Helpful but Spooky? Acceptance of AAL-systems Contrasting User Groups with Focus on Disabilities and Care Needs

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Keywords: Ambient Assisted Living, Technology Acceptance, User Diversity, Age, Needs of Care, Needs of Assistance, Disabled People.

Abstract: Ambient Assisted Living (AAL) technologies present one approach facing the challenges of recent and rising care needs due to demographic changes in western societies. Beside the technological implementation, the focus on user acceptance of all stakeholders plays a major role for a successful rollout. As most research deals with age-related issues, this paper emphasizes especially on the sector of disabled persons. In a qualitative interview pre-study (n=9) and a validating questionnaire study (n=279) the perceived benefits and barriers of AAL technologies were contrasted in four user groups: healthy "not-experienced" people, disabled, their relatives, and professional care givers. Results indicate that disabled and care-needy people show a higher acceptance and intention to use an AAL system than "not-experienced" people or care givers and that the motives for use and non-use differ strongly with regard to user diversity as well. The results show the importance to integrate diverse user groups (age, disabilities) into the design and evaluation process of AAL technologies.

1 INTRODUCTION

Demographic change represents one of the major challenges for today's society. A constantly increasing number of older people and people in need of care poses exceptional burdens for the care sector (Bloom & Canning, 2004; Walker & Maltby, 2012). Concurrently, in particular most of the older people desire to live at their own home as long as possible and as autonomously as possible (Wiles et al., 2011).

Age and age-related diseases (e.g., diabetes, dementia, cardiovascular diseases) are enormously important and increase steadily (Shaw et al., 2010; Wild et al., 2004; Roger et al., 2011), but represent only one side of the coin. Age-independent diseases and disabilities are also of importance and should be considered as they cause huge needs of care and assistance as well (Geenen et al., 2003). Additionally, there is the comparably new phenomenon of "old disabled" people, on the one hand, due to medical and technical developments in healthcare concerning new innovative medicines and therapies. On the other hand, especially in Europe - due to the specific historical background of euthanasia offenses, in which disabled people were systematically aborted, deported, and even murdered (Poore, 2007).

Hence, age, diseases, and disabilities are all relevant factors that have to be considered with regard to increasing needs of care and related challenges. In the last decades it is tried to face these challenges developing various technical single-case solutions but also complex ambient assisted living systems (AAL) (Schmitt, 2002).

A huge amount of systems exist that monitor medical parameters or detect falls as well as facilitate living at home using smart home technology elements (Cheng et al., 2013; Baig & Gholamhosseini, 2013; Rashidi & Mihailidis, 2013). Beyond multiply available single solutions, current research focuses also on holistic AAL systems, that combine various functions and are ideally cost-effective, retrofittable, and adaptable to the individual needs of diverse user groups.

In particular with regard to different user groups, the question arises whether and to which extent such AAL systems are desired and accepted. Which factors are crucial for acceptance and to what extent does this evaluation depend on user factors?

Several studies investigate the acceptance of such and similar technologies focussing on age (e.g., Fuchsberger, 2008; Demiris et al. 2008) or gender (Wilkowska et al., 2010) as presumed influencing

Heek, J., Himmel, S. and Ziefle, M.
Helpful but Spooky? Acceptance of AAL-systems Contrasting User Groups with Focus on Disabilities and Care Needs .
DOI: 10.5220/0006325400780090
In *Proceedings of the 3rd International Conference on Information and Communication Technologies for Ageing Well and e-Health (ICT4AWE 2017)*, pages 78-90
ISBN: 978-989-758-251-6

factors. As disabled people have hardly been considered so far, this paper investigates the acceptance of AAL systems with focus on people having experiences with disabilities in different perspectives.

2 AAL & ACCEPTANCE

First, the state of the art concerning AAL technologies is shortly summarized. Afterwards, the theoretical background of technology acceptance research is presented focusing on the influence of user diversity factors. Further, an overview of current acceptance research on AAL systems is given.

2.1 AAL Technologies

The use of Information and Communication Technologies (ICT) in everyday life has been studied since the 1980s (Silverstone et al., 1989). Different types of monitoring are enabled by integrating ICT (e.g., microphones, cameras, and movement sensors) into people's living environments. In recent years, the number of commercially available AAL systems as well as AAL research projects increased significantly. In this context, retrofittable, modularly constructed (as required), and multifunctional systems are offered including -among others - smart home functions (such as sensors for control of lighting, heating, doors, and windows), fall detection, and other health care applications like providing of and reminder for drugs or blood sugar measuring. These systems are available for an integration in the home environment (e.g., Casenio, 2016; Essence, 2016), in hospitals (EarlySense, 2016), and in nursing homes (Tunstall, 2016).

Besides commercial solutions, research projects also focus on the development of holistic AAL systems (e.g., Sixsmith et al., 2009; Gövercin et al., 2016). However, in contrast to most of the commercial solutions, these projects attach importance to consider future users (mainly older people) iteratively in the development process of the AAL system (Kleinberger et al., 2007). This is of significance in as much as the user's perspective is decisive for a successful integration of AAL systems in their everyday life. Currently, AAL technologies are not widely integrated in private home environments, although they have the potential to facilitate the everyday life of older, diseased, or disabled people. To understand the barriers of AAL usage, we have to focus on potential users of these systems, their perception, ideas, wishes, and their willingness to adopt home-integrated ICT.

2.2 Technology Acceptance, User Diversity & AAL Systems

AAL technologies as a possible solution for the challenges of the demographic change were mostly perceived and evaluated positive and the necessity and usefulness of technical support were also highly acknowledged (Beringer et al., 2011; Gövercin et al., 2016). In particular, the opportunity of staying longer at the own home and an independent life are strong motives to use (or imagine to use) an AAL system. On the other hand, restraints and acceptance barriers such as feelings of isolation (e.g., Sun et al., 2010), feelings of surveillance, and invasion of privacy (e.g., Wilkowska et al., 2015) were frequently mentioned when asking people to think about a concrete implementation of an AAL system in their living environment.

To understand this trade-off it is necessary to consider both user diversity and technology acceptance. In the last years, research became more aware of the limited suitability of traditional technology acceptance models like TAM or UTAUT as - in contrast to conventional ICT - AAL systems address especially older, diseased, and frail people with individual requirements, wishes, and concerns (Kowalewski et al., 2012). We assume that this concurrently leads to a different weighting of important perceived benefits and barriers and a different acceptance of using an AAL system. Therefore, an overview of acceptance research findings focusing on user diversity and different user group perspectives is presented.

2.2.1 Factor Age

The benefits and barriers of AAL technologies for elderly are widely discussed and researched in the last decade. To understand the perception of AAL technologies, numerous focus groups (Demiris et al., 2004; Ziefle et al., 2011) and interviews (Beringer et al., 2011) with people aged above 60 show similar results: elderly remark the benefits of staying at home longer, understand the imminent lack of care nurses and the chances of AAL technologies. On the other side, they fear dependency on technologies they cannot control, the lack of personal contact, demur data and privacy concerns. Plentiful surveys verify these qualitative gained results over time (e.g., Himmel & Ziefle, 2016). However, the measurement of attitudes towards technologies strongly depends on the research method and hands-on experience in real-life scenarios is inevitable to understand older peoples' actual approach to AAL tech-

nologies (Wilkowska et al., 2015). While several projects for ambient intelligence and ubiquitous computing in smart homes focused mainly on the technological implementations, recent projects on AAL labs, e.g., Philips Research CareLab (de Ruyter & Pelgrim, 2007), SOPRANO (Sixsmith et al., 2009), eHealth Future Care Lab (Brauner et al., 2015), to mention but a few, have understood to implement the user into the design and evaluation circle. The role of acceptance, the influence of privacy and trust, especially of elderly users, is therefore extensively investigated.

2.2.2 Factors Diseases & Disabilities

While research for AAL technologies emphasized on elderly people with age-related chronic or physical illnesses, the acceptance of AAL technologies for disabled persons still needs more and specified research attention. On the one hand, assistive technologies could improve the inclusion of people with disabilities into society, supporting mobility, and communication as well as holding down a job. On the other hand, age-related illnesses come along with already existing disabilities, which is as already mentioned a quite new phenomenon (Poore, 2007).

Regarding the care sector, besides pediatric nursing, ageing, diseases, and disabilities are the three central challenges. Frequently, age, diseases, and disabilities are summed up and neither investigated in depth nor separately. How different diseases and disabilities affect the use of medical technology is investigated and summarized in occasional studies (e.g., Harris, 2010; Gentry, 2009). These studies try to analyze why numerous existing technologies are abandoned and lie unused. The problem is that research on AAL technology acceptance of diseased or disabled people is partly comparatively unspecific, superficial, and on a theoretical level. We assume, this is mainly due to the fact that especially disabled people are considered and directly asked for their opinions, whishes, and needs only in few cases. However, this is precisely where research is required: especially disabled people have to be integrated in the design of assistive technologies and the interaction of age, diseases, and disabilities has to be focused as these factors constitute the major part of care needs.

To do especially justice to needs of care and care in itself, the perspectives of professional care givers or family care givers have to be considered as well. Within the research landscape concerning AAL technologies and their perception, some studies examined the requirements and professional and family caregivers' perspectives on AAL systems and technologies separately and not comparatively (López et al., 2015; Mortenson et al., 2013). In these studies, the effectiveness of different technologies is focused and guidelines for design and implementation are derived. Single studies try to concentrate on the user (care givers and patients) and perceived concerns regarding in-home monitoring technologies (Larizza et al., 2014). These studies deliver first insights into different perspectives on the acceptance of AAL technologies. However, they do not allow to directly compare the perspectives of "patients" (older, diseased, or disabled people) with family or professional care givers and "not-experienced" people, as they were each mainly focused on a specific user group and no equivalent or comparable methodological approach was used for the user groups.

So far, there is only little knowledge about the acceptance of AAL technologies with regard to disabled people and people with special care needs, about the interaction of the described user factors (age, diseases, and disabilities, needs in assistance and care) as well as about the perspectives of different user groups (affected themselves, relatives and families of people need in care, professional caregivers). Therefore, these interactions were addressed in the present study.

3 METHOD

In this section, the research design is presented starting with a short summary of the qualitative interview study, which was taken as a basis for the subsequent quantitative study. Afterwards, the empirical design of the quantitative study and the sample's characteristics are detailed. We choose a multimethod approach for this study consisting of a qualitative interview study and a consecutive quantitative questionnaire study. Our study addresses three essential research questions:

1. How do the participants evaluate a holistic AAL system (see 3.3) and which perceived benefits and barriers are most important for its acceptance?
2. To which extent do age, experiences with disabilities, and current care needs influence the AAL system's evaluation?
3. Are different benefits and barriers decisive for AAL acceptance depending on diverse user group perspectives?

3.1 Research Design

As it was detailed in chapter 2, research on the acceptance of AAL technologies mostly focused on older users so far. In contrast, there is only sparse knowledge about developing AAL technologies for people with disabilities and rarely research on the acceptance of AAL technologies focusing on disabled users. Further, other perspectives (e.g., professional caregivers, relatives, and families of disabled people) are also of prime importance as they can support and complete the understanding of potential user's needs and wishes. Hence, a qualitative interview study was initially necessary to identify perceived motives and barriers of use as well as use conditions. Only based on these results it was reasonable to design and conduct a quantitative study focusing on people having experiences with disabilities (themselves, families and relatives, professional caregivers).

3.2 Qualitative Pre-study

A preceding interview study was conducted focusing on people with disabilities (n=7), their relatives (n=1), and a professional caregiver (n=1) and the interviews took between 40 and 70 minutes. As the quantitative study and results should be focused in this paper (especially perceived benefits and barriers of AAL systems), only the results of the qualitative study are presented which were essential for the conception of the quantitative questionnaire. With regard to the described holistic AAL-system (scenario similar as detailed in 3.3), the participants discussed 11 different benefits and 9 potential usage barriers (Table 1).

These results align with previous research concerning several aspects (e.g., comfort, facilitating everyday life (e.g., Himmel et al., 2013)), but, to a larger extent, the results are multifaceted and go beyond previous findings due to the reference to disabilities and constraints (e.g., compensation, reduce confrontation with care needs, to be afraid of isolation). Hence, these aspects have to be examined quantitatively to be able to do justice to diverse user groups.

Further, the participants evaluated the described AAL system differently: the related person and the caregiver assessed the scenario rather negative and critical using words like *spooky*, *lonely, inhuman, not self-determined*, and *personal rights*; in contrast, the disabled participants associated it with more positive and fascinated words such as *exciting, luxury, very useful*, *helpful* and *comfortable*. These results showed the importance of differentiating between different user groups and their considering in the subsequent study.

Table 1: Overview of discussed benefits and potential barriers of AAL systems in the interview study.

Perceived Benefits	***Potential Usage Barriers***
Expansion of autonomy	Isolation due to the substitution of care staff by technologies
Reduction of dependency from others	No real time savings (spend more time on technology use)
Facilitating the everyday life	Only if needed (doing as much as possible autonomously)
Saving of time	Missing relevance as care needs are often too high
Comfort	Functional incapacity (failure of technology)
Reduction of confrontation with own care needs	Feeling of surveillance
Increase the feeling of safety	Too large proportion of technology in everyday life
Staying longer at the own home	Expectation of a too complicated handling
Relief of family, relatives, and caregivers	Transmission of false information (e.g., false alarm)
Compensation of mobility constraints	
Enabling a fast data access	

3.3 Questionnaire of Quantitative Study

The questionnaire items were developed based on the findings of the previous interview study. The questionnaire consisted of different parts, while the first part addressed demographic aspects, such as age, gender, educational level, and income.

In the next part, the participants were asked for their experiences with disabilities by indicating if themselves are disabled (1), if they are related to a disabled person (2), if they are the caregiver of a disabled person (3), or if they have no experiences with disabilities (4). Afterwards, the participants were asked to indicate, whether and to which extent (care time, type of care, intensity of care) themselves (1+4) or the person they put themselves in position with (2+3) is in need of care.

To ensure that all participants pertain to the same baseline with regard to the evaluation of an AAL technology, a scenario was designed. Depending on their background (need of care, experience with disabilities), the participants were introduced to the scenario differently. For cases 2-4, the participants were asked to put themselves in the / a disabled person's position (respectively the person they are related with or they care (2+3)) while answering the questions concerning the AAL scenario. Participants who indicated to be not in need of care were asked to imagine that they would be in need of care.

The scenario was designed as a very personal everyday situation wherein the participants should imagine that an specific, invisible AAL system was integrated in their home environment and contained the following functions: setting of the home temperature (via smartphone), automatic opening and closing of (front) doors and windows (via sensors), automatic lighting control (via light sensors and position localization), hands-free kit for phoning (integrated microphones), monitoring of front door area (via cameras), and fall detection (sensors in floor and bed).

Afterwards, they had to evaluate a list of use conditions, perceived benefits (11 items) of the AAL system (e.g., to increase autonomy, to reduce dependency on others, to facilitate everyday life, to relieve fellow people), and perceived barriers (9 items) (e.g., feeling of surveillance, no trust in functionality, to assume a too difficult usage, to be afraid of isolation) based on the findings of the qualitative interview study (see 3.2).

Following that, the participants should assess 8 statements regarding the acceptance or rejection of the described AAL system as well as the behavioural intention to use such an AAL system. All described items had to be evaluated on six-point Likert scales (1 = min: "I strongly disagree"; 6 = max: "I strongly agree").

Finally, the participants were able to reason their opinions towards the described AAL system on an optional basis and to provide their feedback concerning the questionnaire and the topic itself. Completing the questionnaire took on average 15 minutes and data was collected in an online survey in Germany. Overall, the questionnaire was made available for 6 weeks in summer 2016.

3.4 Sample Description

A total of 279 participants volunteered to participate in our questionnaire study, which was distributed online in social network forums and acquired by personal contact. Since only complete data sets could be used for statistical analyses, a sample of n=182 remained. The participants (62.1% female, 36.3% male, 1.6% no answer) were on average 38.7 years old (SD=13.95; min=20; max=81) and highly educated with 46.7% holding a university degree and 14.8% a university entrance diploma. Concerning experience with disabilities, 51 participants indicated to be disabled (28.0%), 12.1% (n=22) were professional caregivers, 35 participants were relatives of a disabled person (19.2%), and 40.7% (n=74) had no experience with disabilities. Regarding current needs of assistance and care, 79 (43.4%) participants indicated to need care or that the person - they put themselves in position with - needed care (56.6% were not in need of care). These factors are related only partially: age is not related with experience with disabilities (r=-.132; p=.075 >.05) nor with current care needs (r=-.096; p=.197 >.05). Instead, age is related with gender (r=.200; p=.007 <.05; 1=female; 2=male). Not surprisingly, experience with disabilities correlates with current care needs (r=.607; p=.000 <.05). Further, the participants reported to have on average a positive technical self-efficacy (M=4.5; SD=1.0; min=1; max=6) and a slightly positive attitude towards technology innovations (M=3.9; SD=1.0; min=1; max=6). Further, they indicated their needs for data security (M=4.1; SD=0.8; min=1; max=6) and privacy (M=4.4; SD=0.7; min=1; max=6), which both were on average positive.

4 RESULTS

Prior to descriptive and inference analyses, item analyses were calculated to ensure measurement quality. Cronbach's alpha > 0.7 indicated a satisfying internal consistency of the scales. Data was analysed descriptively, by linear regression analyses and, with respect to the effects of user diversity, by (M)ANOVA procedures. The level of significance was set at 5%.

To analyse the impact of need of assistance and care on perceived benefits, barriers, and acceptance, we choose the factors age, experience with disabilities, and acute care needs for further analysis. The results are structured as follows: first, the results for acceptance of AAL, perceived benefits, and perceived barriers were presented for the whole sample. In a second step, the influences of user-specific characteristics on the perception of benefits and barriers as well as acceptance of AAL are examined.

4.1 General Acceptance of AAL

As it is shown in Figure 1, acceptance of AAL technologies was on average positive (M=4.6; SD=1.0).

In particular the items with regard to care needs *(…due to care needs* (M=4.7; SD=1.1) and *… reduce my care needs* (M=4.5; SD=1.3) were evaluated highest. Three items concerning a concrete intention to use an AAL system were rated rather positive, while the item *I would install…* (M=4.3; SD=1.4) was assessed higher than the aspects I like

to use… (M=4.0; SD=1.4) and *I can imagine to use…now* (M=3.8; SD=1.6).

The three negative acceptance items were rejected similarly (e.g., … *AAL technologies are superfluous* (M=1.9; SD=1.1). As perceived benefits (r=.433; p<.01) and perceived barriers (r=-.560; p<.01) are both significantly related with acceptance, their evaluations are presented in detail for the whole sample).

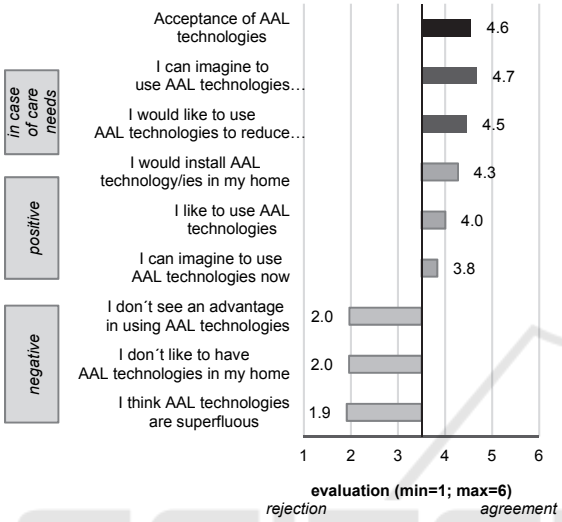

Figure 1: Evaluation of AAL system acceptance.

The evaluation of perceived benefits of the described AAL system is shown in Figure 2 and obviously all aspects were assessed and perceived as benefits as all values were above the mean of the scale. The most important benefits were *to facilitate everyday life* (M=5.2; SD=0.9), *to expand own autonomy* (M=5.2; SD=1.0), *to extend staying at home* (M=5.1; SD=1.0), and *to reduce dependency from other people* (M=5.1; SD=1.0). The aspects *to relieve fellow people* (M=4.9; SD=1.1), *to compensate reduced mobility* (M=4.8; SD=1.0), *comfort* (M=4.7; SD=1.2), and *to increase the feeling of safety* (M=4.6; SD=1.3) were only little less important. Comparatively, *time savings* (M=4.3; SD=1.4), *to enable fast data access* (M=4.0; SD=1.4), and *to reduce own conflict with care needs* (M=3.9; SD=1.4) were minor important.

Besides the descriptive analysis of the perceived benefits, we examined which benefits affect the acceptance of the described AAL system the most. Therefore, a stepwise linear regression analysis with all perceived benefits as independent and the acceptance sum score as dependent variable was calculated and revealed two significant models for the whole sample. The first model predicts 27.2% (adj. r^2=.272) variance of acceptance and is based on the benefit *"to expand own autonomy"* (β = 0.525; t = 8.279; p < .000), which therefore is the most important beneficial aspect for the acceptance of this study's AAL system. The second model additionally contains the aspect *"time savings"* and explains +2.0% variance (adj. r^2=.292). Thus *"time savings"*

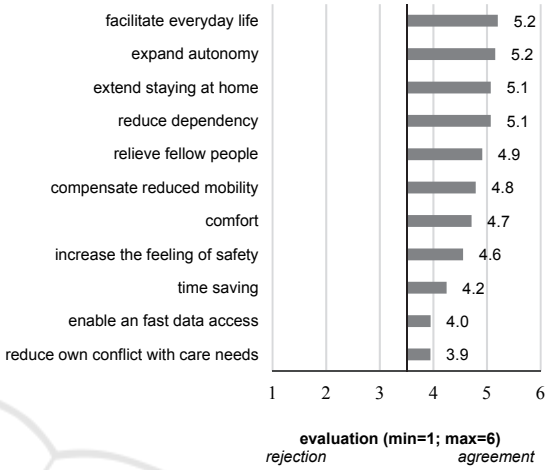

Figure 2: Evaluation of benefits with regard to the described AAL system scenario.

(β = 0.166; t = 2.459; p < .05) and *"to expand the autonomy"* β = 0.462; t = 6.823; p < .000) are the most important beneficial factors affecting the acceptance of the AAL system.

The evaluation of perceived barriers of the described AAL system is shown in Figure 3. Apparently, none of the items was perceived as "real" barrier as all values were below the mean of the scale and thus, the items were rejected to be barriers of AAL systems. AAL technologies were not perceived as *superfluous* (M=1.9; SD=1.0) and *irrelevant* (M=2.4; SD=1.1). The *usage* was not estimated *to be too difficult* (M=2.6; SD=1.2) and the participants rather rejected to have *no trust in the functionality* (M=2.8; SD=1.3) of the AAL system. Further, the participants slightly rejected that the *proportion of technology in everyday life is too high* (M=3.0; SD=1.5) and also to expect to have *no "real" time savings* (M=2.9; SD=1.2). The aspect to *be afraid of isolation* (M=3.2; SD=1.5) was also slightly rejected. *Transmission of incorrect information* (M=3.4; SD=1.3) and *feeling of surveillance* (M=3.4; SD=1.5) were rather evaluated neutrally and therefore, they represented the most likely as barriers perceived aspects.

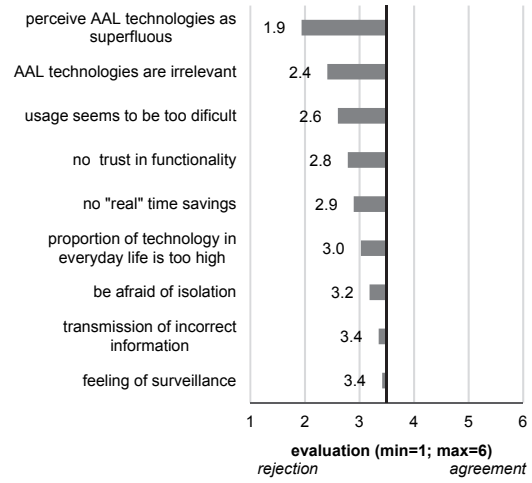

Figure 3: Evaluation of barriers with regard to the described AAL scenario.

In addition to descriptive analyses, a stepwise linear regression analysis with perceived barriers as independent and the acceptance sum score as dependent variable revealed three significant models for the whole sample. The first model predicts 35.1% variance of the acceptance (adj. r^2=.351) based on the barrier "*irrelevant*" (β = -0.596; t = -9.945; p < .000), i.e., this barrier - the participants accept the AAL system only if it is needed and that they want to do as much as possible autonomously – affects the acceptance most. The second model additionally explains +6.6% (adj. r^2=.417) and contains "*proportion of technology in everyday life is too high*" (β = -0.285; t = -4.624; p < .000) besides "*irrelevant*" (β = -0.484; t = -7.850; p < .000). The final model explains +1.2% (adj. r^2=.429) and includes "*to be afraid of isolation*" (β = -.139; t = -2.151; p < .000) besides "*proportion of technology in everyday life is too high*" (β = -0.235; t = -3.591; p < .000) and "*irrelevant*" (β = -0.453; t = -7.228; p < .000). Hence, these three barriers are most important for acceptance.

As the perceived benefits and barriers were not evaluated very differently, it is of major importance to analyse if these factors differ evenly more in their assessment with regard to diverse user groups. Equally, it has to be analysed to which extent the acceptance of AAL systems differs depending on users with different needs for assistance.

4.2 User-specific Characteristics

To analyse a potential influence of different assistance and care needs on the acceptance and evaluation of AAL systems, the factors age, experiences with disabilities and current needs of care were examined as independent variables.

4.2.1 User-specific Acceptance of AAL Systems

Overall, MANOVA analyses revealed significant influences of age (F(16,308)=2.104; p<.01), experiences with disabilities (F(24,465)=2.060; p<.01), and current care needs (F(8,153)=3.779; p<.01) on the acceptance of AAL systems. In the following, the most striking results are presented.

With regard to age, middle-aged and older people especially indicated a higher *intention to install AAL technology in their home* than younger people (F(2,162)=4.708; p<.05).

The influence of the factor experiences with disabilities on all items concerning the acceptance of AAL technologies is shown in Figure 4. Overall, the *acceptance of AAL technologies* was rated rather similar, except for the group of professional caregivers who showed comparatively the lowest acceptance scores (F(3,162)=2.646; p<.1).

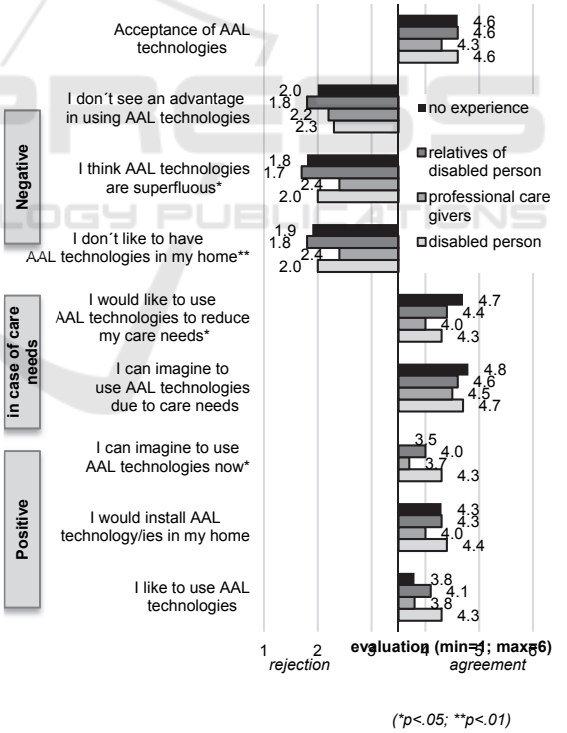

Figure 4: Evaluation of AAL acceptance depending on experience with disabilities.

Two of the negative statements (… *superfluous* F(3,162)=2.895; p<.05 and … *don´t like to have AAL technologies in the own home* F(3,162)=4.907;

p<.01) were lowest rejected by the group of the professional caregivers. Thus, this group showed in tendency a higher negative attitude towards AAL systems than the other three user groups. This pattern was also reflected in the evaluation of *the intention to use AAL technologies to reduce care needs* (F(3,162)=2.981; p<.05). On average, all user groups agreed to these both statements, while the professional caregivers comparatively showed the lowest agreement. Interestingly, the group of not experienced participants showed the highest agreement scores of the "in case of care needs"-statements. This evaluation changed with regard to the more concrete item *I can imagine to use AAL technologies now:* here, the not experienced participants (M=3.5; SD=1.7) showed a clearly lower agreement than the group of disabled people (M=4.3; SD=1.3; p<.05, post-hoc-tests: Tukey's HSD).

With regard to current care needs, most of the items concerning the acceptance of the AAL system differed significantly (see Figure 5). The overall acceptance of AAL systems is slightly higher for people with current care needs (M=4.7; SD=1.0) than for people without current care needs (M=4.5; SD=1.0; F(1,162)=7.309, p<.01). With regard to the negative aspects, especially the item *I don´t like to have AAL technologies in my home* was significantly more rejected by people with current care needs (F(1,162)=10.187; p<.01).

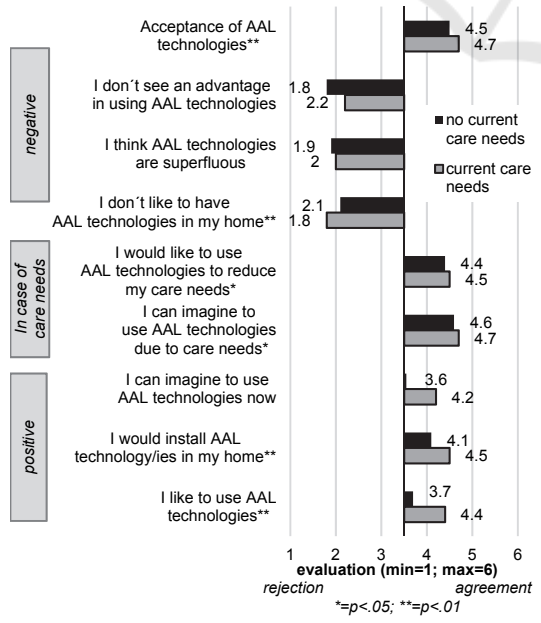

Figure 5: Evaluation of AAL acceptance depending on current care needs.

Both items regarding care needs (*to reduce care needs* F(1,162)=5.321, p<.05 and *due to care needs* F(1,162)=4.441; p<.05) are only slightly more accepted by people with current care needs than by people without current care needs. The group differences became more obvious concerning the positive intention-to-use-statements: here, people with care needs clearly assessed the items *I would install AAL technologies in my home* (M_{care}=4.5; SD_{care}=1.3; M_{no}=4.1; SD_{no}=1.5; F(1,162)=7.107; p<.01) and *I like to use AAL technologies* (M_{care}=4.4; SD_{care}=1.3; M_{no}=3.7; SD_{no}=1.4; F(1,162)=13.592; p<.01) higher than the participants without current care needs.

4.2.2 User-specific Evaluation of AAL Benefits

Overall, MANOVA analyses revealed no significant omnibus effects of age, current care needs, and experiences with disabilities on the evaluation of AAL system benefits. However, single benefit items were rated significantly different depending on the user factors experiences with disabilities and current care needs. To examine these differences and to investigate which benefits are most acceptance-relevant for which user group, a stepwise linear regression analysis was conducted. First, the regression results concerning the experience with disabilities user groups are presented followed by the results for people with and without current care needs.

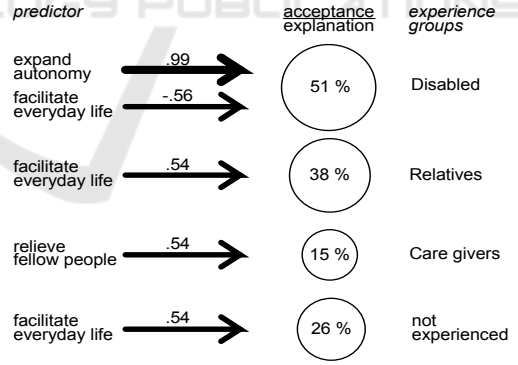

Figure 6: Results of regression analysis – benefits & acceptance for experience with disabilities groups.

As illustrated in Figure 6, the final regression model for the group of disabled participants predicted 50.5% (adj. r^2=.505) of AAL acceptance and was based on the benefits *to expand autonomy* (β = .985) and *to facilitate everyday life* (β = -.564). For the group of relatives of disabled people the model explained 37.5% of variance (adj. r^2=.375; β = .535) and for the not experienced group 25.5% (adj. r^2=.255; β = .633) each based on the benefit *to facili-*

tate everyday life. For the professional care givers the final regression model explained only 15.4% (adj. r^2=.154) and was affected by the benefit to relieve fellow people (β = .399).

Concerning the current care need groups, a comparable pattern was found for the prediction of AAL acceptance by benefits (Figure 7). AAL acceptance could be partly explained by the benefit *to expand autonomy* for the current care need group (adj. r^2=.312; β = .519) and by the benefit to facilitate everyday life for the group without current care needs (adj. r^2=.324; β = .612).

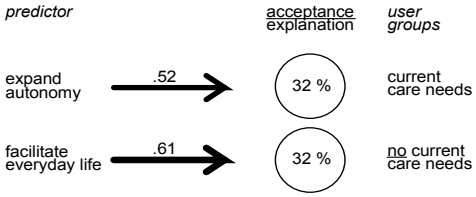

Figure 7: Results of regression analysis – barriers & acceptance for current care needs groups.

4.2.3 User-specific Evaluation of AAL Barriers

Overall, MANOVA analyses revealed significant omnibus effects of age (F(18,310)=1.939; p<.05) on the evaluation of AAL barriers. Tukey's HSD post-hoc tests revealed significant differences between the younger and both older age groups (p<.05): younger participants (M=3.8; SD=1.4) had stronger concerns about a transmission of incorrect information than the middle-aged (M=3.1; SD=1.2) or old (M=3.0; SD=1.0) participants and they (M=3.9; SD=1.6) also feared the feeling of surveillance significantly more than the middle-aged (M=3.2; SD=1.5) and old participant group (M=3.1; SD=1.3). For experiences with diseases (F(27,468)= 1.502; p<.1) and current care needs (F(9,154)= 1.894; p<.1) groups differences were in the looming. Since single barrier items were rated significantly different depending on these user factors, further regression analyses were conducted in order to find out which barriers were most decisive for acceptance for which user group. Figure 8 illustrates the results of the final linear regression analyses for all experiences with disabilities groups.

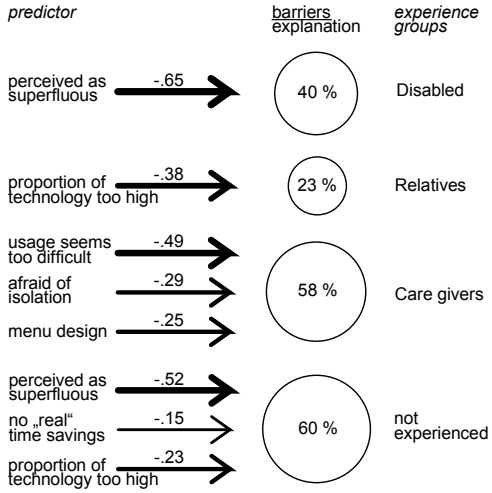

Figure 8: Results of regression analysis – barriers & acceptance for experience with disabilities groups.

For the groups of relatives, the model predicted only 23.1% of variance of AAL acceptance (adj. r^2=.231) and was affected by concerns that *the proportion of technology in everyday life is too high* (β = -.376). For the group of disabled participants, the model explained 39.9% of AAL acceptance variance (adj. r^2=.399) based on the barrier *to perceive AAL technologies as superfluous* (β = -.649). Further, the final model predicted 58.3% (adj. r^2=.583) of variance for the professional care giver group and was affected by the barriers *usage seems to be too difficult* (β = -.494), *to perceive AAL technologies as superfluous* (β = -.293), and *to be afraid of isolation* (β = -.249). For the not experienced group, the final model explained 60.2% of AAL acceptance variance based on the three barriers *to perceive AAL technologies as superfluous* (β = -.520), to expect *no "real" time savings* (β = -.154), and the concerns that *the proportion of technology in everyday life is too high* (β = -.227).

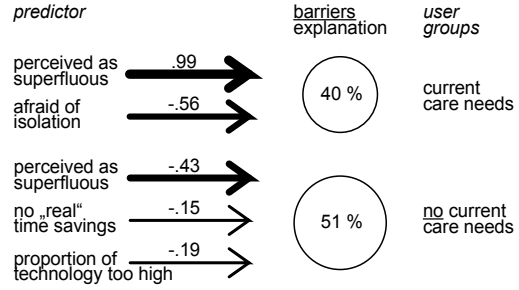

Figure 9: Results of regression analysis – barriers & acceptance for current care needs groups.

Regarding the current care need groups, a comparable pattern was found for the prediction of AAL acceptance by barriers (Figure 9). AAL acceptance could be partly explained (39.7%) by the barriers *to perceive AAL technologies as superfluous* (β = -.422) and *to be afraid of isolation* (β = -.216) for the current care need group (adj. r^2=.397). For the group without current care needs, the final model predicted 48.9% variance of AAL acceptance (adj. r^2=.489) and was affected by the three barriers *to perceive AAL technologies as superfluous* (β = -.426), the concern that *the proportion of technology in everyday life is too high* (β = -.189), and the expectation of *no "real" time savings* (β = -.153).

5 DISCUSSION

This study revealed insights into acceptance patterns concerning AAL systems in home environments. In order to understand specific needs of diverse future users, we considered and compared different user perspectives regarding distinct experiences with respect to disabilities and care needs. The results provide valuable insights into user-specific acceptance-decisive factors of AAL systems and should be taken into account for development, design, and configuration of AAL systems as well as in future studies concerning the acceptance and adoption of AAL systems.

5.1 Acceptance of AAL Systems

Align with previous research results (e.g., Gövercin et al., 2016) our results show that a holistic AAL system with a wide spectrum of functions (see 3.3) is generally accepted and rated positive by all user groups. Especially in the context of care needs, the intention to use such a system is universally present and differs only slightly with regard to the different user perspectives. Whenever hypothetical care needs are mentioned in an intention-to-use-statement, they are more important than other wishes or concerns and the AAL system would be used in this context.

However, if a concrete intention to use is mentioned without the context of care needs, significant differences between the user perspectives become apparent: in tendency, older people, disabled people, and people in need of care indicate a clearly higher intention to like to use an AAL system currently or to want to install an AAL system in their home environment than presumably healthy people without experiences with disabilities or care needs. Hence, the facts that people are concerned with health issues and needy influences the intention to use an AAL system. Concerning age, this aligns with previous research results where older participants also indicated higher acceptance scores of assisting technologies than younger people (e.g., Wilkowska et al., 2012). In contrast, this is a comparatively new phenomenon with regard to diseases and disabilities.

With regard to the different user perspectives, the group of professional care givers is striking concerning their evaluations: in comparison with all other groups they indicated to have a more negative attitude towards AAL systems (Klack et al., 2013). This was also true for the evaluations in the preceding interviews, where AAL systems were partly described as spooky or inhuman. In line with previous research results, we assume that this group takes a critical attitude due to concerns to be replaced by technology, a lower general trust in technology, and maybe also due to concerns about a difficult handling of technology (see 5.2).

In conclusion, this study's results show that the acceptance of AAL systems depends on the user factors, age, experience with disabilities, and current care needs. Equally, reasons for use or non-use of an AAL system differ with respect to user diversity.

5.2 Acceptance-Decisive Factors

The evaluation of motives to use and perceived barriers not to use an AAL system differed with regard to user diversity.

Disabled people and participants with current care needs described the within the scenario pictured AAL system in particular as helpful, comfortable, and very useful. For this people, it is most important that applied technologies help to *expand their autonomy*. Facilitation of everyday life is comparatively incidental or even not desired as most people of this groups want to cope with as much everyday tasks as possible on their own. Hence, in this way AAL systems could be very enriching for those people helping them to help themselves. Concurrently, it is striking for this group, that the main perceived benefits carry greater weight than the perceived barriers. The most important barrier for this people represents the aspect that AAL systems are *seen as superfluous* which refers to concerns that the technology undertakes tasks the people would like to do autonomously. Thus, this aspect is the most important benefit's counterpart and emphasizes the importance of autonomy for this specific user group.

The perspective of relatives of disabled people can be best compared with the disabled people's

perspective: for them, also the perceived benefits are in tendency more important than the perceived barriers.

In contrast, in line with previous results (Himmel et al., 2013) for people without current care needs and also the other experience with disabilities groups, the benefits *facilitation of everyday life* and *relief of fellow people* are the main motives to use AAL systems. Moreover, for the not experienced group and the group of professional care givers, the most perceived barriers carry clearly more weight than the perceived benefits of AAL systems. This fits the pattern, that the professional care givers described the scenario's AAL system primarily as spooky and undesirable (see 3.2 and 5.1). However, the perceived barriers differ between these two groups. The care givers are especially worry about a difficult usage of the technology as they maybe assume that the workflow is affected and slowed down by difficulties due to handling the system. In contrast, the not experienced group doubts about if the technology is necessary and a too high proportion of technology.

On the basis of these results, we suggest to include disabled people into early development stages of AAL technologies in order to reach technical solutions that are personalized and sufficiently adapted to individual requirements. Thus, not only facilitating and management of everyday life at home can be ensured but also the inclusion in working and leisure time within the whole society.

5.3 Limitations and Future Research

Our empirical approach provided valuable insights into the acceptance of AAL systems considering different user perspectives. However, some limitations concerning the applied method and sample should be taken into account. As the present study was a first approach to compare different user perspectives, it had to be concentrated on the general acceptance of a holistic AAL system and the evaluation of crucial benefits and barriers. In future studies, we will consider other aspects, e.g., relationship between privacy and safety, trade-off between perceived benefits and maybe perceived intrusion of privacy, that have not been taken into account so far.

Further, the evaluation referred to a holistic AAL system with different functions and technologies, as this study aimed for an assessment of a whole system and not of single technologies, which are largely researched. In future studies, it has to be examined if scenarios with slightly divergent descriptions (e.g., adding or changing functions) of a holistic AAL system will be evaluated differently.

It has also to be mentioned that the evaluation was based on a scenario and thus, on a fictional and not on a real AAL system. At a later stage, an evaluation of the real AAL system and also a comparison between the scenario and the real system evaluation would be very interesting.

Also some aspects concerning the sample could be enhanced and pursued in future follow-up studies: first, this study's sample size was adequate, but the study should be replicated in even larger and especially more representative samples. In particular this was true for gender: as this study contained a higher number of women than men, future studies should focus on more gender-balanced samples. Second, correlations revealed that age was not related to disabilities or current care needs. Hence, our study reached similarly younger as well as older people with disabilities. To be able to focus on the new phenomenon of "old" disabled people (Poore, 2007), future studies should also try to reach a higher proportion of old and disabled people. Nevertheless, this study enabled a first analysis of the relationship and influences of age, experiences with disabilities, and current care needs on the acceptance of AAL systems. This relationship should also be addressed in future studies and with regard to aspects that were not considered in detail in this study, e.g., the trade-off between safety and privacy or attitudes towards data security and privacy.

Finally, as this study focused German participants, it represents a perspective of only one specific country with a specific health care system. For future studies, our approach should be applied in other countries to compare AAL acceptance and future users needs depending on different countries, their specific health care systems, and cultures.

ACKNOWLEDGEMENTS

The authors thank all participants for their patience and openness to share opinions on a novel technology. Furthermore, the authors want to thank Lisa Portz for research assistance. This work was funded by the German Federal Ministry of Education and Research project Whistle (16SV7530).

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