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Towards a Software Tool for Planning IHE-Compliant Information Systems

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Abstract: As hospital information systems are complex and the requirements for interoperability grow with the increasing networking in healthcare, careful planning becomes more and more necessary. The use of standards as described in IHE profiles, for example, are an important prerequisite for enabling interoperability. Enterprise Architecture Planning (EAP) methods should support this, but none of the currently available EAP methods offers the option of using IHE profiles. The 3LGM2IHE project wants to close this gap and implement the support of IHE profiles in the 3LGM² tool. This paper describes how requirements for this tool were determined and presents the results.

Keywords: 3LGM², modeling, health care, hospital, information system, IHE, interoperability, requirements

1. Introduction

Healthcare information systems, especially in hospitals, are complex. The complexity results from the multitude of regulatory, functional and technical constraints, but also from the tasks to be supported, such as the administration of patients or the support of medical documentation (doctor's letters, laboratory findings, radiological imaging, etc.). The integration of medical care and research as well as the cross-sectoral and cross-project exchange of medical data are also becoming increasingly important, e.g.in Germany through the medical informatics initiative [1]. Information systems require careful planning to meet the resulting requirements, taking into account the reuse of software modules and in particular interoperability aspects.

Integrating the Healthcare Enterprise (IHE) is an international initiative² that aims to improve the exchange of information in the healthcare sector. In order to facilitate interoperability, IHE relies on the use of standards and the description of use cases, which bundle the requirements from practice. From the use cases, IHE develops Integration Profiles (IHE profiles) which specify the information exchange via transactions between functional components of healthcare IT systems (actors) [2]. The IHE profiles are drawn

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² https://www.ihe.net/, https://www.ihe-europe.net/, http://www.ihe-d.de/

up by committees in currently 12 domains publishing own technical frameworks (IHE specifications). However, due to the large amount of documentation, it is often difficult for an information manager, e.g. Chief Information Officer (CIO), without IHE experience to access and use IHE profiles in planning.

Methods of Enterprise Architecture Planning (EAP) provide assistance in the planning of information systems [3]. Meta-models, such as Zachman [4], ARIS [5], TOGAF [6], ODP-RM [7] or 3LGM² [8, 9] provide tools to support modeling. However, none of them provides direct support of using IHE profiles.

Therefore, the German Research Foundation (DFG) funded project "3LGM2IHE" aims at closing this gap and expanding the EAP tool 3LGM² tool accordingly. Such an adapted tool would be a substantial contribution to the use of standards in healthcare and thus to greater interoperability. In our opinion, this should already be taken into account when planning the IT architecture. A prerequisite for this is to have IHE support and design patterns based on it for typical scenarios in health care available in a planning tool and to support the needs of the users. A conceptual prototype was published in preparation of this project in 2015 [10].

Before implementation, concrete requirements must be known. The aim of this article is to present and discuss these requirements and the methods used.

2. Methods

In order to obtain the broadest possible range of requirements, a set of methods of requirements engineering were used, in particular requirements elicitation, which are described in more detail in 2.1-2.3 below.

2.1. Literature review

The literature review should answer two questions: a) Are there any existing methods or tools that support the modeling of IHE-compliant information system architectures? b) What requirements are known from the literature regarding IHE-based templates for modeling information systems? Therefore, we did a bibliographic search on PubMed, Google and Google Scholar using a combination of MESH and free terms, for example "template based enterprise architecture planning", "integrating the healthcare enterprise" and "IHE". The result lists of the search queries were evaluated in two steps. First, the title of the publications was evaluated with regard to its relevance to the question. The publications assessed as relevant in stage one were examined in a second step with abstract and, if available, in full text with regard to the above-mentioned questions.

2.2. Questionnaire

In order to involve potential users as early as possible, a questionnaire with a maximum of 28 questions was developed. The questions are grouped in two sections:

- 1. Information about the participant and the use of EAP in its organization
- 2. Requirements with regard to
 - 2.1. Overview and search of IHE profiles
 - 2.2. Support in planning and design
 - 2.3. Evaluation and analysis of models

In addition to structured questions, some open questions were also asked in order to capture further ideas of the participants.

The questionnaire was realized with the electronic data capture system (EDC) redcap [11] as an online survey [12]. The invitation to take part in the survey was distributed via mailing lists of the University Computer Centre Directors (CIO-UK), participants of TMF workshops on the subject of registers, as well as via the project homepages, the project page at Researchgate and the project page on the homepage of IHE Germany³.

2.3. Expert panels / workshops

Another source of requirements in the project were expert panels and workshops. Expert panels were held, for example, in the context of the "Interoperabilitätsforum"⁴ and "User Group Archiving"⁵ (joint activity of GMDS and IHE Germany). In 2 workshops on the subject of registries for medical research, the project 3LGM2IHE was presented and discussed. Another workshop was initiated out of the project. Experts and interested parties were invited via mailing lists and personal contacts. After participants had been introduced in IHE and 3LGM², a planning exercise was used to collect requirements.

2.4. Requirements analysis, specification and agile management

The requirements determined in 2.1-3 were then analyzed, and finally summarized. Personas [13] were developed for this purpose, which were assigned to the requirements of typical representatives from the intended user groups. This was followed by a prioritization, taking into account the questionnaire results, the complexity of the implementation of individual requirements, the fulfilment of the project's objectives and the available resources. Finally the requirements were documented in the requirements specification document (according to ISO/IEC/IEEE 29148 [14], chap. 5.2.6).

In order to implement the specified requirements, it is important to manage changes, priorities and dependencies. The software tool "kanboard"⁶, which works according to the Kanban method [15], was used for an agile approach. The requirements were created as tasks in Kanboard, parameterized (priority, description, etc.) and linked with each other. The requirements were split into realizable blocks as issues (tickets) in the issue tracker of bitbucket⁷ and linked to the requirements in kanboard via webhook. Commits to the source code repository of the 3LGM² tool are also linked to the issues. These links can be used to monitor the fulfillment of requirements in kanboard.

3. Results

In step one of the literature search 18 publications were evaluated as relevant. In step two, the findings of 10 publications have been incorporated in answering the questions, see 2.1. Regarding question a) the assumption was confirmed that there is currently no EAP tool with IHE support. However, interoperability is an important aspect in the planning of healthcare information systems. Regarding question b) the bibliographic search revealed

³ http://www.3lgm2ihe.de , https://www.researchgate.net/project/3LGM2IHE , http://www.ihe-d.de/projekte/3LGM2IHE/

⁴ http://interoperabilitaetsforum.de

⁵ http://www.gmds-aku.de/

⁶ https://kanboard.net/

⁷ https://bitbucket.org/

that the template based modeling is known but no specific requirements with regard to IHE-based templates could be found.

The questionnaire was completed between January and September 2017 by 20 participants. - 65% (13) of the participants are planning the current- and future-state IT architecture and all of them indicate that interoperability and the consideration of standards is a topic (20). No participant indicated that he is already supported to use IHE profiles by existing tools.

According to the survey, the EAP tools should fulfill the following requirements: It should provide

- 1. current and old IHE profiles (100%, 19 votes, 1 missing))
 - a. in the granularity of actors, transactions, content modules (79%, 15)
 - b. in the granularity of further details, e.g. communication standards or options (21%, 4)
- 2. templates of typical scenarios (94,4%, 17 positive votes, 1 negative, 2 missing)
- 3. mechanisms to analyze the IT architecture with regard to search for special model elements or to find conflicts between interfaces using different standards.

The workshops and expert panels took place in the period December 2016 - October 2017. The participants requested that the following key requirements for the tool should be fulfilled:

- Usability should be "as practical as MS VisioTM in operation".
- Visualization of the models in "meaningful graphics" is important.
- Links from the model, e.g. to external references like CDA templates (provided in Art-Decor⁸), terminologies and ontologies should be possible.
- Based on use cases or object types, relevant IHE profiles should be proposed.
- The complexity should be manageable through coarsening / refinement.
- The preparation of tender documents from the model should be supported.

Further requirements were the handling of communication standards, transactions, mapping of authorization concepts and validation of the models with regard to IHE conformity.

4. Discussion and Outlook

Our requirement analyses was based on different methods: literature review, a survey and expert interviews. All of these methods had some weak points:

- The literature review was restricted by limited resources. But we searched in the most relevant bibliographic databases using appropriate search terms.
- Even if we tried to spread the link of our survey via many different channels, only 20 persons participated in our survey.
- Some answers collected by the survey apparently contradict the assessment of experts. Our survey told us, that most persons (15/20) are satisfied, if they can find IHE profiles in granularity of actors, transactions and content modules. Experts told us, that options of actors must be modelled in order to ensure interoperability. Therefore, we suspect that there is really a need to assist persons using IHE profiles.

That is why we have decided to use the answers of the survey to prioritize the requirements collected by experts. For example, all integration profiles must be available

⁸ https://art-decor.org

in an overall level as a first step. Afterwards options and necessary groupings of actors should be integrated in an enhanced version. Even if the survey was not only completed by experts, it is the ideal basis to capture ideas of more persons, how an EAP tool should look like. Therefore, we captured further ideas via open questions, so that the ideas of the participants are not influenced in any manner. In order to collect some more ideas for further development the survey remains online available [12].

Even if some of these methods have their weak points, we think, that the combination of these methods enabled us to collect representative requirements.

These requirements are now the basis for the specification of the extensions of the 3LGM² tool⁹. In order to be able to react quickly to the needs of the users, especially regarding usability, software development is carried out using an agile method. Therefore, some further workshops with potential users are scheduled.

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⁹ The download is available via http://www.31gm2.de/en/Downloads/3LGM2_Tool/