

eHealth-extended Care Coordination: Development of a Collaborative System for Inter-municipal Dementia Teams

A research project with a user-centered design approach

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Abstract—In Norway, a health reform was recently adopted to improve continuity of care. Services that were carried out in hospitals were transferred to municipalities. Small and medium size municipalities have established inter-municipal cooperation to provide specialized services across borders. The research project *eHealth-extended Care Coordination* studied the inter-municipal cooperation for assessment of dementia, identifying a need for improved communication and coordination. This paper presents the development process of a collaborative information system for dementia assessment using a user-centered design approach. Mixed methods, such as observations, semi-structured interviews and questionnaire, were used for data collection. The results showed that end-user involvement usefully informed the development. The information system effectively supported collaborative work and shared access to information for the inter-municipal team.

Keywords—User-centered Design; Usability; Inter-municipal Cooperation; Dementia Assessment; Health Information System

I. INTRODUCTION

Health care services are provided by organizations where information systems play an important role for coordination and collaboration within and between their members. In Norway, the health authorities addressed the need for continuity of care for citizens across the established organizational borders of health care services. The Coordination Reform [1] was adopted with the aim of enhancing *adequate treatment at the right time and right place*. As a consequence, services that traditionally were carried out by specialized health care services (e.g., hospitals) were then transferred to primary health care provided by municipalities. Due to the large number of small (less than 5000 inhabitants) or medium (between 5000 and 20000 inhabitants) size of municipalities in Norway, the challenge of providing specialized health care services to citizens by local institutions required structural and organizational changes [2]. In order to

improve capacity, competence and quality, many municipalities have established inter-municipal cooperation (IMC) with specialized health care teams carrying out specialized health care services, such as assessment of the cognitive disorder dementia [3][4][5] in neighbor municipalities.

However, a recent Delphi study [6] with experts in coordination and IMC in health care services, reached consensus about the challenges concerning electronic communication. Specifically, the lack of available tools impeded the coordination and collaboration in health care services. This brought to light the need for available information and communication technologies (ICT) tools that support effective coordination and collaboration across organizational borders.

In this context, the research project *eHealth-extended Care Coordination* (Samhandling uten grenser) 2011-2015, focused on the communication and information flow of an inter-municipal dementia team based on the organization of IMC. The project was divided into four phases, already presented in [7][8][9].

This paper reports from the overall user involvement throughout the entire project, where representative end-users participated during all its phases.

The two research questions (RQ1, RQ2) of this study were:

RQ1: *How can an information system be developed taking into account the needs and requirements of the end-users for collaborative access and information sharing in an inter-municipal team?*

RQ2: *What lessons and methodological procedures from this study are transferable and applicable to the development of technological solutions for other clinical assessment workflows?*

II. RESEARCH BACKGROUND

Health care services are complex organizations by nature, integrated by multiple and diverse user groups interacting between them. ICT are present in the majority of processes carried out in clinical environments, such as communication between peers, storage and process of information, and support for decision-making procedures. Development of efficient information systems requires detailed analysis of end-user groups' needs, preferences and suggestions to inform system design. User-centered design (UCD) [10][11][12][13][14] involves end-users throughout the entire development cycle, describing the context of use and user requirements. These are all key elements for building and continuously using over time new information systems. Through iterations in the development phases, users participate in usability evaluations and contribute to potential refinements. The aim of a usability evaluation [15][16][17] is to analyze user's interaction with the system and the user satisfaction. In addition, for adoption and user satisfaction purposes, the usability aspects of ICT are crucial for continuous and efficient use of technological solutions.

III. METHODS

Qualitative methods were used in the research project *eHealth-extended Care Coordination* for data collection and analysis. The data collection in the UCD process was executed from November 2011 until June 2015. The project had four phases, see Figure 1. The project phases comprised from the initial end-user requirement elicitation phase until final deployment of the collaborative information system. The new system was intended to provide a platform to facilitate the communication and information flow across municipal borders.

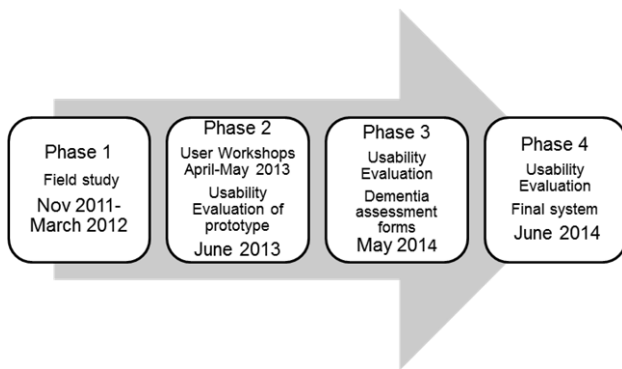


Fig. 1. The four phases of the project *eHealth-extended Care Coordination*.

A. Participant Selection

In the participant selection, all participants had to work in inter-municipal dementia team based on IMC organization. In total seven members of the inter-municipal dementia team participated in project phases two, three and four. They were five female and two male participants, aged 25-58, see Table I for the participant distribution. They reported an average of 12.7 years of experience using clinical systems and evaluated their computer skills as *medium*, except one with *good* skills.

TABLE I. END-USER PARTICIPATION

End-users n=7	Project Phases			
	Phase 2 User workshop n=2	Phase 2 User test n=5	Phase 3 User test n=4	Phase 4 User test n=5
Team Coordinator	x	x	x	x
Nurse 1	x	x	x	
Nurse 2		x	x	x
Nurse 3			x	x
Nurse 4				x
Physician		x		
Social Educator		x		x

B. The Research Team

The research team was composed of six people in total, see Table II for the participation in the different project phases. They had background on health informatics and human-computer interaction, all with working experience in health and technological environments.

TABLE II. RESEARCHERS' PARTICIPATION

Researchers n=6	Project Phases				
	Phase 1 Field study	Phase 2 User workshop n=2	Phase 2 User test n=4	Phase 3 User test n=4	Phase 4 User test n=5
Project leader and Professor		x	x		
Associate Professor	x		x	x	
Assistant Professor					x
Postdoctoral Research Fellow				x	x
PhD Research Fellow	x		x	x	x
PhD Research Fellow		x	x	x	x

C. First Project Phase

In the first project phase, a field study was conducted in an IMC consisting of four municipalities, focusing on the information flow and collaborative processes. Observations and interviews were made by the research team with the inter-municipal dementia team that was responsible for carrying out dementia assessment. The observations were annotated by the involved researchers and the interviews were audio-recorded.

D. Second Project Phase

In the second project phase, members of the inter-municipal dementia team participated in two user workshops, in order to define end-users' needs, preferences and suggestions for the development of a functional prototype for a collaborative information system. The user workshops were held to understand the context of use and the workflow for dementia assessment in inter-municipal dementia team. In addition, these workshops allowed collecting user requirements for the

development of the initial functional prototype. When the first version of the interactive web-based prototype had been developed, a usability evaluation took place with five members of the inter-municipal dementia team. The evaluation was performed in the Usability Laboratory of the Centre for eHealth and Healthcare Technology at the University of Agder, Norway. The details of the technical infrastructure are further described in [18]. The usability evaluation followed a Think Aloud (TA) protocol [15][16][17][19] and entailed several tasks. To score user satisfaction, the questionnaire System Usability Scale (SUS) [20] was individually filled in by each participant. Group interviews were made after the evaluations in order to qualitatively complete the feedback. The user workshops and usability evaluation were audio-video recorded. The group interviews were annotated by the research team.

E. Third Project Phase

In the third project phase, electronic dementia assessment forms, (e.g., Mini-Mental State [21]) to be used in home visits by the inter-municipal dementia team, were developed based on user needs identified in the user workshops of previous phase. A usability evaluation of the electronic dementia assessment forms was made together with test of a videoconference solution for shared documents visualization in the Usability Laboratory. The videoconference solution was used to test collaborative dementia assessment report writing with participants located in different municipalities. The usability evaluation had four test participants and used a TA protocol. After the evaluations, group interviews were made to complete the feedback. The usability evaluations and group interviews were audio-video recorded.

F. Fourth Project Phase

In the fourth project phase, the final version of the collaborative information system was developed by a project partner (Devoteam AS in Grimstad, Norway) and deployed within the secured Norwegian Health Network (NHN) [22]. A usability evaluation with a TA protocol was carried out in the Usability Laboratory together with five members of the inter-municipal dementia team in order to validate whether the system accomplished acceptable levels of effectiveness, efficiency and satisfaction. After each task, participants were asked to score the task solving. After all the tasks were solved, the SUS questionnaire was individually filled in. Semi-structured post-test group interviews were made. The usability evaluations and group interviews were audio-video recorded.

G. Data Collection

All three usability evaluations and the group interviews in phases three and four were recorded from two independent cameras (one fixed, another portable). The audio-visual data from the cameras and a screen capture tool (used in usability evaluations) were merged into one single video file using the software Wirecast v.4.3.1 [23]. The purpose was to ease the data analysis, having just one file including multiple video perspectives with a single audio channel. The recordings (.mov video file format) were imported into QSR NVIVO 10 [24]. The audio- and video recordings were transcribed verbatim by

members of the research team and the transcripts were coded into categories for a qualitative content analysis [17].

H. Ethical Considerations

This study was approved by Norwegian Social Science Data Services [25] with the project numbers: 28027 and 37920. All participants received oral and written information about the project and confidential treatment of the collected data. All participants signed a consent form and the participation was voluntary. Participants were aware that they could withdraw at any time without reason. In this case, their data would be consequently destroyed.

IV. RESULTS

The results are presented following the four phases of the UCD process.

A. First Project Phase

The field study identified that the inter-municipal dementia team faced challenges such as limited information flow across the borders of the municipalities and interoperability problems between different information systems. Due to legislation, the dementia team members did not have access to information systems outside their own municipality. One of the main conclusions of the field study was the need for a collaborative information system with shared access between the municipalities to improve the information flow and coordination within the inter-municipal dementia team.

B. Second Project Phase

In the workshop, the end-users described their current clinical workflow of dementia assessment and how the user interface (UI) of a collaborative information system would best fit into their work processes. The outcome of the workshops creatively informed the design of the working interactive prototype, which was qualitatively usability tested. The results of the usability test identified several graphical issues, but it showed that overall the UI effectively and efficiently supported the work processes of the inter-municipal dementia team. The SUS questionnaire scores indicated a sufficient level of satisfaction among the end-users. In the group interviews, the users suggested to make individual usability evaluation, but also a group evaluation in order to analyze the system from a multi-personal perspective. They also suggested having in advance the opportunity to get familiar with the system through self-exploration before the usability test. This would save time to test participants and would allow them to provide more reflective comments during the post-test interviews.

C. Third Project Phase

The usability evaluation of the electronic dementia assessment forms showed that the digital version of the forms would help to reduce the paper load in the dementia assessment process. In addition, it would allow members of the team to have multiple accesses to the forms for retrospective amendments and reviews. The test of videoconference with shared document visualization between two municipalities was reported to be an effective and satisfactory tool to

cooperatively work on the final report of the assessment between the members of the dementia team.

D. Fourth Project Phase

Based on the outcome of project previous phases, the final version of the collaborative information system was developed. The findings in the usability evaluation of the final system identified graphical issues that needed refinements. All participants successfully solved all the tasks during the tests. The scores of the SUS questionnaire showed sufficient level of user satisfaction. In the group interviews, participants positively evaluated the participation in the UCD process. They found the test situation interesting, but not easy to score the difficulty of task accomplishment. For further evaluations, they suggested user training in advance or some time for self-exploration, in order to get familiar with the system and be able to provide more reflective feedback. Even though some tasks were not straight forward to solve, they evaluated the system as easy to navigate within. Due to their experience with other clinical systems, they recommended to have as few actions (e.g., mouse clicks) as possible while interacting with the system.

V. DISCUSSION

This paper has presented the UCD process for the development of a collaborative information system for an inter-municipal dementia team. Health care information systems typically involve multiple users in number and type. The involvement of those groups of end-users in the design of a new technical system is crucial to understand the clinical workflow where the solution will be deployed, its context of use and the interactions involved. The two research questions (RQs) formulated at the beginning of this paper are answered below based on the results from the study.

About the RQ1, which asked about how to take into account user needs and requirements in the development of a new collaborative information system, the involvement of end-users was the key in the development of the clinical system. The UCD approach divided the study into different phases. The first project phase consisted of a field trial, including observations and interviews to analyze the information flow and work processes in a dementia assessment. This gave the research team an in-depth understanding of the clinical workflow, allowing identifying the need for a collaborative information system that supported inter-municipal work. In the second phase of the project, the workshops with end-users provided an insight in the dementia assessment workflow. It drew a clear picture of how users would have liked to interact with the new system and integrate the new tool in their existing work processes. Users' suggestions about the UI practically informed the graphical UI design. The usability evaluation, questionnaire and interviews enabled the users to give useful feedback and first impressions about the graphical UI, functionality and interactions with the system. In the third project phase, the usability evaluation of electronic dementia assessment forms and videoconference enabled the users to test their own suggestions from earlier phases regarding an improved workflow. The fourth project phase that included usability evaluation, a questionnaire filling and interviews

regarding the final version of the collaborative information system, enabled the users to provide feedback about the graphical UI, functionality and user interactions. Overall, the iterative mixed methods approach efficiently took into account and considered user needs in the development of the system, and in line with previous research findings, elaborating on the importance of involving end-users throughout the development process [26][27].

About the RQ2 that asked about lessons and methodological procedures learned during the UCD process that could be transferable for the development of systems other clinical assessment workflows. Firstly, the development of health care information systems requires active and continuous involvement of the end-users in the design and evaluation of the solution. The mixed methods research approach was a sufficient model for the data collection in all the phases of the UCD process. Secondly, a lesson learned, was that the circumstances for the context of use and key requirements for the system gathered in an early project phase may change as the project evolves due to rapid development of other technologies and applications. A long time for system development should be avoided. Thirdly, new systems should support already existing work processes and integration of new systems with existing ones is vital in order not to increase the users' workload, which impacts on user acceptance.

The research study of the UCD process also had limitations such as a reduced number of end-users and user-scenarios tested in a simulated environment. However, the simulated test environment allowed creating highly realistic scenarios under controlled conditions and the test participants meaningfully represented the end-users of the system. In addition, in qualitative usability studies, a small number of participants can be sufficient for having valid results [28][29].

VI. CONCLUSION

This study was framed within the research project *eHealth-extended Care Coordination*, which aimed to study the communication and information flow in an inter-municipal dementia team. In order to provide a platform for communication and shared access to information, a collaborative information system was developed in order to improve the information flow between the members of an inter-municipal dementia team. This study focused on the user involvement in a UCD process, which included end-users' needs, suggestions and preferences in the design and evaluation of an information system. Positive results were reported after user evaluations regarding ease of use and user satisfaction of the collaborative information system. The user involvement in the development was the key to fully develop an information system suitable for collaborative work in inter-municipal teams.

In terms of future work, it is proposed to address research on integration of other clinical inter-municipal teams to the collaborative information system, with added decision support in the application.

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