the hospital buildings to their destinations. Therefore, CliNav transforms loudspeakers into indoor GPS satellites. The project explores a web-based positioning solution on non-audible ultrasonic tones so that the clinic's website can navigate every webpage visitor to the desired space. Concerning this research, the actors' needs for indoor positioning are interesting and have to be ascertained as well as investigated in terms of potential outcomes concerning the reference architecture. Additionally, data from other use cases already exist [15] and could lead to further improvements by comparison. Further, the outcomes regarding the enterprise architecture of the hospital (e.g.

advantages, risks, complications, procedure of integration) will be captured and evaluated in order to improve the intended reference architecture, which leads to the fourth sub research question:

S-RQ4: How could the artifact be further developed to better fulfill the existing or new-emerged needs of the actors?

To gain the information needed, several approaches are conceivable and the selection will depend on the progress of the case study. A possible attempt could be the comparison between the situations before and after conducting the case study. For example, error-proneness's regarding the hospital's architecture as well as time savings or expenditures due to the navigation system could be measured. Furthermore, satisfaction surveys, client feedback or simulations are possible [3].

As the sixth and last step of the research, the overall process, which includes the problem and its importance to handle it, the artifact including its utility and novelty (and possible improvements) as well as its effectiveness to researchers and other audiences will be communicated [3]. Concerning this research process, the summarizing communication should be a publication, which comprises the whole research work and is the doctoral thesis.

3 Methodology

As the methodology for this research, the design science approach by Peffers et al. [3] is used. It provides the following six steps to carry out the research process:

1. Prolem identification and motivation,
2. Define the objectives for a solution,
3. Design and development,
4. Demonstration,
5. Evaluation and
6. Communication.

These six steps are presented below in figure 2 and adapted to this research. Additionally, several factors [20] influence the process steps. First, the column *research methods* describes the approaches that are relevant for the progress. Second, the columns below the research methods describe the *data collection* and *data analysis* and respectively the tools applied. Third, on the bottom of the figure, are the databases relevant for the research. They are separated in *knowledge base* (light green), e.g. research publications within the area and *environment* (dark green) with data derived from use cases, e.g. information from expert interviews.
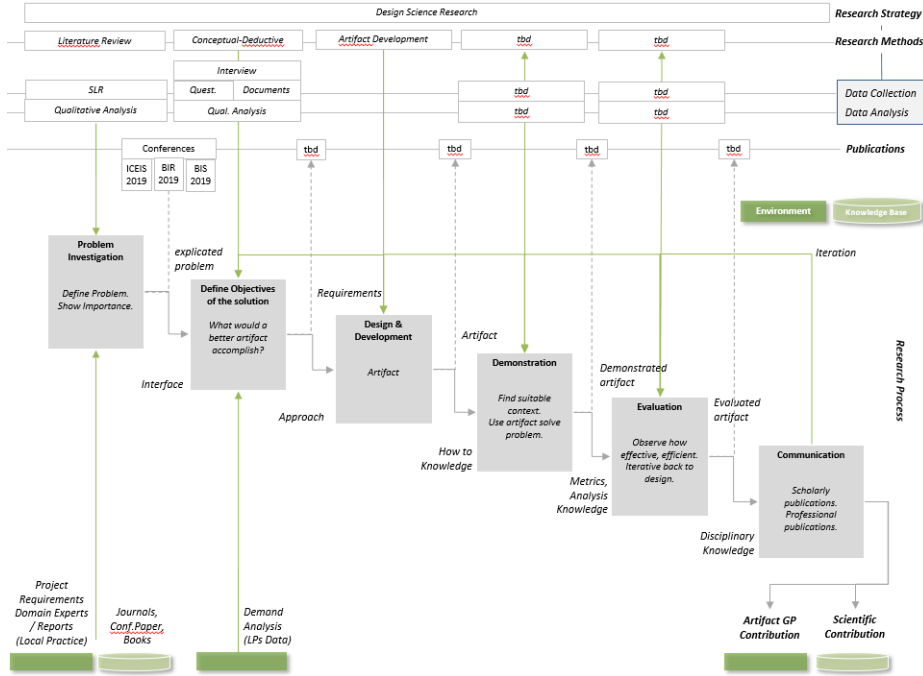
Fig. 2. Adapted Design Science Research Methodology by Peffers et al. [3] and Wißotzki [20]

4 Preliminary Results & Outlook

In relation to the first step of this research, possibilities and interests in terms of indoor location-based services were gathered. Qualitative interviews with domain experts in several sectors were conducted [15] to determine, if those services trigger a general interest and if they could be implemented in several branches. Additionally, the Digital Innovation and Transformation Process has to be verified, improved and tested concerning the suitability in hospitals. Therefore, implementations in different contexts took place, such as zoo gardening facilities [17]. By considering the *S-RQ1*, a systematic literature review has been conducted [7, 16]. SpringerLink, AISeL, IEEE and Scopus have been selected as the relevant databases and it was ascertained, that efforts concerning digitalization and new approaches for enterprise architecture management exists and that the number of researches within the area is rising (figure 3). In order to gain a holistic view, the outcomes of the systematic literature review were categorized in sub-groups by a similarity approach according to Palinkas et al. [19]. As the most important topics, the 405 relevant were sorted as:

1. Clinical Process Management, including Lean Management (132 paper),
2. Business or Enterprise Architecture Management (69),
3. Platform Development & Management (40),
4. Process Mining, including Data Management (38),

5. Decision Management (35),
6. Conformance Management (16),
7. Simulation Management (16),
8. Quality Management (9),
9. Knowledge Management (8) and
10. Petri Net Models (6) [16].
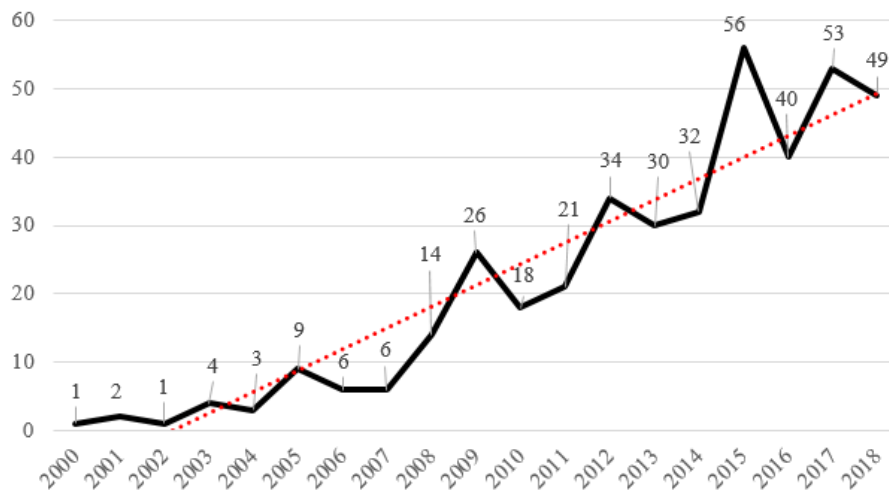
Fig. 3. Trend and Number of digitalization-relevant Paper concerning hospitals per Year [16].

The next steps of the research process will be to determine actor-based digital building blocks in hospitals and the respective state of research as well as to prepare qualitative studies in terms of expert interviews. Therefore, research questions have to be considered that trigger the actors' needs for the artifact.

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