

Requirements Engineering for Home Care Technology

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ABSTRACT

The focus of this work is the requirements engineering process in the home care domain. The overall aim is to design and document a flexible methodology to facilitate the elicitation of complex, dynamic, multi-stakeholder requirements and needs. This paper details the complexity and uniqueness of the home care domain and outlines the features of home care that demand a new or tailored approach to requirements engineering. It concludes by presenting a consolidated list of features that must be available or supported in requirements engineering methods in the home care domain.

ACM Classification Keywords

D.2.1 [Software Engineering]: Requirements Specifications---Methodologies, H.5.2 [Information Systems]: User Interfaces ---User Centred Design.

General Terms

Design, Documentation, Human Factors.

Author Keywords

Home Care Systems, Care at Home, stakeholders, requirements, Home care technology, Requirements Engineering.

INTRODUCTION

An increasing number of people, coping with a variety of illnesses, impairments or disabilities (age related or otherwise) prefer to stay in their own home to receive care. This is both socially beneficial - they can remain in a familiar environment, close to family and friends - and economically beneficial - it is costly and impractical to provide sufficient specialized care facilities given the increasing ageing population [7]. Technologies can support health and social care at home. It can be used to monitor situations in the home such as someone being immobile or incapable and

therefore requiring outside intervention [7]. Increased networking capabilities have increased the potential for users to send and receive important care information from their own home to friends and family or to health and social care professionals involved in their care [6].

Advanced home care technologies and home care systems have not been taken up in people's homes as eagerly as we might have anticipated [7]. Yet with an increasing ageing population and an increased drive to keep people out of hospital and support people living independently in their own homes, there is a continuing need for well designed, acceptable home care technologies.

Home Care Systems, by their very nature, involve a number of direct users and other stakeholders all of whom are interested in and potentially able to influence how the system should perform and behave [6]. In addition to the person being cared for in their home, there are likely to be partners living in the same space, friends and family living elsewhere who are involved in care or interested in its status, visiting medical personnel such as community nurses and remotely located medical staff, such as a consultant in a clinic that the patient visits [4, 8]. Each person involved in the system and its development is likely to have very different needs, perspectives, and accountabilities [1, 5], all possibly changing over time as the condition of the person and the possible behaviours of the systems change [3, 6]. This can result in complex, dynamic and potentially conflicting needs and requirements and therefore novel methods are needed for identifying and resolving requirements [2].

The complexity of the requirements of both individuals and the network of care surrounding people in their homes makes providing home care solutions a difficult task. This paper is part of a project on Mobilising Advanced Technologies for Care at Home and highlights the complexities of the home care domain that make traditional RE approaches difficult to use. This is done by outlining the characteristics of home care and the resulting challenges and concludes by presenting suggested features for RE methods in the home care domain.

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THE HOME CARE DOMAIN

We define home care as a potentially linked set of services of either social care, health care, or both, that provide, or support the provision, of care in the home. Our focus is on technologically supported home care, in particular those that involve specialised computer systems. Such home care support can range from simple stand-alone electro-mechanical alarms installed in a person's home, perhaps to indicate a bath overflowing or a door left ajar, to systems integrated into the home's physical infrastructure that monitor patient state, perform sophisticated analyses, deliver customised information to patients and clinicians and support communication among them.

We refer to 'Home Care Systems' to mean the technology used to support and realise activities of the network of care, providing the means to collect, distribute, analyse and manage care related information [6]. Such technology typically includes sensors, devices, displays, data, and networks, and computing infrastructures.

We refer to a 'Network of Home Care' as the wide array of people and organisations involved or interested directly or indirectly in a person's care at home [6]. It is the complex nature of this network of home care and the social and professional interactions [1, 4, 8] that creates many of the issues in the application of traditional requirements processes to the home care domain.

Together these are referred to as the 'Home Care System'.

Characteristics of Home Care

The defining features of home care have to be identified and described in such a way that their structure and characteristics are revealed with respect to potential resolution during RE. What follows is not intended as a comprehensive and complete analytic model of such features, but merely an initial attempt to examine some examples, to illustrate the features that will need to be addressed in RE methods for home care.

The key features of home care systems in this work are:

- *Homecare is multi-user*

Most systems that exist or are the subject of research have multiple users. The cared person is probably a data source, but they are often also a user of homecare services, such as personalised symptom management information, medical condition alerts, reminders, etc. Carers may or may not directly use the technology themselves but most likely will use the system to support their care role somehow [8]. Generally speaking, anyone involved in the network of care around a person being cared for at home might be considered a potential user of that homecare system.

- *Homecare is multi-stakeholder*

The terms stakeholder is used broadly to refer to anyone who might have some direct or indirect influence on the system's requirements. The stakeholders can be direct users

of the system(s) themselves. Many stakeholders however may have an interest in how the system works, or the data it contains yet never actually be a direct user of the system or technology themselves.

The challenges concerning involving multiple stakeholders in the RE process include [2]:

- Different perspectives on the system being developed
- Different backgrounds, which can cause communication problems [1]
- Different objectives, which influence views on the requirements [8]
- Different abilities to express requirements and requirement documentation using a technical platform [2]
- Different involvements – for example, some stakeholders are allowed to make decisions and others are not [6].

- *Home care is distributed*

Information from a variety of sources can be correlated and used to build up a picture of the home environment (e.g. to detect an abnormal situation or to guide remote consultation). An important issue is to relate what is happening in the home to the outside world and different organisations (e.g. to alert a responder or carer) [8]. Through the use of sophisticated networking and management software, a variety of care situations can be detected and reported to various users of the system in order that they can respond appropriately to that particular care scenario.

- *Homecare System Interaction is multimodal*

Home Care systems are often capable of providing implicit, multimodal, and non-standard means of interacting to facilitate a more natural user experience. This may include the use of speech and non speech audio, graphical output delivered via mobile devices or digital television, gesture input and tactile output. Allowing users the choice of various single or combined modalities for different interaction tasks in different contexts is important [6].

- *Homecare system needs are dynamic*

Each user within the network of care might have very different needs, perspectives, or accountabilities [4], all possibly changing over time. Different users within the same network may want different views onto the same set of health related data or different means of interacting with that data depending on their needs and their client's needs as the care plan and the available devices, services, and data change over time. A person-centred approach requires that information about what matters most to each client be systematically collected, kept up to date, and communicated to staff. The home care system should be able to adapt to dynamically changing requirements [3] of the client themselves and the appropriate stakeholders.

Complex and Dynamic Features of Home Care

- Complex care conditions

It is common in an ageing population that the people being cared for will have a cluster of conditions to manage [4], some of which might interact with each other. This means that a home care system must be capable of dealing with decisions on which rules to follow if health indicators from different conditions or symptoms are conflicting with each other. There is of course the added problem that conditions are not only multiple within one person but of course can be spread between the persons living within the home.

- Complex Care relationships

Socially speaking it is likely that conflicts will arise from conflicting interests or at least differing priorities or goals from different people [5]. There is the underlying problem of who the system should rank 'highest' if each places similar but competing demands on the system. These conflicts arise because of the variety of different goals, needs, expectations or perspectives of the various stakeholders.

- Shared Interaction Spaces

The home might include not only the cared but one or more others. The system's configuration may be acceptable for some but not for others. For example, the cared may wish to have care messages and alerts presented by speech, but this might be annoying and disruptive to the carer if delivered via speakers. Similarly, information provided on a television might either be disruptive of TV use by others in the household or it might allow private and potentially embarrassing health information to be read by others.

- Service vs. User Experience

This is a fundamental source of conflict, where demands of the provision of care interact poorly with other aspects of the life of the cared or carers. The user requirements generated on behalf of the user given their care conditions might for instance conflict with what the user believes he or she needs or wants. Balance between achieving clinical efficacy and an acceptable user experience must be sought.

- Control and ownership of data

It is important that peoples' privacy is not disrespected as this remains one of the fears of Home Care Systems. The question of who owns the different data input/output from the system needs to be clarified. If two users want access or control over the system's data at any time then there needs to be some negotiated rules in place regarding this issue.

- Accountability

The issue here is that, following on from some of the previous points, it may be unclear whose responsibility it is if there are issues with the correctness or completeness of the data or with control over devices and their configuration. Conflicts can arise particularly when there are both institutional and personal interests at stake.

- Multiple changing requirements

It is likely in the home care context that user requirements will change [3]. This may be as a result of changes in the medical conditions, new devices, changes in family circumstances, or simply changes in what people believe or the way they behave.

Given the *multi-user, multi-stakeholder, multimodal dynamic*, potentially *collaborative* and *distributed* nature of Home Care Systems, it is likely that the software and system solutions will produce conflicts and challenges that home care research must address.

Consequences of Requirements Conflict

We identify three basic consequences of conflict that can result if home care requirements are not identified, negotiated and validated successfully.

- *System failure*

The most important consequence is that either the home care network or the actual network of home care (or both) may fail to deliver the desired benefits or may do so at an unacceptable cost. This cost may include a reduction in the quality of life of the participants [4]. The resistance of participants to the introduction of certain technologies can threaten the delivery of health or social care [7].

- *Poor Usability (and unintentional misuse)*

Home Care systems should be capable of providing implicit and multimodal means of interacting to facilitate a more natural user experience [6]. It should be possible for advanced custom technologies to be integrated with standard devices already in the home. In this way, users' existing knowledge, skills, and habits are not always replaced but instead supported or complemented. Depending on the nature of the task, and the current users, multiple ways of accessing certain functionality is needed. This will require modelling of all of the potential users and scenarios in order to offer them differing and suitable means of access as appropriate. All of this should lead to improved usability but is proving difficult to realise in the home care setting [7].

- *Reluctance to use/accept the system*

We distinguish this from poor usability as it refers to an effect on attitude or inclination, rather than actual performance. This remains a problem in the uptake of home care technologies and needs to be addressed.

A REQUIREMENTS ENGINEERING APPROACH FOR THE HOME CARE DOMAIN

It should be clear from the previous sections that home care is a complex domain with many characteristics making it difficult to apply any one standard existing requirements methodology. Many existing RE methods fail to offer the flexibility required in the home care domain. For example, different stakeholders may need to be given different priorities at different times depending on the context. Outcome

measures may need to be socially negotiated as the best clinical outcome might not always be preferred over the best well being outcomes. The home care domain is also extremely dynamic and RE methods should be capable of monitoring and adapting requirements [3] over long periods of time as a persons care circumstances change.

The features of home care described can and should be translated to features for a requirements engineering approach suited to home care systems. This is essential for the realisation of effective and usable home care systems. In this section, we present some initial recommendations for home care systems requirements engineering methods.

The methodology must address the issues relevant to a range of stakeholders and fit into stakeholders current work practices and care plans. The RE process must also be lightweight enough to be useable yet rigorous so as to be justifiable. It should also be possible to elicit requirements at different levels of detail and to tailor the process to the resources available for the requirements exercise.

Based on our exploratory work and several engagement exercises with stakeholders in home care we would suggest that an RE approach for home care should provide or support the following features:

- (1) Participatory elicitation and negotiation [4].
- (2) Distributed elicitation and negotiation [8].
- (3) Iteration affording rounds of eliciting, balancing and validating requirements [3].
- (4) Identification of and engagement with appropriate stakeholders to elicit high quality requirements [1].
- (5) Prioritisation or weighting of requirements [2, 3].
- (6) Retention and traceability of requirements over time [3].
- (7) Identification and categorisation of requirements conflict [6].
- (8) Resolution of requirements conflict [2, 5].
- (9) Annotation of requirements to enable both negotiation and traceability [2].
- (10) Correlation with other processes and work practices such as care assessment [4, 6].

CONCLUSIONS

Ultimately we believe that appropriate RE solutions will involve improving the identification, description and resolution of stakeholder requirements and potential conflicts between them. This process should include stakeholders at the design stage to elicit requirements and identify possible conflict. It should also involve ongoing negotiation and resolution between both the stakeholders themselves and the stakeholders and the system. This is likely to include the ability of the system to dynamically evolve with the (nego-

tiated) changing requirements of the stakeholders where possible. A RE approach for home care must also be capable of evolving with the ever changing needs of the user and the many influencing factors in the home care domain.

This paper details the features that characterise home care and illustrates the complexity of the home care domain. It therefore argues that a novel RE approach is required for the development of home care technology and suggests several features that should be available in requirements engineering for home care technology. Our current work includes developing and testing RE tools that incorporate these features in the home care domain with multiple, distributed stakeholders.

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