

Health in Hand: Putting mHealth Design in Context

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Abstract—Wireless technologies, cloud computing and connectivity have enabled mobile services that extend the coverage of health services, resulting in a branch of eHealth now commonly referred to as mHealth. However, at least in Sweden, where the healthcare sector is heavily institutionalized and regulated, mHealth has so far mainly evolved in the form of applications for support of healthy life-style and self-management of chronic diseases, implemented outside of the firewalls of traditional healthcare delivery environments. In this paper we present an on-going Indo-Swedish research and development project in which we are putting mHealth design into context both from a patient's perspective and from the perspective of a healthcare team working within a professional healthcare organization. Our research approach is inspired by the Scandinavian tradition of Participatory Design of ICT and informed by studies of how to measure usability, user experience and impact of mHealth interventions. The involved research teams are multi-disciplinary, including researchers from engineering, computing and health sciences. The project includes, on the Swedish side, a partner from the public healthcare sector, three SME:s and an industrial partner who is currently providing Electronic Patient Record and other healthcare information system solutions and who is interested in developing mobile solutions for healthcare professionals. We are currently in the process of collaborative articulation and specification of problems, goals and requirements within the framework of the first Swedish case study of the project, focused on mobile support for patients with diabetes type 2 and their healthcare teams.

Index terms—Interaction design, mHealth, usability, accessibility, participatory design.

I. INTRODUCTION

Wireless technologies and connectivity have during recent years enabled mobile services that extend the coverage of health services, resulting in a branch of eHealth which is now commonly referred to as mHealth. Mobility and reduced location dependency in mHealth is further supported by cloud computing, which has introduced new ways of using computing resources. Both mobility and reduced location dependency are important for the effectiveness of healthcare delivery in an mHealth context. Location dependency here indicates the need for applying a dynamic interactive person-environment perspective, as location dependencies can considerably limit mobility. As we have discovered in our first Swedish case study, presented in the following, mobility of healthcare professionals may be reduced due to location dependency, e.g. in relation to distribution of and access to

medicine stock, medical tools and equipment, specialist knowledge and competence, as well as in relation to local security regulations and ID technologies and practices in healthcare organizations and built environments.

A third trend in current technology development which has implications for mHealth while at the same time contributing to bringing location and context of use back into focus, is the ongoing evolution of intelligent sensor-enabled environments and context-aware applications [1]. mHealth undeniably seems promising at a time when an unprecedented aging population worldwide [2] high-lights the need for innovative solutions for healthcare, home care and independent living solutions for people living with one or multiple chronic diseases. However, such solutions depend heavily on integrated technologies which can support people living with chronic diseases, their next of kin and informal care-takers on one hand, and teams of healthcare professionals and home care service providers on the other. In Sweden, where the healthcare system is highly institutionalized and regulated, mHealth has so far mainly evolved in the form of more or less stand-alone applications for support of healthy life-style and self-management of chronic diseases, well outside of the firewalls of traditional healthcare delivery environments.

In this problem statement paper we present experiences so far from the first Swedish case study within an on-going research and development (R&D) project in which we are putting mHealth design, usability, accessibility and user experience into context both from a patient's perspective and from the perspective of a healthcare team working within and across one or more professional healthcare organizations. Our research approach is inspired by the Scandinavian tradition of Participatory Design (PD) of ICT [3] [4]. It is also informed by studies of how to measure usability, user experience and impact of mHealth interventions [9] [10] [11].

In the following we first present the case study and some of the issues we are currently facing when it comes to specifying problems, goals and requirements in this context. Thereafter, we provide background information about the project and our multi-disciplinary approach. We are grateful for the insightful feedback from the three reviewers of the first version of our paper, which helped us get to the point.

II. SWEDISH CASE STUDY 1: A CLOSER LOOK AT CONTEXT

As the Indo-Swedish R&D project *Health in Hand* started in January 2014, we are still in the initial stages of the first Swedish case study, in which we are mapping out current information and communication flows and work practices within the involved hospital ward and between the hospital and their patients. The case study is focused on supporting patients with diabetes type 2 in living a healthy life. This includes supporting secure, effective and efficient communication between healthcare professionals and patients in ways that support good health for the patients, high quality healthcare provision as well as a manageable work situation for the healthcare teams.

Our field studies so far have already raised issues about how to integrate mHealth applications into an organizational context where current technologies in use are poorly integrated and in many cases managed through numerous work-around practices. The Swedish county hospital we are collaborating with in the project provides a work environment for its staff where legacy systems, firewalls and local ICT policies limit and restrict what is perceived as possible to change and what is possible to implement. This is in no way a unique situation in Swedish healthcare environments today, even though Swedish healthcare is in many ways considered to be at the forefront in using technology to enhance healthcare delivery.

During the spring of 2014 we have initiated a pilot study within the framework of the Swedish case study 1. In the pilot study we are taking a closer look at current use contexts into which we plan to introduce the future mHealth service for supporting diabetes patients and their healthcare teams. Using ethnographic field-study methods (individual and group interviews, observations, shadowing), we are mapping current work practice and communication flows from the healthcare provider's perspective within the medical clinic at the Blekinge county hospital in Karlskrona, in parallel with doing field-studies of everyday life for patients (who have volunteered to participate in the study) with diabetes type 2.

What we have discovered so far from our field-studies at the county hospital is that there are many problems with the current technologies in use, and not least with the firewall in the hospital, which are causing great frustration among healthcare staff. So, for example, search strings are written down on bits of paper beside the workstation and repeatedly fed into different systems due to insufficient integration of information and incompatibility of different systems which are constantly in use in parallel. The same information is entered into different systems by hand, when this should easily be able to be automated. Many patients are proficient with smart phones and e-mail, and could easily send their blood values etc. via a mobile app or a digital form attached to an e-mail, but the security regulations within the county hospital do not allow this. Instead, patients are required to use a website which requires a digital ID and does not allow for communication that includes attached files. This means that blood values etc. are sent in unformatted free text through the web site, resulting in difficulties for healthcare staff to interpret important and potentially health critical information correctly.

It quickly became clear to us that if we simply brought in yet another stand-alone application, in this case a mobile prototype of a service supporting communication with patients with diabetes type 2, we would be adding to the frustration of the healthcare professionals rather than supporting their work. Thus, we have decided to map the current obstacles and challenges to transformation of healthcare delivery with mHealth technologies and aim to discuss possible solutions to at least some of the current problems before introducing our prototype in the medical clinic. As one of our industry partners in the Health in Hand project provides several of the information systems (IS) currently in use in the County hospital, we believe there may be possibilities of improvement of the current situation through giving voice to some of the usability issues experienced in everyday work life by the healthcare professionals. Our ambition is to carry out Participatory Design workshops with patients and healthcare professionals in the autumn of 2014, with a focus on designing the first prototype of an mHealth solution.

III. USABILITY AND USER EXPERIENCE AS STRATEGIC ASSETS

Thus, when we took a closer look in our pilot study at how we might smoothly integrate mHealth applications into an organizational context in the healthcare sector, we found that there were a number of serious usability issues with already implemented technologies in this sector that might threaten the effective implementation of mHealth solutions. The American Health Information Management Systems Society (Himss) has recently presented an adapted Usability Maturity Model (UMM) [12] for leveraging user experience to be a strategic asset in health organizations. As one of our PhD students has been collaborating with researchers who have been central in developing the UMM for health organizations, we decided to test this model with our Swedish project steering committee as a shared model for moving ahead in the Swedish case study 1. The steering committee, which includes representatives of the public healthcare sector and IT and health service providers as well as of all the involved research disciplines, approved of the idea of using the health related UMM and focusing on usability and user experience as strategic assets in the continued work with defining problems, goals and requirements in the Health in Hand project. The service providers could clearly see the benefit of driving this development themselves in close collaboration with the county hospital and on-going research in innovative mHealth technologies.

IV. THE PROJECT AND ITS OVERALL GOALS

The Indo-Swedish R&D project of which the above case study is a part is called *Health in Hand – Transforming Healthcare Delivery* (VINNOVA Reg.No.2013-04660). Project leader in India is professor Ashok Jhunjhunwala, Indian Institute of Technology Madras (IIT-M). Project leader in Sweden is professor Sara Eriksén, Blekinge Institute of Technology (BTH). The authors of this paper are part of the Swedish multi-disciplinary research team, which is distributed across two Swedish universities, Blekinge Institute of

Technology (BTH) and Lund University (LU). The project is co-funded by the Swedish Governmental Agency for Innovation Systems (VINNOVA), Sweden, and the Department of Biotechnology (DBT), Government of India, for a period of three years (2014-2016). The Swedish research team is collaborating with a multi-disciplinary research team called the TeNeT Group (Telecommunications and Computer Networking Group) at IIT-M in Chennai, India, around design, development, implementation and evaluation of innovative mobile technologies for health promotion and disease prevention.

The project has a multi-disciplinary approach, with a focus on health and health promotion on one hand, and design and development of technology that facilitates the delivery of health promotion and healthcare on the other. We are using an iterative Participatory Design approach, combining design-oriented action research, evidence-based health practice, method and tool development for measurement and evaluation of quality of service, usability [9] [10] [11], user experience and end user adaptation as well as for measuring how these services impact health. Additionally, studying issues concerning up-scaling and commercialization of mHealth technologies in collaboration with industry and public sector are part of the project, although these issues will mainly be addressed during the final year of the project (2016).

The main objective of the 3 year Health in Hand project is to establish long-term Indo-Swedish R&D collaboration around leading-edge applied health technology, with a focus on mobile health services. '*mHealth technologies*' here refer to mobile services which inform, motivate and enable individuals to manage their own health information and knowledge sharing, as well as support communication and community building among both patient and caregiver communities. Another important objective is to contribute to method and tool development for measuring impact of mHealth technologies on health outcome.

V. THE MULTI-DISCIPLINARY APPROACH

The Health in Hand project is one of the first multi-disciplinary projects at BTH where health sciences, computing and engineering sciences are all jointly involved and have shared interests. The methodological challenges we are facing in our research project concern not only bridging of cultural differences between Sweden and India, but also - and above all - bridging of different research cultures and practices between different disciplines, in both Sweden and India. In fact, we expect the multi-perspectivity of the research teams in both countries to offer new and richer insights concerning established research practices within the various involved disciplines, their strengths and limitations. One of the aims of the project is to develop research methods and practices that can be applied and shared across disciplinary boundaries, for enhancing collaboration around the complex systems which are the base for innovative mobile technologies in healthcare. These systems include software-intensive communication networks as well as hardware, people, their lifestyle habits and health issues, healthcare organizations and their established

work practices and cultures. (Not to mention new and rapidly developing markets.)

VI. FOUR CASE STUDIES IN THE PIPELINE

As the Health in Hand project started in January 2014 in Sweden, we have not yet come very far with the fieldwork in the project. The following provides an overview of what we have planned for the near future concerning the case studies.

The work plan for the Health in Hand project has been set up based on positive experience from previous multi-disciplinary R&D collaboration between BTH and IIT-M in a Swedish Research Links Asia project 2007-2009 funded by the Swedish Research Council and SIDA with a focus on Participatory Design of e-government services and methods for measuring User Experience of e-services [5] [6] [7].

The aim is to have a comprehensive shared work plan which is characterized by low resolution. Detailed planning is shared only regarding exchange visits and shared workshops. Milestones and deliverables are coordinated through the iterative design and development cycles that are part of each use case during the 3 year project. These are set up so that the prototypes of mobile health services that are developed in the different use cases can be tested and evaluated through at least one full cycle per year. One type of deliverable is thus a prototype, evolving from a first to a second and finally a third version during the 3 year project.

The two use cases in India and the two use cases in Sweden have been specifically chosen because they are part of the on-going health initiatives in each location where target groups and goals are to some extent similar or overlapping between the Swedish and Indian cases. The challenges of transforming healthcare delivery with mobile health services are in many ways vastly different in India and in Sweden, but there are also interesting parallels and similarities. From past experience, we know that participating in, exploring and comparing developments in local R&D projects between globally distant sites in this way can be extremely inspiring. It can help both partners to "see things differently" in ways that are conducive to innovative thinking around designing and developing innovative mobile health services and transforming healthcare delivery, in India, in Sweden, and, not the least, in Indo-Swedish collaboration in the rapidly evolving area of applied health technology. The use cases provide the touchstone and shared arena for the Indo-Swedish R&D collaboration during the 3 year project.

Research activities on both sides will be coordinated by the schedule and timeline for the cooperative project. This in turn will follow a yearly prototyping cycle where shared milestones and deliverables for the 4 different use cases provide the base for comparisons between use cases and planning of visits in both directions. This allows for flexibility of content of deliverables between the use cases, which means contingencies in the different use cases can be managed without upsetting the overall time plan. In fact, contingencies and how they are managed are part of the challenge of transforming healthcare delivery with innovative mHealth technologies for health promotion and better health outcome in

both Sweden and India, and thus part of the object of study in this R&D collaboration.

Central elements of cooperation will be discussions and negotiations around shared milestones and deliverables in the project, the development of shared ethical guidelines, shared mentorship and supervision of the younger researchers and PhD students participating in the project, sharing of innovative ideas and practices around design, development, implementation and commercialization of mHealth technologies, insights into existing and emerging health-related ecosystems and business models in this area in Sweden and India respectively, as well as jointly developing methods for measuring, mapping, evaluating and validating the health outcomes of using the mHealth solutions in the 4 use cases.

Validation of the use of the mHealth technologies, to which degree they meet expectations in terms of functionality and quality, and to which degree they become (and remain!) integrated in people's daily lives and struggle for health are important issues in the *Health Hand* project. This type of validation can be done per site, and cross-site, the later in order to include different angles of view.

VII. PARTICIPATORY DESIGN AS A WAY OF SHARING KNOWLEDGE IN MULTI-DISCIPLINARY R&D COLLABORATION

Scandinavian Participatory Design (PD) approaches are distinguished by three principles: striving for democracy and democratisation; explicit discussions of values in design and imagined futures; and ways that conflicts and contradictions are regarded as resources in design [3]. Taking these principles seriously, and bringing them into our design practices and design collaborations, both locally and globally, is one of the challenges and opportunities we are addressing in the *Health in Hand* project. One of the central methodological issues in our project, about bridging of different research cultures and practices between different disciplines in both Sweden and India, is also an ethical issue, as it is basically about how to design human technologies in an age when technologies are converging into complex systems of which no one has a comprehensive overview, but which need to be managed in everyday life. Although it could be seen as anecdotal that some of us are doing research with a focus on designing technical artifacts (such as in Design Science and Human-Computer Interaction) while others are doing research which strives to minimize artifacts in technical systems (such as in Telecommunication systems) – i.e. we have widely varied and often incommensurable understandings of technology design and development – it does imply that we need to develop conceptual models that support multi-disciplinary R&D collaboration for complex systems such as those which are now evolving within mHealth. Usability, accessibility and user experience are all examples how a shared, problem-oriented approach and focus on user-centered aspects of technology can help bridge theoretical isolationism.

The Scandinavian tradition of Participatory Design highlights power relations and ethical issues in ICT design, claiming that the context and the specifics of design situations

are important and need to be attended to in order to achieve viable and sustainable technology design for those who will, ultimately, be affected by the outcome of the design [8]. Can context awareness and ethics of design be more explicitly included in cross-disciplinary research methods and practices as well as in engineering education, for more sustainable outcomes - and more rewarding and inspiring R&D collaboration?

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