

# Activity-Driven Needs Analysis and Modeling in healthcare information systems development

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## Abstract

Healthcare is networked, multiprofessional and cooperative work where information systems are used as means to manipulate, store and share critical and sensitive information within the work tasks of the different professionals. The changes in information systems cause changes in the work practices as well. It is important to understand the work activities where the information system will be embedded. However, the traditional information systems development (ISD) approaches are technically oriented instead of work oriented. Especially the starting point of any development project is often fuzzy and without methodologies and guidance. The research objective is to provide theoretically based, practically adaptive methods for the early phases of work oriented ISD in user organizations.

Activity-Driven Needs Analysis and Modeling was studied and developed as an integral part of larger research of Activity-Driven (AD) ISD approach. The previous research results utilizing Activity Theory and Developmental Work Research in ISD were taken as materials to be tested and developed further in iterative research cycles. Participatory action research, case study, and constructive analysis were the main forms of the research. The empirical studies were carried on in healthcare organizations in Finland, China and Mozambique. Empirical data were gathered from the participating organizations e.g. by group and individual interviews, workshops and brainstorming sessions. Multiprofessional and multidisciplinary research groups, including “lay” healthcare professionals, have been involved to the research.

The research produced knowledge about the nature of ISD in the participating organizations and methodological knowledge for supporting the starting point situations. Activity-Driven Needs Analysis and Modeling was developed and tested; and related to mainstream methodologies, e.g. process modeling. The results of this research mainly focused on improving the applicability of the approach and the means for analysis and modeling. Specifically, the results show that the ADNA and AD Modeling fit for the starting point analysis in healthcare organizations: capturing the essence of the work activities and the information needs of the different actors within work activities, including the need for information sharing between the individuals and work activities.

**Keywords:** information systems, systems analysis, modeling, organizational aspects, health care, Activity Theory

## Introduction and background

Healthcare is a complex and multifaceted domain of activity: multi-professional, cooperative, networked and dynamic workflows of several kinds of experts using sensitive and critical information within their working tasks [1]. Typically, several organizations (e.g. public and private hospitals, primary and secondary care) may be involved to a patient's care chain. Information systems are used to store, manipulate, and mediate the information necessary for taking action within the care process. The work activities set the needs for information and information systems.

Healthcare information systems are found as a typical large-scale system, where the scalability of modeling, abstraction, and analysis techniques are critical [2], and use of applications of socio-technical theory is beneficial in developing the systems [1]. In this paper, socio-technical view is used. Information system is an entity which includes both people, processes and artifacts [3].

New ICT is one of the most common sources of change at work [4]. In addition to the articulation of the needs for a new system, the possible changes in the work system also have to be estimated and the necessary actions planned. Furthermore, the starting point of any development project is often fuzzy and without methodologies and guidance [e.g. 5]. Relevant information for making decisions as to whether "to go or not to go", or where deeper analysis is needed, should be captured rather quickly.

For all the apparent need for considering work development activities together with information systems development, the existent information systems and software development methodologies tend to be neglecting such interlinking. The mainstream methods for developing information systems [e.g. 6,7] have technical focus. Socio-technical approaches consider both human and technical systems together [3], but some of them also are argued to "handle development of work and IT as activities separated in different environments" [8]. Thus there is a mismatch between the methodologies and the actual need for methodologies in user organization ISD, especially in the starting point.

The Activity Driven (AD) approach to ISD belongs to the socio-technical category. The basic concepts of AD approach originate from Activity Theory [9], the Activity Analysis and Development (ActAD) framework [4], and Participatory Design [10]. The approach emphasizes the information needs of the work activities in case, in contrast to the technological emphasis, and provides the basis for work oriented ISD [4,11-13]. However, further steps to prove the practical relevancy of the theoretical roots were needed [11].

In this research, the objective was to respond to the need for *methodological support for work oriented ISD in user organizations*, especially concerning *the early phases of ISD*. The organizations were studied in order to understand the needs for methodological support. The AD approach was taken under study as an approach to be developed further.

This paper summarizes the research. This section presents the research problem and objective. Section 2 presents the research context, methods and materials. Section 3 summarizes the results and refers to the detailed results respectively. Section 4 provides discussion on the results in relation to overall development of the AD approach, and potential future research.

**Research context, methods and materials**

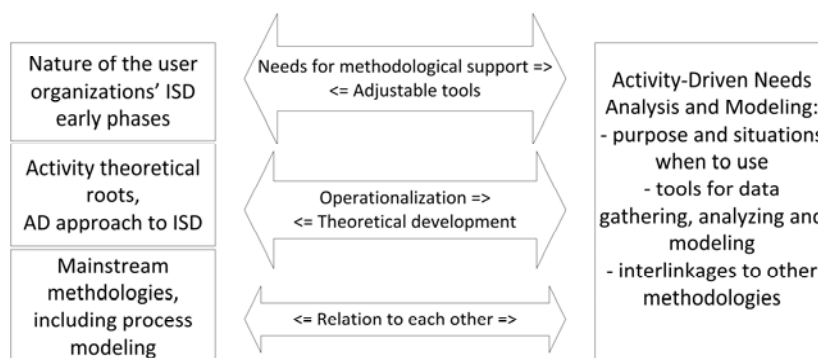
The research spanned four large projects and mainly healthcare organizations provided the context for the empirical studies. Particularly home healthcare, maternity care, and cross-organizational care chains were in the focus. The empirical materials were gathered in the following four applied research projects: ZipIT (2004–2007), China-Finland eHealthPartnership (2007–2008), SOLEA (2009–2011), and INDEHELA Education (2010).

The main concepts under study, the user organizations’ viewpoint to ISD, the early ISD phases, and the method development for Activity-Driven Needs Analysis and Modeling, were researched in relation to each other. The cumulative results were gained through several action research cycles. In action research, the empirical results and theoretical considerations form an inseparable dialectic relationship [14]. The research cycles included reflection between theory building and empirical testing, and interaction between researchers and practitioners. Each phase included planning, doing and evaluating the research. Participatory action research, case study, and constructive analysis were the main forms of the research, and interviews, workshops and brainstorming sessions were the main methods for empirical data gathering.

The empirical studies were carried on in healthcare organizations in Finland, China and Mozambique. Multiprofessional and multidisciplinary research groups, including “lay” healthcare professionals, have been involved to the research. The empirical research materials include data sets from the interviews, field notes, workshop notes and presentations, oral recordings, and collaborative research diaries.

**Results**

The research produced knowledge about the nature of ISD in the participating organizations and methodological knowledge for supporting the starting point situations. Activity-Driven Needs Analysis (ADNA) and Modeling, as an integral part of the development of the AD approach to ISD, was developed and tested to support the starting point analysis, and related to some mainstream methodologies (Figure 1). The next sub sections present the main results described in more detail in [15] and other publications.



**Figure 1.** The summary of the results.

***The early phases of User Organizations’ ISD***

In user organizations, the ISD activities are most often related to acquisition process of new software to be integrated to existing legacy system or Enterprise Architecture (EA) development [15]. There is a need for methodolog-

ical support for the starting points of the different sub-activities that form the ISD process and enterprise architecting, instead of only at the starting point of a major ISD process. The empirical research confirms that at least a feasibility study, implementation, deployment, and training [16], enterprise architecting [17], and even process modeling [18] are activities in which some preliminary overview should be established, so that the actual phase could be planned on the basis of the shared understanding of the situation and the goals.

The shared understanding needs to be build amongst the different stakeholders participatively, including healthcare professionals, managers, and IT experts [15, p. 56–61]. Cooperative work activities, and activity networks must be the in the focus in the starting point, instead of details of ICT. The models should facilitate the cooperation; that is, they should be understandable for the participants. Furthermore, the models should facilitate interlinkage and traceability in several dimensions: time, granularity, and between items belonging to separate EA sub-architectures.

The question of the applicability of the AD approach was iterative addressed by applying the theoretical knowledge in practical use [e.g. 19], by applying previous research results and experiences in different cultural contexts [e.g. 16,17] and by researching the teachability of the approach [20]. The practical learning experiences were mirrored back to the theory. The results of the iterations supported the participant organizations (case based reports, see e.g. [www.uku.fi/zipit](http://www.uku.fi/zipit)), and contributed to the method development.

### ***Activity-Driven Needs Analysis and Modeling***

ADNA and Modeling emphasizes cooperative sessions with participants from the work activities that are to be modeled. The ActAD framework gives the activity-theoretical basis for the structure of analysis and modelling the target domain. In applications, the general terms of the framework are to be replaced with the specific terms in the target domain. The essential elements are selected depending on the situation. AD tools that were created are the concrete instances of such applications, including tables, question lists, and templates (e.g. storytelling), as well as structured and illustrative but still informal diagrams. The rich examples are provided in, e.g., [15,19,21,22]. AD tools can be used in the modeling activities, for data collection and analyses, as well as means of communication between the different stakeholders.

The tools are structured on three levels: activity network, work activity, and individual actions, following the structure of AD ISD Model [19]. A phenomenon on a lower level model can be localized on the next level up in order to see the “zone of effect”. For example, if an action of an individual worker is changed in his process, how will it affect cooperative work, or, further, the networked level of activity? This is a necessary feature in order notice the solutions which will ease the work of one individual but will have negative effects on the holistic level.

Despite the admitted shortages [18,23], process modeling is a common way of obtaining information about the functionality of an organization and is used in relation to both ISD and EA. Therefore, the interlinkage between AD Modeling and traditional process modeling is important one. The relation of AD modeling and mainstream approaches, including traditional process modeling was defined in [23], and an activity-theoretical framework for understanding and improving the process modeling activities was created [23]. AD modeling was interrelated to process modeling with a six-level framework for modeling [22], and situated mainly on the context and overview levels, while traditional process modeling methods are used in the more detailed levels.

## Discussion and conclusions

The broad research objective to develop the AD approach as a work oriented ISD approach has been addressed by joint efforts of several people in the research group. The three-leveled Activity-Driven ISD Model [19] was created in ZipIT-project, and its theoretical underpinnings were defined in [24]. The definition of the AD approach and a summary of the development is provided in [25]. AD Methods for interaction design methods [26], and AD information analysis [27] have been researched.

The results of this research (Section 3), mainly focused on improving the applicability of the approach and the means for analysis and modeling. ADNA and AD Modeling promotes a quick starting point analysis that clarifies the essence of a target area: starting the analyses with the work activities and supports modeling the linkage between work and the information that is needed to conduct the tasks. This is important aspect of a methodology for developing work and information systems together.

The results that relate AD Modeling and process modeling provides basis for further research on adapting the approach in Enterprise Architecture purposes.

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