Ambient Assisted Living: Towards a Model of Technology Adoption and Use Among Elderly Users

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Abstract
Ambient Assisted Living (AAL) technologies offer a promising perspective on autonomous aging in place. This is in the interest of the older adults themselves, overburdened caregivers and policy makers who try to control health care budgets in the face of the ever growing older population. However, these technologies are still in their infancy and little is known whether the older adults are ready to adopt and use them. So far, most research efforts are of exploratory nature. While they identify factors which are important for the adoption and use of AAL technologies, only a few attempt to test and quantify the underlying relations between these factors. Furthermore, many studies focus on a pre-adoption stage (a technology has not been used yet) and do not consider post-adoption (users have used and experienced a technology). This dissertation seeks to fill this gap by constructing a model which tests the underlying relations between the various influencing factors across both pre-adoption and post-adoption stages.

Author Keywords
Ambient Assisted Living (AAL); technology adoption; aging in place; older adults
ACM Classification Keywords

Background and Problem Statement
By 2050, it is expected that one in four people in the more developed countries is 65 years or older [21]. The majority of those older adults have a strong desire to age independently in their own home environment [19, 22]. Shifting from institutional care to care at home is also in the interest of policy makers, who deal with scarce budgets and lack health care professionals [7, 17]. However, age-related physical, cognitive and perceptual decline makes aging in place challenging. Even the still healthy and active older adults might need some form of assistance in the near future [5, 18]. Informal family caregivers often provide assistance, but caring for a family member can be stressful and overwhelming [11, 22, 24].

AAL technologies offer a promising perspective on aging in place. AAL is a term for a new generation of information and communication technology (ICT) products, services and systems which promote and support healthy and active aging at home, the community and at work [1]. These technologies operate in a more adaptive, anticipative and unobtrusive manner than the majority of commercially available products (e.g. emergency button), and are therefore easy to use and flexible to the individual context of the user [10]. For example, through unobtrusive sensors the older person’s activity level can be monitored, thereby allowing the caregivers to detect emergency situations and recognize functional decline at an early stage [11, 20]. Despite the fact that AAL technologies have a great potential to facilitate independent living and reduce the burden on caregivers and health care budgets, the likelihood of adoption of those technologies remains uncertain [7]. Barriers including usability problems [5][6], the lack of perceived benefits [7][12][19] and technology self-efficacy [7][13] can jeopardize the successful adoption of new technologies. In our view, this highlights the need for a better understanding of factors which drive the adoption and use of AAL technologies and the potential barriers which could interfere with a successful adoption.

Technology adoption and acceptance are well-researched topics and have been studied with regard to a variety of contexts, applications and user-groups. Several theoretical approaches of technology adoption and acceptance have been introduced and tested. The most acknowledged include the Technology Acceptance Model (TAM) [3, 4], the Unified Theory of Acceptance and Use of Technology (UTAUT) [23], the Diffusion of Innovations Theory (DoI) [15] and the Domestication Theory [16]. While TAM and UTAUT originate from the field of Information Systems, DoI and Domestication Theory stem from a sociological perspective. In contrast to TAM and UTAUT, DoI and Domestication Theory describe the adoption of technology as a process which can be divided in several stages including pre- and post-adoption. Thus, to understand technology adoption and use, one should investigate which factors are relevant throughout the various adoption stages. This is supported by findings of Bhattacherjee and Premkumar [2] and Karahanna, Straub and Chervany [9] who demonstrated that
influencing factors differ between the pre-adoption and post-adoption stage.

A recent systematic review showed that previous work on the adoption of AAL technologies mostly focused on the pre-adoption stage, investigating the perceptions and expectations towards these technologies [14]. However, too little is known about relevant adoption factors once the technology is in use. Furthermore, about two-thirds of the reviewed studies based their findings on only qualitative data. While those studies identified relevant factors for the adoption and use of AAL technologies, only a few tried to test and quantify the underlying relations between these factors.

In an attempt to fill this gap, my dissertation aims at developing a model for the adoption and use of AAL technologies to test and quantify the links between the various influencing factors. Thereby, I want to differentiate between several stages in the adoption process. Thus, the questions central to this research are:

1. What are the factors influencing the adoption and use of AAL technologies among older adults?
2. Which factors and underlying relations play a role across pre-adoption and post-adoption stages?
3. How can these factors be integrated into a technology adoption model for AAL technologies?
4. What implications can be drawn from the model for the developers of AAL technologies?

**Preliminary Results**

Parts of this research are conducted within the SONOPA project (Social Networks for Older Adults to Promote an Active Life) which is carried out in the framework of the Ambient Assistant Living Joint Program (AAL JP). The aim of the SONOPA project is to employ a set of available ICT technologies for stimulating and supporting activities at home. Various sensors and behavior modelling techniques are used to generate a personal activity profile of the elderly user and track variations in the daily activities over time. When the user’s activity level is low, the system provides a recommendation, suggesting individual activities or social interactions with peers. SONOPA intends to empower elderly people to stay active, independent and socially involved in their home environment, so to maintain their psychological and physical well-being.

The first part of our work was of qualitative and exploratory nature to get a better understanding of the elderly user and their perceptions of AAL technologies. Following this approach we first conducted a literature study to learn about the perceived benefits and barriers of AAL technologies. The six perceived benefits identified from literature include: (1) independent living and aging in place, (2) health and safety, (3) social involvement, (4) support with the activities of daily living, (5) support for the care network, and (6) education and leisure. In contrast, the eight perceived barriers include: (1) lack of perceived need and perceived usefulness, (2) privacy, obtrusiveness and control, (3) lack of experience, technology anxiety and self-efficacy, (4) fear of a social stigma, (5) reliability, (6) lack of human interaction, (7) cost, and (8) health concerns. Secondly, to evaluate these benefits and barriers in the context of the SONOPA technology, a user-requirement study with older adults (n=28) and elder care professionals (n=9) was conducted in October 2013. Three focus groups (UK: n = 8; FR: n =
5; BE: n = 9) and 21 semi-structured interviews were conducted in the UK, France and Belgium. Six of the older adults participated in both focus-groups and in-depth interviews. A video was used to illustrate two potential user-scenarios of the SONOPA technology. Subsequently, the perceived benefits and barriers were accessed. Findings from the user-requirement study reinforced and further specified the perceived benefits and barriers from the literature study. Together, results from both studies led to an initial blueprint of requirements for AAL technologies: (1) clear, specific and flexible benefits, (2) ensuring privacy, security and unobtrusiveness, (3) simplicity and familiarity, (4) training and low level of level of active interaction, (5) emphasizing abilities rather than disabilities, (6) reliability and technical support, (7) flexibility and adaptiveness, (8) promoting not replacing social interaction and (9) low cost and spread payments [8].

**Future Work**

Future work will focus on integrating the identified benefits and barriers of AAL technologies with existing technology adoption and acceptance theories. Consequently, a conceptual model for the adoption and use of AAL technologies by the elderly user will be developed. This model will be tested using qualitative and quantitative approaches to further verify benefits, barriers and other factors relevant for the adoption and use of AAL technologies. The aim is to develop a model which illustrates influencing factors and their underlying relations across both pre-adoption and post-adoption stages of technology adoption. Furthermore, instead of using scenarios a SONOPA prototype will be developed and evaluated in the field. The AAL adoption model can help researchers, product developers and policy makers to get a better understanding of AAL adoption by the elderly user and lead to several requirements for the development and implementation of such technologies.

**Objective for Attending the Doctoral School**

Soon entering the second year of my PhD, I think it is a good moment to reflect on the work that has been done and take a critical look at the proposed research plan. In my opinion, the UbiComp Doctoral School is a great platform to receive expert feedback and exchange knowledge with fellow PhD students. As a social scientist I am keen on receiving insights from peers and experts from other disciplines. In turn, I can provide constructive feedback from a social scientist’s perspective. In this multidisciplinary field, I think it is of great value to share the knowledge with peers and experts from various fields as they can provide a new perspective on one’s own research. I hope by attending the UbiComp Doctoral School to further shape and direct my research for the years to come.

**Biographical Sketch**

I started as a PhD student in June 2013 at the Media, Communication and Organization Group of the University of Twente. Together with my advisor Dr. Somaya Ben Allouch I transferred to the research group Technology, Health and Care at the Saxion University of Applied Sciences in January 2014. Dr. Somaya Ben Allouch is now the Head of this Research group. Prof. Dr. Jan A. G. M. van Dijk, Head of the Media, Communication and Organization Group of the University of Twente is the head of my promotion committee. I expect to complete my PhD in December 2016. My background is in Communication Science, where I hold a BSc. and MSc. with honors, both awarded by the University of Twente.
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