Context Sensitive Health Informatics: Human and Sociotechnical Approaches
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How to Co-Develop Services, Work, and Information Systems in Healthcare: The Daisy Approach

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Abstract. Information systems in healthcare need to be designed and developed in a collaborative way. However, existing collaborative methodologies for the parallel development of healthcare work and information systems are vague and fragmented. Furthermore, they neither address people-centred healthcare nor limited-resource contexts. In this paper we introduce an emerging holistic approach, based on a unifying theoretical basis, for co-developing the services, work and information systems in healthcare. The approach intends to (a) be collaborative in nature; (b) address the domains of both healthcare professionals and ordinary people / communities; (c) span the main analysis and design tasks of socio-technical information systems development from needs assessment through requirements setting to functional-architectural solutions; (d) be contextually sensitive; and (e) be practicable in "real life" beyond research settings.

Keywords. Human activity, work activity, everyday life activity, community, socio-technical information systems, needs analysis, modeling, collaborative design, information systems development, ICT for development.

Introduction

Information is a critical tool for healthcare professionals in their daily work of providing care. When information systems (IS) in organizations are seen as socio-technical systems of people working together and using technologies for a purpose [1, 2], it has become widely recognized that work flows and information flows in healthcare must be developed in par with the software systems that are supposed to facilitate the healthcare work. Such development is not possible without active collaboration between healthcare professionals and systems professionals (left-hand half of **Figure 1**). However, existing collaborative methodologies for the parallel development of healthcare work and information systems are vague and fragmented [3].

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The emergence of "patient centred", "consumer centred", "citizen centred", or – more generally – people-centred healthcare models [4] has even broadened the need for collaboration. In those perspectives, the starting point is ordinary people's needs for appropriate health-related services, facilitated by information technology. These should also be developed in a collaborative manner (right-hand side of Figure 1). However, collaborative methodologies for people-centred IS are even less existent.

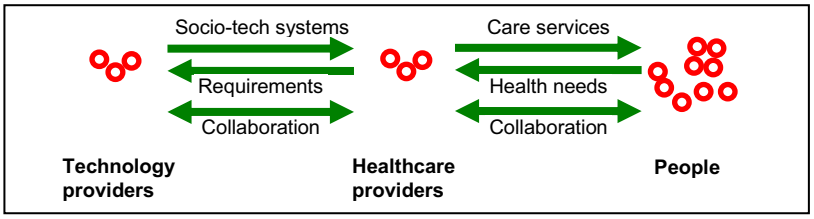

Figure 1. The main stakeholders and relations in information systems development in healthcare.

All the above is even more challenging in limited-resource contexts e.g. in Africa, where it is very explicit that information and communication technologies (ICT) need to contribute to human development, e.g. to community health [5].

There is a great need for *holistic approaches* – portfolios of methods based on a unifying theoretical basis – on the analysis, design and development of health information systems which (a) are *collaborative* in nature; (b) address the domains of *both healthcare professionals and ordinary people* / customers / communities; (c) *span the main analysis and design tasks* of socio-technical information systems development from needs assessment through requirements setting to functional-architectural solutions; (d) are *contextually sensitive*, i.e. applicable in both resourceful and limited-resource contexts as well as in different socio-political, cultural and organisational settings; and (e) are *practicable in "real life"* beyond research settings.

In this paper we introduce interlinked research areas towards such a holistic approach for co-developing the services, work and information systems in healthcare.

1. Materials and Methods

The approach presented in this paper has resulted from long term research and development since the early 1990s. Cases in Finland, China, South Africa, Nigeria and Mozambique provided the empirical material for the methodological development [3].

Action research [7] in two national projects in Finland was used for experimenting with specific methods and for producing a comprehensive model and methodology. Theoretical foundations for the approach were developed on the basis of Activity Theory [8]. Contextual sensitivity was studied in projects in China and Africa. Real-life applicability has been tried in commercial settings [6].

2. Result: Holistic ISD approach

The proposed holistic information systems development (ISD) approach for developing IS-supported healthcare services (Figure 2) is a "daisy" of integrated methodologies for (1) understanding the *contexts* of healthcare providers, healthcare "consumers" and

technology providers; (2) understanding the needs arising from the everyday life activities of *healthcare "consumers" in communities*; (3) understanding the needs arising from the work activities of *healthcare professionals*; (4) defining *architectural-level requirements* for information-technological solutions that address the needs; and (5) co-designing the *interaction and usefulness requirements* of the required solutions.

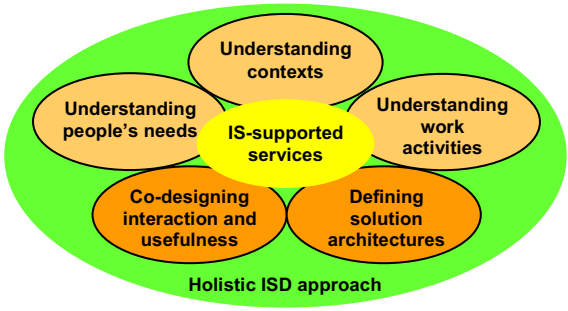

Figure 2. The "petals" of a holistic approach for developing IS-supported services.

The three top "petals" deal mainly with *analysing* the *present state* of people's lives, healthcare work, health-related services and the socio-technical information systems involved (phase 1 in Figure 3), but also with *designing* an aspired *goal state* (phase 2 in Figure 3). The two bottom "petals" deal with how to proceed from the blueprint of a goal state towards realising the information-technological solutions required by it (part of phase 3 of Figure 3). They produce inputs to software development professionals for technologically implementing the software artefacts required in the goal state.

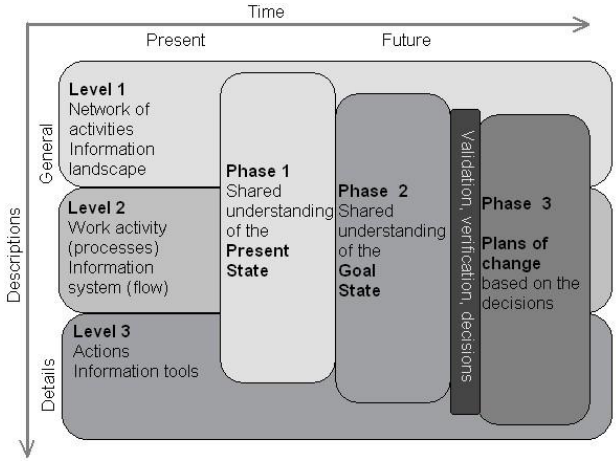

Figure 3. The levels and phases of the Activity-Driven ISD model.

All the "petals" are based on collaboration between systems developers, systems users and "systems beneficiaries" – co-analysing and co-designing. Many "sepals" of commonplace methods of analysis and design are also required. The "daisy" covers the ISD part only, interfacing with but not overlapping the software engineering part.

2.1. Understanding contexts

Understanding the context of a would-be information system is the basis for developing systems that fit their users' needs. The contexts of the stakeholders differ from each other, but the stakeholders do not perceive the differences. Thus it is not sufficient to understand the context of the IS users only, but the contexts of all the three main stakeholders identified in the introduction (Figure 1).

We have developed the LACASA model for context analysis. It differentiates between the *levels of context* – the individual, group, organisational and societal contexts of the three main stakeholders. At each level it identifies major *categories* of contextual factors – technological (infrastructure), human (people), socio-political etc. The factors arise from different *scopes* – natural environment, human cultures, historical developments, or the occasional immediate surroundings [9].

2.2. Understanding the everyday life activities and needs of individuals, families and communities

We see people's *life activities* as a key concept that links individuals with each other and with collective structures like families, households and communities. We have applied that lens in analysing health and wellbeing related information management of families with small children and in developing a life activity-driven information analysis method for personal ubiquitous health and wellbeing systems [10, 11].

In addition to such "objective" analysis, it is important to understand people's "subjective" everyday social and symbolic realities. That perspective is important for understanding not only people of the public, but also healthcare professionals. We have explored methods for such analysis in evaluating an existing IT supported maternity care service from the mothers' everyday life perspective and in making visible how maternity care nurses and midwives experience the interactions between their daily information work practices and the technologies they use [12].

2.3. Understanding the work activities and needs of healthcare professionals

For developing healthcare work in par with the software systems that are supposed to facilitate it, the starting point of course is to understand that work. Similarly to the everyday life activities of people in the public, we recognise *work activities* as the key concept that links the actions of individual healthcare professionals with each other. We regard a work activity as the systemic entity of purposeful, cooperative human action, where several actors work in an organized way upon a shared object of work to transform it into an intended outcome, by using different kinds of means of work and means of cooperation and coordination. The intended outcome forms the purpose (motive) of the activity. Information entities, information tools, and information systems are used within work activities alongside with other means of work and means of cooperation and coordination [6].

We have developed an approach for IS needs analysis and development that takes work activities as its starting point; the Activity-Driven ISD model. It provides frameworks and tools for understanding the everyday work activities and the information needs within the activities. It combines three integrative levels (individual actions, group activities, and networks of activities), and three phases

of development (current state analysis, goal state analysis, and planning the changes) (Figure 3) [6, 8, 13].

At each level of analysis, there are various analytical models and tools like diagrams, tables, question lists, examples, and templates for gathering, modeling and describing relevant information for the parallel and integrated development of work and IS (Figure 4) [13].

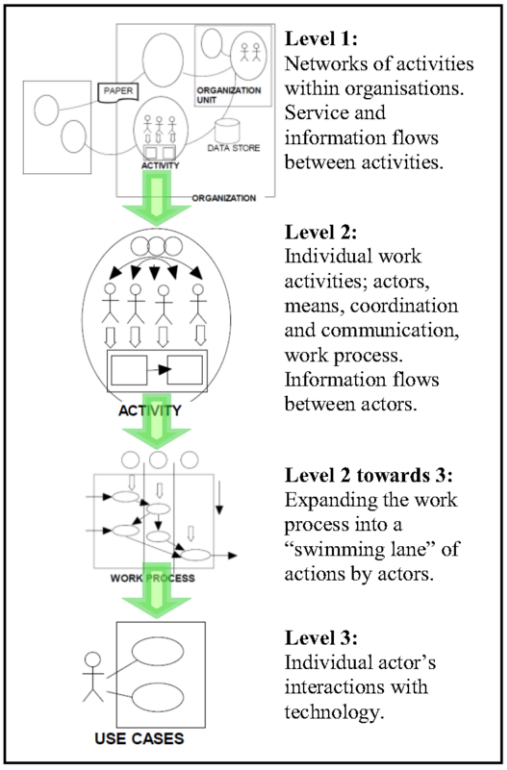

Figure 4. Models for analysis at levels 1-3.

2.4. Defining architectural-level requirements for information-technological solutions

Moving from the present state to the goal state jointly defined by the stakeholders is a holistic change, usually requiring organisational changes, training, etc. Usually some previously unavailable information technology also needs to be introduced. Not *all* technology will be new, but rather the existing "information infrastructure" is partly replaced, partly supplemented by new bits and pieces (software artefacts, IT systems).

There is thus a need to describe the current information infrastructure and the goal infrastructure, and specify the new bits that are required. The bits can then be procured as commercial-off-the-shelf products or purposely developed to fit the need.

This "petal" of our approach is still fragmentary. We have studied methods to develop shared understanding of the information-technological solutions; activity-driven methods for specifying the information architecture; and methods for describing the essential-only aspects of the existing infrastructure [11, 14].

2.5. Co-designing the requirements for interaction and usefulness

When new software artefacts or IT systems need to be purposely developed, or existing ones radically re-developed, the needs of the system users and "system beneficiaries" in the goal state must be made explicit enough for the system developers.

Contrary to commonplace usability methods, the holistic development of work and IT systems require, however, that the starting point is the group-level work activity (level 2 of Figure 4) which determines the goals of the individual-level actions. The usefulness is determined at the level of the daily "swimming lane" of an actor.

We combine existing participatory methods of co-designing the user interaction and user experience with domain expertise, deep understanding of the work processes of healthcare workers, design expertise, the activity-level perspective, and the use of simple prototypes to illustrate the not-yet-existing IT artefact. The commonplace set-up of participatory IS design, involving IT professionals and end-users, must be enlarged into a triad involving design experts also as "mediators" [15].

3. Discussion

Regarding criteria (a)-(e) stated in the introduction, the proposed holistic ISD approach is entirely *collaborative* in nature; all the analytical and design-oriented "petals" are based on collaboration between healthcare professionals, ordinary people, communities, systems professionals and/or design experts, depending on who are the stakeholders.

The approach contains a "petal" that specifically addresses the work and needs of *healthcare professionals* and another one that addresses the life and needs of *ordinary people* as individuals and as communities. Two "petals" deal with the *needs assessment* tasks of socio-technical information systems development. Both of them deal also with *setting the requirements* for the goal state of work, services and information infrastructure. One "design petal" focuses on identifying the *architectural aspects* of the information-technological solutions in the goal state, while the other one focuses on specific *interaction and usefulness requirements* for the required software artefacts.

The approach contains methods for *contextual analysis* that make it applicable in different socio-political, cultural and organisational settings, particularly both in resourceful contexts and in limited-resource contexts. Finally, the approach has been developed in action research settings, but there is already scattered evidence of using it in *"real life" practice* where researchers are not involved.

4. Conclusion

All in all, we argue that the proposed holistic ISD approach is a good step forward from currently existing, technologically oriented or fragmented ISD methods, as measured against the criteria (a) to (e) set forth in the introduction.

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