MODELLING KNOWLEDGE PROCESSES IN HEALTH CARE ORGANISATIONS

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ABSTRACT
Knowledge is a key factor for the work in health care organizations. The theory of learning organizations is one possibility to describe knowledge processes. Despite this dissemination a concept for combing the organizational and technical dimension is still missing. For this organizational concepts are introduced to describe knowledge processes. A mapping between organizational theory and business economics offers the opportunity to use proven modelling languages like KMDL (for knowledge modelling) and 3LGM^2 (for modelling IT architectures in health care organizations) on a conceptual basis. At least, both languages are combined and illustrated with the ideal-typical example of a clinical conference.

Keywords: organizational learning, modelling, 3LGM^2, KMDL®, health care

1. INTRODUCTION

The increase of knowledge and information is a general phenomenon and thus also applies to healthcare. Emerging cooperation between health care organizations (HCO) and in addition Mergers & Acquisitions by highly integrated health care groups extend the organizational knowledge base even more. In addition medical schools and medical university hospitals represent key actors in medical knowledge development.

The new established European Medical School (EMS) and the Medical University Hospital Oldenburg (in German: Universitätsmedizin Oldenburg/ UMO) present booth groups. The UMO is formed by three existing hospitals (cooperating HCO) whereas the EMS is a transboundary cooperation between the universities of Oldenburg/ Germany and Groningen/ Netherlands. And as a medical university the EMS is estimated to be a medical knowledge developer.

During and afterwards the foundation process new organizational and network learning processes are expected to occur. Recent studies have already shown organizational learning processes in one of the involved hospitals [Rölker, 2007]. The widened focus of the ongoing studies is now on the connection between organizational learning and hospital information systems and on inter-organizational learning processes. For this study two components are needed: a clear definition of organizational learning and a modelling approach to cover the fields of organizational learning and information systems. Before the modelling approach is developed, the learning organization will be introduced.

2. LEARNING ORGANIZATIONS

Learning organizations can be described from different viewpoints. In this paper the learning organization is analyzed in sense of Wengelowski. He defines three main areas: learning levels, learning types and learning determinants, which all can be practically mapped over an organization for analyzing its accordance with the learning organization concept [Wengelowski, 2000].

Four learning levels can be distinguished: individual learning, group (team) learning, organizational learning and inter-organizational learning. Individual learning means the changes in behaviour, theories and concepts by an individual whereas group learning means the same in a group context. Organizational learning focuses on the changes in organizational behaviour or theory. If more than one organization is involved in the learning process then inter-organizational learning can be identified.

Learning types can be differentiated into single-loop learning, double-loop learning and deutero learning [Hislop, 2009]. Single-loop learning focuses on incremental changes inside a constant framework while double-loop learning focuses on the framework. Finally, the process of learning and extending an organization's awareness itself is in the focus of deutero learning. The learning types are based on each other. The abstract theories of learning levels and types are brought together into the organization by the learning determinants. Three determinants are discussed in literature: organizational member, organizational structure and organizational culture [Wengelowski, 2000]. The specific utilization and advancement of competencies and qualifications among the organizational members are fundamental tasks in learning organizations. Each organizational member has its unique setting of competencies and qualifications, e. g. professional or social competence. Important levers are human resource development (further and advanced education) as well as staffing. The formal organizational structure gives the framework for all intra-organizational and partly inter-organizational processes

and sets the scope of action for the organizational members. Following the organizational view a differentiation can be made between organizational structure, process organization, communicational/ knowledge organization and informational organization. The organizational structure describes the long-term primary organization (functional, divisional, matrix organization) and flexible short-term organization (such as project organization), the process organization describes how organizational tasks are executed. The communicational/ knowledge organization describes how knowledge is shared inside organizations and which communicational areas can be used. The informational organization contains written, spoken and IT-based information systems. Organizational culture can be interpreted as the informal organizational structure. In context of the learning organization three different types of culture can be distinguished: learning culture, communication culture and culture of trust [Rölker-Denker, 2010].

This definition of learning organizations has been already used in previous studies [Rölker, 2007] [Rölker-Denker, 2010] [Rölker-Denker, 2011]. This ensures the comparability of actual and future work with recent studies. As a result of this recent work a method for modelling organizational learning processes was declared to be useful [Rölker-Denker et al., 2011].

3. APPROACH

Two procedure models are possible: the development of a new modelling language from scratch and the consolidation of well-proven concepts for this specific purpose of modelling knowledge processes in HCO. For the second approach, two modelling concepts seem to be suitable: the Three-Level Graph-Based Meta Model for the Management of Hospital Information Systems ($3LGM^2$, [Winter & Haux, 1995] [Winter et al., 2003]) and the Knowledge Modeling and Description Language (KMDL®, [Gronau & Fröming, 2006]). Both concepts are introduced below before they are consolidated to meet the demand for modelling knowledge processes in health care organizations on a conceptual basis.

3.1. $3LGM^2$

$3LGM^2$ is used for modelling hospital information systems and architectures. Models build with $3LGM^2$ use a simple intuitive notation. It can not only be used for modelling hospital information system but also connections to hospital's environment like physicians, care-givers and other HCOs. $3LGM^2$ is based on three layers: domain layer, logical tool layer and physical layer. The domain layer describes typical tasks and subtasks in a HCO like patient scheduling or radiological reporting. The logical tool layer comprises concrete systems like hospital information systems (HIS), radiology information systems (RIS) or picture archive and communication systems (PACS). Finally the physical layer describes physical hardware (PCs, server, switches) and social-technical elements (mail in-trays, archive) and the connections between these elements. The physical layer is left out at the moment due to its subordinate relevance in analyzing knowledge processes [Winter & Haux, 1995] [Winter et al., 2003].

Figure 1 shows a typical clinical conference. Four main tasks (radiological diagnostics, ultrasonographical diagnostics, clinical pathology, and clinical conference) can be identified on the domain layer. Some of these tasks contain subtasks, e.g. radiological diagnostic contains radiological imaging and radiological reporting. Tasks and subtasks generate information objects (e.g. radiological image and radiological report). These information objects are input for other tasks, in this case for the clinical conference. On the logical tool layer the tools needed are modelled. Radiological procedures need modalities to generate images and radiology information systems for managing radiological images, patient data and imaging processes. Both layers are connected through relations between tasks, subtasks and information objects on the domain layer and tools on the logical tool layer.

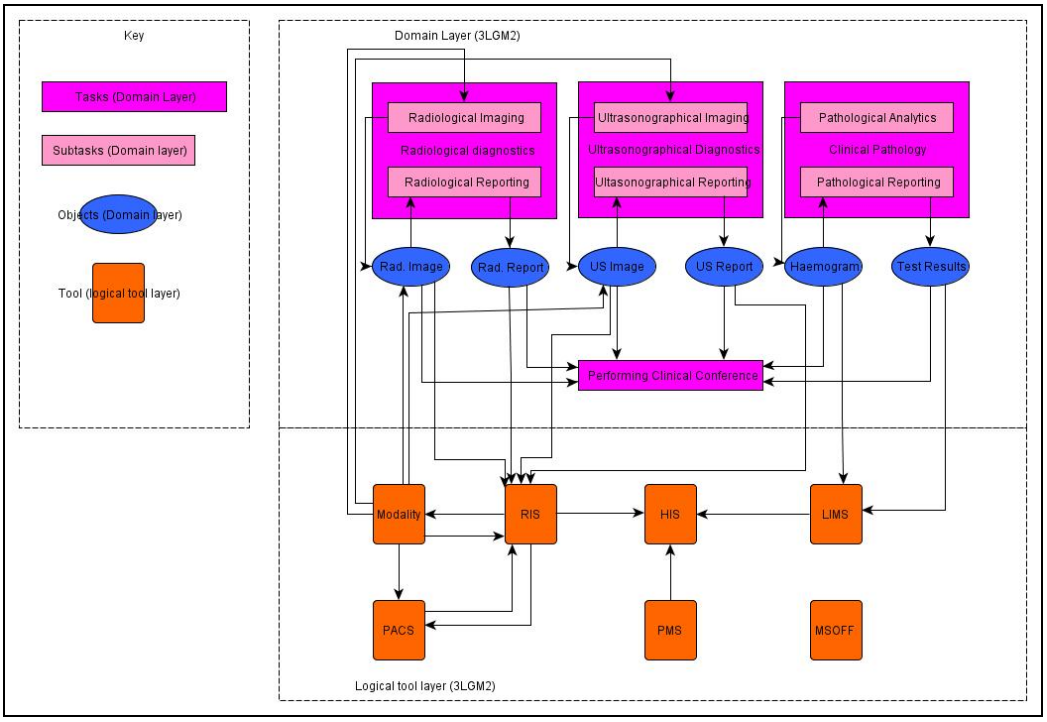

Figure 1: Clinical Conference (3LGM)

3.2. KMDL®

KMDL® is used for modelling knowledge processes in organizations. It is based on the knowledge management model from Nonaka and Takeuchi [Nonaka & Takeuchi, 1995] with its four phases of socialisation, externalisation, combination and internalisation. KMDL® is divided into process layer and activity layer. Tasks, the order of tasks, information systems, functions (provided through information systems), roles and persons are part of the process layer. Objects of the activity layers are information and knowledge objects, single persons (or teams), requirements and the different transformations between the four knowledge management phases.

Figure 2 shows again a clinical conference embedded into a patient treatment process with diagnostics procedures and diagnosis as related tasks. Functions needed and provided through a hospital information system are creating reports, retrieving reports, retrieving images and retrieving and updating electronic health records. Involved roles are hospital doctors and assistants. The activity view shows how the "performing clinical conference"-task is executed. Doctors A and B bring the knowledge through the staffing (they were hired as specialist) and doctor N was qualified through further and advanced training organized by the personnel department. Together they analyze diagnostic images and reports from radiological diagnostics, ultrasonographical diagnostics and clinical pathology (socialisation). The results are reported (externalisation) and combined into a new report (combination). The report is written, the EHR is updated and the doctor in charge is informed. Once the doctor reads the clinical conference report and updated HER and uses the new information he internalise the knowledge (internalisation).

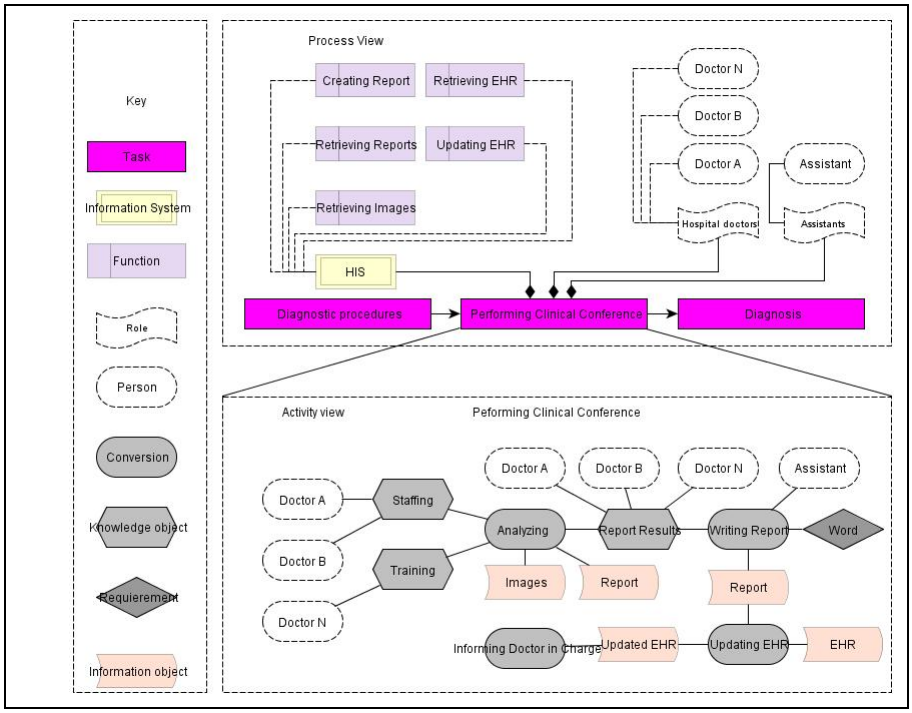

Figure 2: Clinical Conference (KMDL)

3.3. Consolidation

On the functional layer 3LGM^2 solely describes typical hospital task and is not process-oriented. However KMDL® describes processes and focuses on information systems, roles and especially tasks on the process layer. The connection of both concepts can be achieved by mapping 3LGM^2's domain and logical tool layer and KMDL®'s process layer. The result is a fourth layer above the functional layer of 3LGM^2 and can be understood as a knowledge layer. The knowledge layer is connected to the domain layer by tasks and roles and to the logical tool layer by information systems. Using the knowledge layer it is possible to map knowledge processes into a HCO and identify key success factors for these processes.

4. APPLICATION

The application of 3LGM^2-KMDL® is demonstrated by modelling an ideal-typical clinical conference used in the examples before. A clinical conference is a cross-departmental and interdisciplinary combination of meeting and advanced training course. The application is shown in Figure 3.

The task "Performing clinical conference" on the domain layer is specified on the knowledge layer/ activity view. Images and reports on the knowledge layer/ activity view are assed through the HIS on the logical tool layer. The HIS on the knowledge layer/ process view is identical with the HIS on the logical tool layer. This approach allows connecting abstract knowledge management processes, as identified in a clinical conference, with real IT architectures in HCOs.

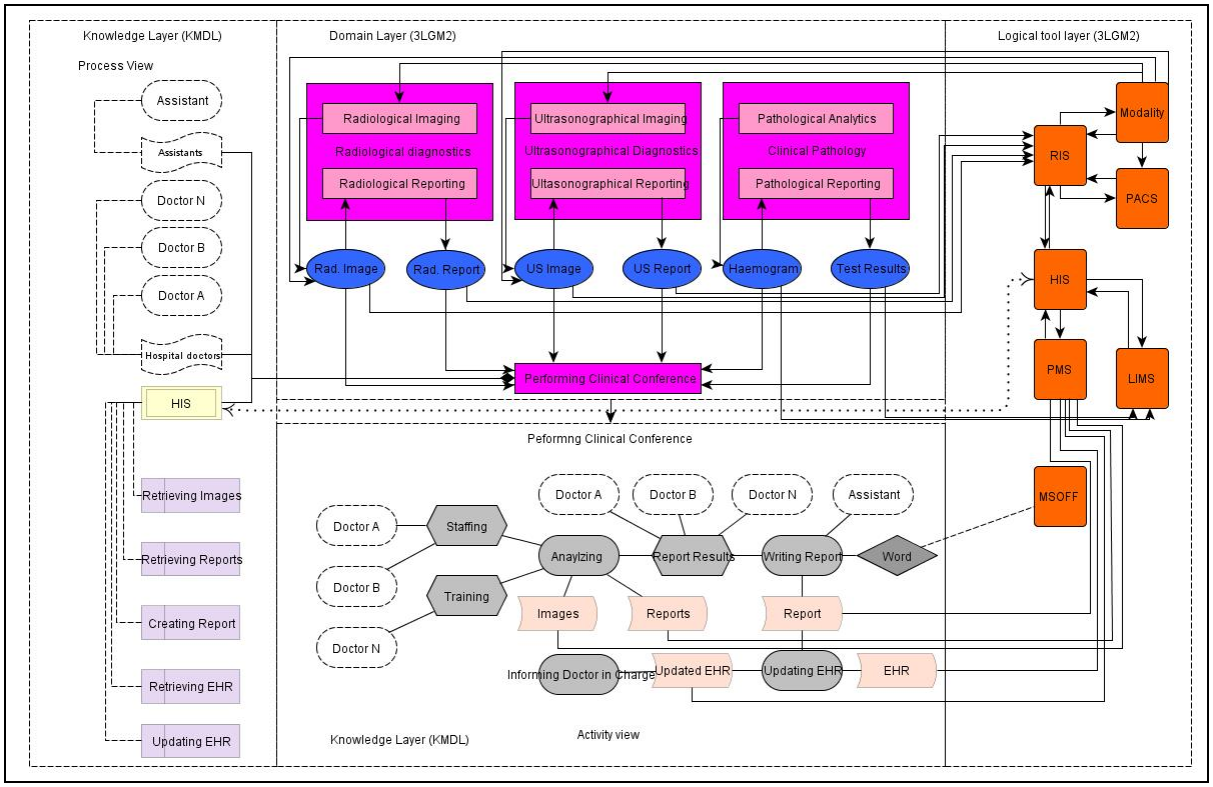

Figure 3: Ideal-typical Clinical Conference

4.1. Context EMS

The combined 3LGM^2-KMDL® approach will be used to model emerging knowledge processes during the foundation period of the EMS and UMO. This is essential because in previous studies regarding a hospital which now is participating the UMO, there was a gap between identified knowledge processes and the connection to the technical infrastructure [Rölker-Denker, 2010] [Rölker-Denker et al., 2011].

One main research topic of the EMS will be health services research. By using the combined 3LGM^2-KMDL® approach it will be possible to analyse the influence of knowledge processes on patient treatment. Another goal is to identify knowledge processes between the participating UMO hospitals.

5. CONCLUSION

Knowledge processes in context of learning HCO and the modeling approach combing 3LGM^2-KMDL® are useful in ideal-typical settings. It is possible to connect more meta-oriented knowledge processes with concrete roles and IT systems. This is helpful for the understanding of learning organizations.

The goal of further work will be to prove the usability in real health care environments. Focus will be on inter-organizational knowledge processes between connected HCO. Objects of interest will be the new founded EMS and UMO. This future work will be conducted by further studies with focus on employee questionnaires regarding their individual organizational learning experiences and by studies with focus on health services research.

REFERENCES

[Gronau & Fröming, 2006] Gronau, Norbert, & Fröming, Jane. 2006. KMDL® Eine semiformale Beschreibungssprache zur Modellierung von Wissenskonversionen. *WIRTSCHAFTSINFORMATIK*, 48, 349–360. 10.1007/s11576-006-0080-4.

[Hislop, 2009] Hislop, Donald. 2009. *Knowledge Management in Organizations. A critical Introduction*. Oxford University Press: New York.

[Nonaka & Takeuchi, 1995] Nonaka, I., & Takeuchi, H. 1995. *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation.* Oxford University Press.

[Rölker, 2007] Rölker, Lars. 2007. *Das Krankenhaus als lernende Organisation : Unterstützungsmöglichkeiten durch eLearning und Lern-Management-Systeme*. Diploma thesis, Carl von Ossietzky Universität Oldenburg.

[Rölker-Denker, 2010] Rölker-Denker, Lars. 2010. Hospitals as Learning Organizations. *In: Proceedings of the IADIS International Conference e-Health.*

[Rölker-Denker, 2011] Rölker-Denker, Lars. 2011. Environmental Management Systems In Learning Organizations In Health Care. *Pages 389–395 of:* Golinska, Paulina, Fertsch, Marek, & Marx-Gomez, Jorge (eds), *Information Technologies in Environmental Engineering*. Environmental

Science and Engineering, vol. 3. Springer Berlin Heidelberg. 10.1007/978-3-642-19536-5_30.

[Rölker-Denker *et al.*, 2011] Rölker-Denker, Lars, Eichelberg, Marco, & Hein, Andreas. 2011. The organizational learning cube. Adopting the data cube model for analyzing organizational learning in healthcare organizations and networks. *Pages 152–159 of:* Kioulafas, Kyriakos, Gallos, Parisis G., & Lenotis, Dimitrios M. (eds), *Proceedings of 9th Internationl Conference On Information Communication Technologies In Health*. National and Kapodistrian University of Athens, Greece.

[Wengelowski, 2000] Wengelowski, Peter. 2000. *Entwicklung organisationalen Lernens. Ein Lenkungsmodell*. Deutscher Universitätsverlag.

[Winter & Haux, 1995] Winter, A., & Haux, R. 1995. A Three-Level Graph-Based Model for the Management of Hospital Information Systems. *Methods of Information in Medicine*, 34(4), 378–396.

[Winter *et al.*, 2003] Winter, Alfred, Brigl, Birgit, & Wendt, Thomas. 2003. 3LGM2: Methode und Werkzeug zur Modellierung von Unternehmensarchitekturen im Krankenhaus. *In:* Schelp, Joachim, & Winter, Robert (eds), *Proceedings der Frühjahrskonferenz 2003 des GI-Arbeitskreises Enterprise Architecture*. Universität St. Gallen, Institut für Wirtschaftsinformatik.

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