System Analysis of Information Management

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Abstract: The successful delivery of IT services is enabled by information management that can be distinguished into strategic, tactic and operational information management. A major challenge of information management is the structuring and definition of its tasks, entity types and tools. At the same time, the increasing complexity of IT services and related infrastructure, cost effectiveness and increased users expectations demand standardized processes for operational information management. One major approach to structure and standardize IT operations is the ITIL[©][4] framework, the Information Technology Infrastructure Library. ITIL contains best practices to align IT services with the needs of a business in general. Several organizations have introduced processes of ITIL in their operational information management.

As an example of an organization, we study a hospital. So far there is no agreed standard of what constitutes proper information management in a hospital. Therefore it is interesting to study individual hospitals and their information management. This paper describes the results of a system analysis based on 7 interviews to investigate a hospital's information management tasks, entity types, tools and the adoption of ITIL in order to analyze strengths and weaknesses of IT support of Information Management.

Keywords: Information Management, System Analysis, ITIL

1 Introduction

According to Winter et al. [Wi11], information systems (IS) play an important role for many people within organizations in general and especially in organizations of the health care environment. Staff of health care institutions are affected by the availability and quality of information in their daily work, especially in hospitals. For the efficient operation of IS, an information management (IM) is necessary, which is separated into strategic, tactical and operational information management.

Strategic IM establishes strategies and principles for the information management division that result in a strategic IM plan. Tactical IM follows the needs of strategic IM and implements solutions or changes within projects. The provisioning of IT services is the primary task of operational IM.

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All activities of IM consist of tasks that use or update information and are supported by tools in organizations. E.g. the task `strategic IM planning` is responsible for aligning the IM division's goals with the goals of the hospital. The entity type used to document this information is the `strategic IM plan`. Several tools might be involved in the creation of this plan. This could be an `office system` in combination with a `enterprise architecture management tool` or a `balanced scorecard tool`.

Some of the tasks, especially tasks of operational IM have adopted best practices such as ITIL. ITIL, the Information Technology Infrastructure Library [Ar13], [Ra11], [St13] is one of the major approaches to structure and standardize IT operations. ITIL contains a set of best practices for service design, service transition and service operation, governed by a service strategy, allowing a continuous service improvement. Several hospitals have adopted ITIL within their operational IM [Ho11]. However, the tasks, entity types, tools and adoption of ITIL depend on the hospital needs, organizational structure and complexity of IT used. In our research we are interested to understand the IM of different hospitals in order to elicit the IT-related needs of the IM personnel, in particular of the chief information officer (CIO). As a first step we analyzed the as-is-state of the IM of a big hospital. We call this hospital in the following hospital X. It has more than 3500 employees and more than 1200 beds.

This as-is-state can be modeled using the Three-layer Graph-based Meta Model 3LGM^2 (see section 2.3). Previous publications have shown, that 3LGM^2 is suited to model tasks, entity types and tools within hospitals [Ja09] and [Wi07]. Here we use this model for the first time to analyze the IM and its adoption of ITIL.

There are two benefits from system analysis and modeling for organizations: First, the model is the base for comparability of IM between different organizations. The model unveils the ITIL conformity of processes, which can be used to determine the level of maturity, e.g. as described in [WWB15]. Second, the modeling of tasks indicates missing or unnecessary tasks and is the basis for future optimization and consolidation of the IM and it's processes.

The main contributions of this article are:

1. A description of our system analysis to identify tasks, entity types and tools within one particular hospital's IM.

2. First results of this system analysis in terms of a 3LGM^2 model

3. A first assessment, to which extent the identified tasks are based on ITIL.

The remaining part of this paper is structured as follows. We first describe the background and related work. Section 3 explains our system analysis method used to identify tasks, entity types and tools in hospital. Section 4 presents the results of the system analysis in the hospital. Finally, ideas of future work are shown and a conclusion is drawn in section 5.

2 Background and Related Work

This section defines the terms task, entity type and tool. It then describes the method system analysis by Ammenwerth et al. and introduces the characteristics and usage of 3LGM² models. Finally, the concepts of an ITIL reference model are described.

2.1 Task, Entity Type and Tool

According to TORE (Task- and Object-Oriented Requirements Engineering) [PK04] tasks are executed by users in the enterprise. They are identified by considering the current activities of the users. This can be done by interviewing the user and by monitoring of workflows. The applied systems and tools in this case support the processing of tasks. These must be explicitly described and placed in the context of the work environment. Each task is described by a task description, based on the template of TORE.

Figure 1 shows the template, as an example applied to describe the task change management. The description captures aims and possible sub-tasks, responsible persons and input and output data for the representation of the entity types, as well as meta data such as the ID, date and version. With respect to ITIL the tasks represent the (sub) tasks for the ITIL processes.

Task: Change Management	
ID: A-002	
Version: 1.2	
Date: 30.03.2015	
Objective	Collection of changes
Subtask of	n/a
Possibility to intervene	edit request, estimation of change
Trigger	user's request
Priority	low / ~~high~~ / ~~middle~~
Initial situation	completed request form, eligible change rationale
Information In	change request form
Information Out	change report, change appraisal, changed component/system
Resources	staff of operational IM, change advisory board, division manager, possibly department manager
Application Systems / Tools	Microsoft Office (Word, Outlook), Microsoft SharePoint
Interfaces	Exchange server, SharePoint server

Fig. 1: Task template accoring to TORE [PK04], used to describe the task change management

An entity type is any kind of information that is consumed, produced or modified by a task. These can be documents, data structures, objects, files, specified by data types or even paper based artifacts. To know all entity types has two advantages. First, it makes explicit common data interfaces that enable interoperability between IS. And second, it shows which information is necessary to perform the given tasks. In consequence, this

knowledge can be used to model which information is needed by whom in order to fulfill which task.

Tools in this context are all kinds of applications, software systems or software components that support the execution of tasks, in other words any kind of IS.

2.2 System Analysis as method

The purpose of the system analysis method according to Ammenwerth et al. [Am15] is to provide an exact description of the properties of an existing IS or a set of its parts. The analysis results in the description of an as-is-state. In cases when strengths and weaknesses are important, the analysis is followed by an assessment. The method of system analysis is domain independent, yet proposed in the context of health care environments. It comprises a system analysis process model that executes analysis activities within multiple iterations. This allows rework, adaptation and improvement of the activities' results in each iteration.

Several analysis types can be used for various objectives. Beside others, the **task analysis** considers business tasks and activities in a division. The focus of **equipment analysis** is the assessment of tools and application systems for execution of tasks and associated roles. Business processes within a division are investigated during the **process and activity analysis**.
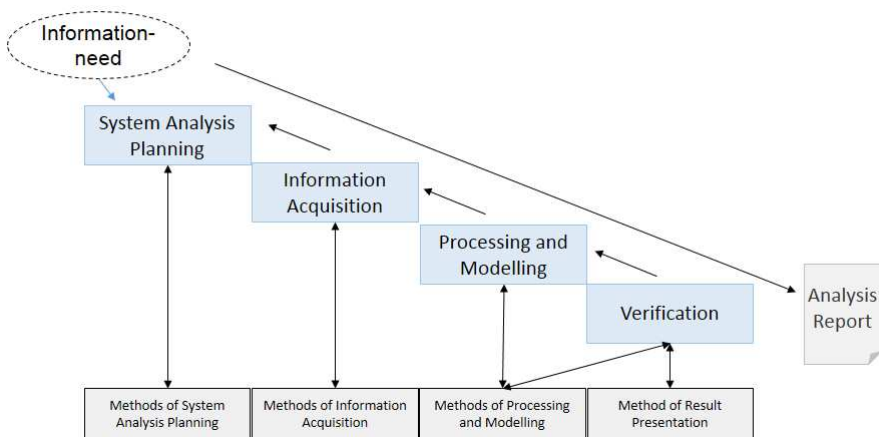
Fig. 2: System Analysis as described in [Am15]

Figure 2 shows the process model of the system analysis. A system analysis is triggered by certain objectives or a primary question. Each of the four phases contributes to the system analysis and utilizes several methods.

The first phase is the **planning of the system analysis**. It results in a documentation of the system analysis objectives as well as primary questions and the scope. Part of the planning is the definition of assessment criteria for a later assessment, if applicable. All information

needed to answer the analysis questions are identified and gathered in the second phase, the **information acquisition**. Information can be acquired by performing interviews, written surveys, observation and data analysis.

Within the third phase, **processing and modeling**, the information is processed and transformed into a suitable model. The system analysis supports any kind of model such as UML diagrams, business process models, as well as ARIS and 3LGM^2 models. The latter is discussed in detail in section 2.3.

The **verification** of the systems analysis results is done in phase four. The focus is on determination of correctness, completeness and appropriateness of the created models. Depending on the complexity of the system analysis, the verification can be either by a direct feedback with responsible persons or by verification meetings.

2.3 Modeling with 3LGM^2

The Three-layer Graph-based Meta Model (3LGM^2) has been proposed by Winter et al. [WBW03, We03]. It enables the modeling of health information systems [Wi11].

The model consists of three layers: First, the functional layer, that shows tasks and related entity types. Second, the logical tool layer that relates application systems to tasks and entity types. Third, within the physical tool layer, the tools or application systems are allocated to specific hardware, computing infrastructure and communication technology.
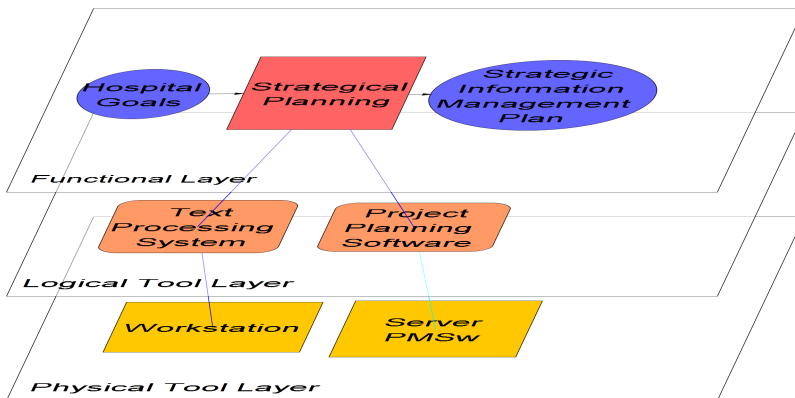

Fig. 3: An example instance of a 3LGM^2 model

Figure 3 shows a simple 3LGM^2 Model. In the functional layer, the task `strategic planning` is depicted, that uses the `hospital goals` as input and outputs a modified `strategic plan`, both entity types. The task is supported by two tools, shown on the logical tool layer: a `text processing system`, which runs physically on a user's `workstation`, and a `project planning software` that runs on a server called PMSW.

2.4 ITIL Reference Model

A reference model describes a class or set of models with similar properties. Such models contain the abstracted and simplified information of a domain or topic and can be used for documentation, presentation or analysis. Only through its application and usage, a model becomes a reference model [Is08]. One major feature of a reference model is its comparability with other models of a specific domain.

A 3LGM^2 based reference model for ITIL has been defined by Ißler [Is08]. The reference model condenses the application of ITIL in a medical environment and contains 9 of the ITIL v3 (published in 2007) processes. These are availability management, capacity management, incident management, IT service continuity management, release and deployment management, service asset and configuration management and service level management. On the functional layer the model contains tasks and entity types. The logical and physical tool layer do not contain any elements, since this is subject to instantiation of the reference model. All of these processes are available as independent perspectives that are partial models.

Figure 4 shows the functional layer of the ITIL process **Change Management**. There are 4 major tasks which handle the request for a change, the schedule for the change, the change and the appraisal for the change, respectively. The figure shows for each major task the three subtasks record, change and delete. In the following only the core task is explained. The first task is to handle `information about a request for change` that creates or modifies the `request for a Change`. This request is input to the task to handle `information about a schedule for a change` that results in `schedule for a change`. The schedule is used by the task to handle `information about an appraisal of a change` that creates or modifies the `appraisal of a change`. The schedule is also used by the task to `information about a change` that creates or modifies a `change`.
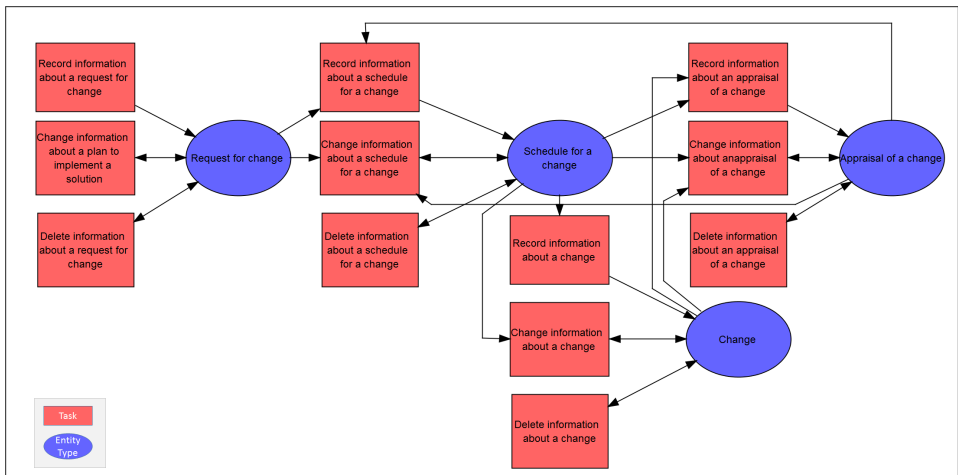

Fig. 4: Functional layer of ITIL change management [Is08]

3 Method

We have chosen the method of system analysis according to Ammenwerth et al. [Am15], since this method investigates the as-is state, addresses the health care environment and is related to 3LGM^2 . This section describes our instantiation of this method for the specific hospital X. All adaptations of the methods are explicitly described.
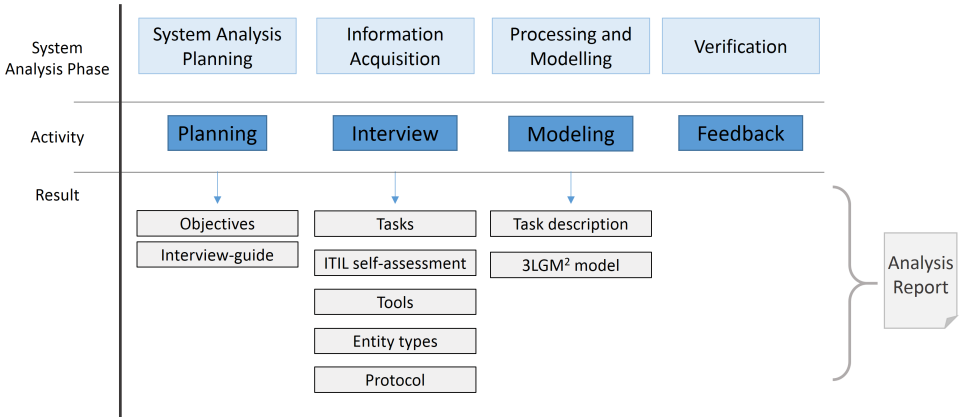

Fig. 5: The information artifacts used and produced by the system analysis

Figure 5 shows the artifacts generated in each phase of the system analysis. They are explained in each of the following subsections. All results are condensed and compiled into an analysis report.

3.1 Phase 1: System Analysis Planning

The objectives (O) of the analysis were:

O1: Elicit the as-is-state of the tasks, their related entity types and supportive tools within the IM of hospital X.

O2: Construct a 3LGM^2 model, indicating the coverage with ITIL processes.

O3: Identify any interoperability issues or media breaks within the tools.

As shown in Section 2.2, the system analysis supports different types. A task analysis discovers the IM's tasks and their relation to the ITIL reference model. Since tasks are performed within processes, the process and activity analysis identifies input and output entity types. Within the execution of tasks, tools can be identified by the equipment analysis. The system environment, organizational structures, communication paths and the content of used documents and forms was not subject of the analysis, because they do not contribute to the given objectives. Thus, we have chosen a combination of task analysis, equipment analysis and process and activity analysis.

3.2 Phase 2: Information Acquisition

The selection of an appropriate information acquisition technique (see 2.2) is based on following consideration: Observations are not appropriate due to staffs time limitation and sensitiveness of the IM division. Data analysis does not fit, since there is no explicit data available about tasks, entity types and tools used. Written surveys would work to gather an exact description of tasks, but address larger user-groups. Interviews have been found to provide appropriate results in combination with reasonable time investment and are able to gather interoperability issues in daily work.

In a first conversation with the CIO, we identified 7 persons within the IM division, who are responsible for tasks of the IM and therefore are relevant as interviewees. Non of the interviewees are related to one of the authors of this article. Interviews of several roles allow a comprehensive view of the IM's tasks, entity types and tools. The roles include the CIO, several department managers, a project manager and assistants as shown in Table 1. We conducted one interview per person, associated with one single role and used the same interview-guide for all interviews. Five interviews were face to face within a four weeks time-frame and two have been held by phone.

Interviewee	Position/Role	Type
Person 1	CIO	face to face
Person 2	Project Manager / IT Strategy	face to face
Person 3	Assistant IM	face to face
Person 4	Application Manager	face to face
Person 5	Service Manager IM	face to face
Person 6	System Manager IM	phone
Person 7	Assistant IM	phone

Tab. 1: Interviewees in hospital X

The questions presented in Table 2 were used within the interview. The table also shows the relations of the questions to the objectives and the envisioned results.

Appointments for interviews have been scheduled 2-4 weeks in advance. During the interview, one interviewer was present with the interviewee and up to two additional persons recorded the answers. Also, the interviewer were taking notes to write a protocol. The interviews had a maximum duration of 1.5 hours.

3.3 Phase 3: Processing and Modeling

Immediately after the interview, the protocols of the minute taker(s) have been combined with the interviewer's protocol into one. The obtained information regarding tasks has been transferred and assembled into the task description (see Figure 1). This task description is the basis for the 3LGM^2 modeling that creates the elements task and entity type on the functional layer. Tasks and entity types that were found to be identical for both the hospital and the reference model have been imported from the reference model into the

Goal	Question	Metric
O1	Which tasks are within your responsibility?	List of tasks
	Who else is in charge of this task?	List of contact persons
	Are there any more contact persons available for further questions?	List of contact persons
O1, O3	Which input and output information is processed?	List of entity types
	Which interfaces are used and based on what communication?	List of interfaces
O1, O2	Who is in charge of this process?	List of responsible persons
O1, O2	What ITIL-Processes are implemented in your division?	List of tasks, List of ITIL tasks
O1, O2	Which application systems are used to support each task?	List of tools
O1, O2	Are there any further application systems that are related to ITIL?	List of tools

Tab. 2: Questions in the interview

hospitals 3LGM^2 model. These elements are marked as green and have an identical ID and description, according to the elements of the reference model. The system analysis results in a hospital specific 3LGM^2 model of information management.

3.4 Phase 4: Verification

The condensed protocol has been sent by e-mail to the interviewee with the request to read the text and identify any mismatches or misunderstandings. The protocol did, however, not contain the task-description and the 3LGM^2 Model. Interviewee Person 1 responded a PDF-scan with some 30 comments written feedback. A PDF with 6 inserted comments was responded by Interviewee Person 3. A PDF with 12 inserted comments was responded by Interviewee Person 7. Their feedback has been integrated into a new version of the protocol and included into the modeling. Interviewee Person 4 responded by e-mail, that the content is alright and topics a represented correctly. No other feedback or comments were retrieved.

Once all tasks, entity types and tools are updated in the 3LGM^2 model, it will be presented to all interviewees for further consolidation.

4 Results

We have identified 13 top-level tasks and 24 tasks altogether that are supported by 47 different tools. The tasks can be hierarchical. For instance, the task change management consist of several sub tasks. For reasons of clarity, we name top-level tasks as processes that consist of several tasks. An overview of the top-level tasks is shown in Figure 6. We associated each top-level task with one level of the IM.
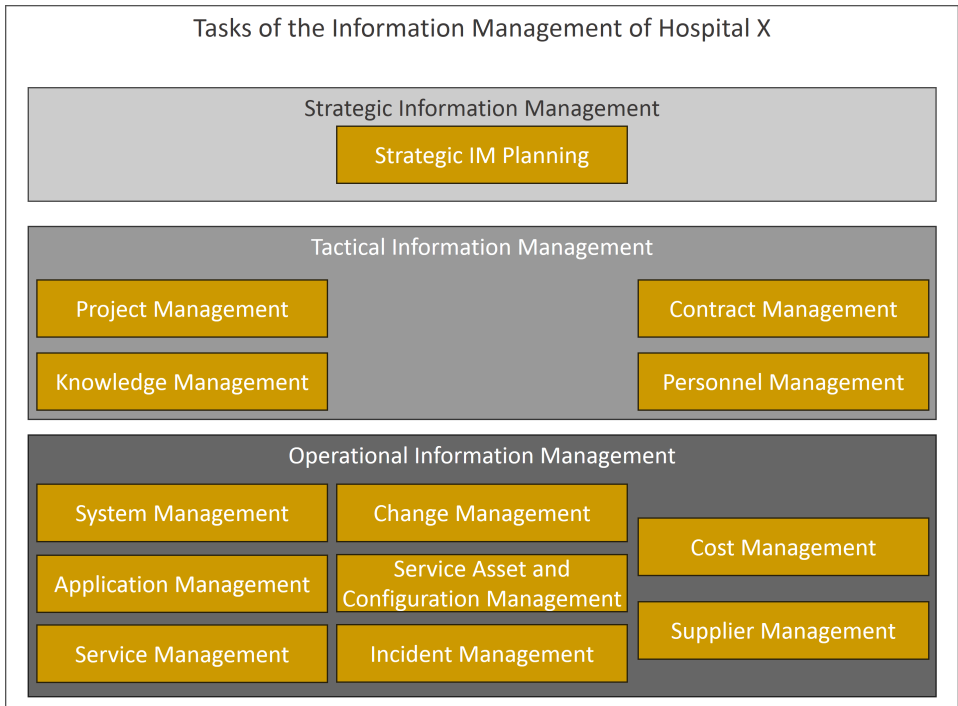
Fig. 6: The identified tasks associated with strategic, tactical and operational IM

Within the strategic IM, we identified the top-level task strategic IM planing. The tactic IM comprises the top-level tasks project management, knowledge management, contract management and personal management. The operational IM comprises the top-level tasks system management, application management, service management, change management, service asset and configuration management, incident management, cost management and supplier management.

The evaluation of the analysis is still ongoing. As a first preview, we want to show the results on the process change management.

4.1 Change Management Process

Figure 7 shows the 3LGM^2 perspective of the modeled change management process in hospital X. The model represents the as-is state of the change management process found in hospital X. The change management process consist of 8 tasks, uses 4 entity types and utilize 3 tools. Tasks, that are identical to the ITIL reference model can be recognized by a green color. The color blue is the standard color for entity types.

The functional and logical tool layers are explained in the following subsections. Since the hardware is not of interest, the physical tool layer will not be discussed.
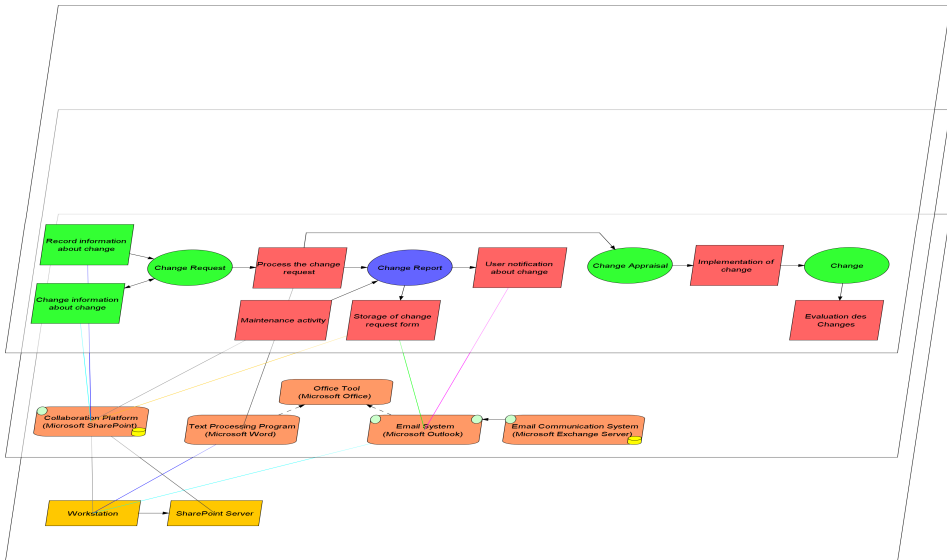
Fig. 7: The identified change management process

4.2 Identified Tasks and Entity Types of Change Management Process

Table 3 shows the identified tasks as well as the consumed and modified entity types of each task. Tasks and entity types correspond to Figure 7.

Whenever a user needs a new or changed functionality, s/he creates a change request using a web based form (T-003 `record information about change`). The output type `change request` is created. In case the change needs a modification, the task T-004 `change information about change` allows editing the `change request`. After the `change request` is received, it is checked for its necessity in task T-005 `process the change request`. When found to be necessary a `change report` with the comment about the change is created. The same entity type `change report` is produced by T-006 `maintenance activity`, which specifies general changes during the monthly maintenance. Then a message about the assessed `change request` is sent to the users in task T-008 `user notification about change`. The `change request` form is now saved for a division-wide access in task T-007 `storage of change request form`. If the `change request` is accepted in the form of a `change appraisal`, the change with the necessary plannings is implemented within the task T-009 `implementation of change`.

As soon as the change is available, its impact can be assessed during the `change evaluation` after its deployment in operations as this is task T-010 `evaluation of change`.

ID	Task	Entity types consumed	Entity types modified
T-003	Record information about change		change request
T-004	Changing information about change	change request	change request
T-005	Process the change request	change request	change report
T-006	Maintenance activity		change report
T-007	Storage of change request form	change report	
T-008	User notification about Change	change report	change appraisal
T-009	Implementation of Change	change appraisal	change
T-010	Evaluation of change	change	

Tab. 3: Entity types used within change management task

4.3 Identified Tools of Change Management Process

The identified tasks of the change management are supported by a collaboration platform (Microsoft Sharepoint), a text editing office system (Microsoft Word) and E-Mail communication (Microsoft Outlook). The mapping between task and tool is summarized in Table 4.

Tool	Task
Microsoft Sharepoint	Record information about change (T-003), Changing information about change (T-004), Maintenance activity (T-006), Storage of change request form (T-007)
Microsoft Word	Process the change request (T-005)
Microsoft Outlook	Storage of change request form (T-007), User notification about change (T-008)

Tab. 4: Tools supporting tasks within change management process

It becomes obvious, that not all of identified tasks performed within the change management are supported by tools. E.g. the evaluation of a change is not supported by a tool. With regard to traceability, a documentation of the change evaluation should be considered.

4.4 Relation to the ITIL Reference Model

The performed system analysis has identified three tasks that have a direct relation to ITIL processes. The interviewees are the source of information about the processes relations to ITIL, i.e. which ITIL elements are used in the process. Obviously the quality of such statements depends on the interviewees' ITIL knowledge. Two of the interviewed persons have an ITIL expert certificate, all others have an ITIL foundation certificate.

Tasks that have a relation to ITIL within the analyzed hospital, are the change management process, the service asset and configuration management and incident management. All other tasks of the ITIL reference model are not implemented in the hospital.

Tasks and entity types in Figure 7, that are used in the hospital, but are not available in the reference model, are marked as red in Figure 7.

As Figure 7 shows for the change management process that the tasks `Record infor-mation about change` and `Change information about Change` are identical to the ITIL reference model in Figure 4. Identical entity types are `change request`, `change appraisal` and the `change` itself.

The ITIL reference model in Figure 4 however does not show e.g. the task `Implementat-ion of change`. This task however, is covered by the ITIL standard so that the reference model must be extended. In principle there might be tasks in the hospitals IM, that do not have any relationship to ITIL. These tasks must not be subject to any reference model extension.

Based on this modeling an assessment of the model can be done. The reference model by Issler covers the ITIL v3 2007. However, there are changes to the current version ITIL 2011. This is subject for further investigation.

There are two aspects of model comparability. First, the hospital model to the reference model and second, two or more hospital models with each other.

In this case the reference model and the hospital's model were easy to compare. In general the model comparison is more difficult. For example, if the same task in the reference model and hospital model in their input and output types.

5 Conclusion

This paper presents the application of the system analysis method according to Ammen-werth et al. to analyze and assess the tasks, entity types and tools used within the IM in a hospital.

The results of the system analysis are 1) a description of identified tasks and entity types and tools and 2) a 3LGM^2 model. The model shows what tools contribute to which IM tasks, how these tasks relate to ITIL and what kind of entity types are used.

As one example, the paper describes the task change management in greater detail.

Based on our experiences the combination of a task-oriented approach with interviews as elicitation method and 3LGM^2 as modeling technique is helpful and can thus also be used by other organizations.

In future work we will finish the evaluation of the analysis and then apply the methods to other hospitals. From this we will derive differences and similarities in the IM of the hospitals and to ITIL. We will use the models to evaluate the integration of tools in IM, especially to identify tasks of strategic, tactical and operational IM with missing or in-appropriate tool support. Then we start in-depth interviews to elicit requirements for an appropriate IT support for the CIO.

6 Acknowledgment

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