Exploring Trade-offs in the Attitude towards Digital Technologies like AAL: An Empirical Study on Conditionals for AAL Acceptance

Eva-Maria Schomakers[a], Anne Kathrin Schaar[b] and Martina Ziefle[c]
Human-Computer Interaction Center, RWTH Aachen University, Aachen, Germany

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Abstract: Currently the digitisation entails a wide portfolio of technical solutions that are perceived to be useful for care and support of older people in the future. In approaches like Ambient Assisted Living (AAL), different (medical) technologies are merged to customizable concepts that offer support for an independent and safe living at home. Based on the principles of ubiquitous computing health relevant services, e.g., measurement of vital parameters, can be provided and take serious actions if necessary. Beside the challenge to integrate the technological issues, the attitude of potential users is still not fully understood and far from predictable. Especially when it comes to formation of a general attitude towards AAL technologies there is relatively little knowledge about the trade-offs in the decision-making process. That is why this paper focuses on conditionals and trade-offs in the acceptance process of AAL technologies. The chosen mixed-method approach consisting of a qualitative study (n=10) and a questionnaire survey (n=177) revealed a set of influencing factors that are related to privacy and situational and ethical conflicts.

1 INTRODUCTION

Would you decide for you mother to use AAL in her home if the only alternative for her is moving to a nursing home?
Would your decision change if she is against AAL monitoring?
What if your mother suffers from dementia and does not comprehend the consequences of using AAL anymore?

With these questions in mind, this introduction focuses on the consequences of digitisation as well as social and structural change processes to motivate the investigation of the acceptance of Ambient Assisted Living (AAL) technologies.

Currently the fundamental digitisation of our society leads to massive technological progress in all spheres of life. In the context of ageing, care, and medical support these new technological opportunities offer solutions for challenges that arise from the demographic change. Especially in western industrial countries where ageing societies require solutions for a declining number of caregivers, rare places in nursing homes, and an increasing amount of people with need for support (Abbing, 2016), this potential should be turned into value. Besides technological aspects, the user's attitude towards such technologies is an integral part of a successful implementation. Especially in the context of AAL where the associated technologies become part of their users home environment the acceptance of potential users is essential.

Therefore, the presented research aims to investigate conditions of AAL acceptance. Research has already gained insights into pro and contra motives for acceptance and use of AAL technologies (for a review, see e.g., (Peek et al., 2014)), but so far the conditions of usage and their impact on the decision-making process are not fully understood. To understand the complex process of AAL acceptance or rejection, more insights into the trade-offs that are performed during this process are needed. That is why our focus is primarily on conditions that are posed for the use of AAL, particularly conditions regarding the circumstances of AAL use as well as ethical aspects.

A mixed-method scenario-based approach was chosen to reveal conditions for AAL acceptance with focus on existing moral concepts of potential users and their influence on AAL acceptance in the future. Thereby, the integrated interview study is executed

[a] https://orcid.org/0000-0002-7650-2686
[b] https://orcid.org/0000-0002-8643-6213
[c] https://orcid.org/0000-0002-6105-4729

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to identify a factor space to understand trade-off decisions and ethical considerations holistically. The questionnaire study (n = 177) aims to quantify the influence of ethical concepts on the decision-making process for or against AAL technologies.

With more knowledge about internal and social trade-offs, emergence of decision dilemma, and relevance of acceptance parameters , scope for action can be opened up, especially at the societal level. This knowledge can be used to stimulate a social debate on how to deal with data protection in different areas of life, or with patient empowerment in a healthcare system 4.0 (Ziefle and Schaar, 2014). Currently the time is right to integrate scientific findings to shape a society that is more digital and networked than ever before.

1.1 Technology Acceptance

Research on technology acceptance usually focuses on the adoption or rejection of technological artefacts with focus on a specific acceptance subject, object and context (Lucke and Hasse, 1998). Triggered by an increasing diffusion of information and communication technologies [ICT] in the working context in the 1980s, the interest in predicting the acceptance of these products increased massively. Established theories are based on empirical studies that have identified *perceived ease of use* and *perceived usefulness* to be central predictors for the behavioural intention to use ICT as the central element of acceptance (Davis, 1989). Models such as TAM (Davis, 1989), UTAUT (Venkatesh et al., 2003) and their extensions are still the central scientific basis of technology acceptance research today. With the extensions of the models, further factors were integrated which allow a more holistic view, also in other areas than the work context. Still, these established technology acceptance models are criticised to not fully suit to special contexts like health technologies and AAL (Vassli and Farshchian, 2018; Holden and Karsh, 2010).

1.2 Acceptance-relevant Factors in the Context of AAL Technologies

The application of findings from technology acceptance research to the field of AAL calls for a consideration of its specific circumstances of use:

First: AAL technologies are usually conceptualised for a special target group, often older adults. Due to the special addressees it is essential to take into account that the attitude towards technology might change with increasing age (Niehaves and Plattfaut, 2014). Often the decrease of cognitive performance and a lack of mental models are reasons for a decline in willingness to use technology or learn new operating concepts. For health related technologies similar patterns were identified (Arning and Ziefle, 2009) .

Second: Due to the special circumstances of use, voluntariness as well as the influence of relevant stakeholders (e.g. relatives, physicians) must be considered to include more relevant variables.

Third: At the same time we have to consider that the attitude towards AAL or other medical related technologies is heavily entangled with the perception of digitisation in general and thus the whole public debate about privacy and data security. Digital technologies, which are based on the collection, analysis, and storage of large amounts of (personal) data, trigger privacy concerns as users feel to have lost control over their data (European Commission, 2015). Moreover for AAL, technologies are integrated into our home environments, for many a safe haven of privacy in our networked world. Therefore, privacy concerns have been identified as one of the main barriers for the acceptance of AAL (Peek et al., 2014).

Fourth: Ageing, care, and illnesses are intimate aspects of life that touch the dignity of affected persons. Besides cost savings, technological feasibility, and the mere usability of technologies, the implementation of AAL should also place importance to the individual wishes, needs, and resentments of each senior. Not enough is yet known about the conditions regarding the circumstances and ethical dilemmas in the adoption of AAL.

In summary, it can be said that AAL acceptance has to be considered as a multi-factorial and multi-criteria construct. Considering this, it is essential to focus on the dynamics of individual, social but also ethical influences and their interplay.

2 THE RESEARCH APPROACH

Addressing the above mentioned challenges and opportunities in the context of innovative medical technological approaches such as AAL, we have chosen a two-step scenario-based empirical approach with focus on situational and ethical aspects of AAL use and acceptability with the aim to better understand decisions regarding the acceptance or rejection of AAL. The included scenarios target trade-off decisions and ethical questions.

First, in interviews, motives, barriers, and conditions for users' acceptance of AAL technologies are assessed regarding AAL in general and within specific scenarios (see figure 1).

Second, this is supplemented by a quantitative as-

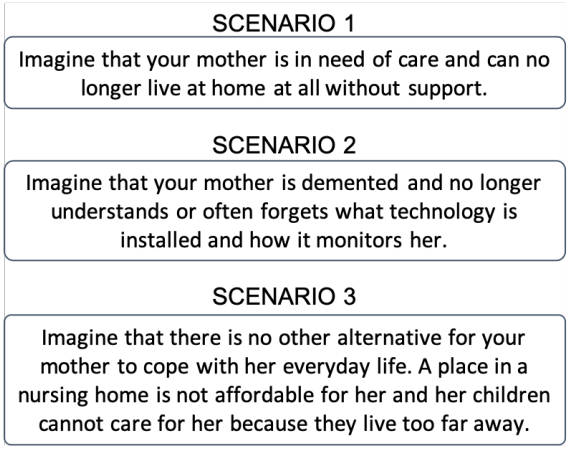

Figure 1: Scenarios Used in Interviews and Survey.

sessment of AAL acceptance in general and in the scenarios with n = 177 participants. In the following, both studies are presented subsequently.

3 UNDERSTANDING CONDITIONS FOR AAL ACCEPTANCE

This section presents the qualitative study with focus on an initial understanding of conditions of AAL acceptance including the presentation of the methodological approach, the sample, and the results.

3.1 The Methodological Approach

In 10 interviews, the participants' opinions to AAL, in general, and specific usage scenarios (see Figure 1) were explored. The interviews were conducted using a semi-structured guideline, were audiotaped and transcribed verbatim. In a conventional content analysis (Hsieh and Shannan, 2005), categories were derived for perceived barriers, benefits, and conditions for AAL acceptance. The interviews were conducted in German. Selected quotes are translated to English for publication.

The interviews started with a general explanation of AAL technologies. A scenario-based approach was used to set the participants in a situation of two siblings who try to decide whether their mother should use AAL technologies or not. Afterwards the participants were asked to state their opinions and explain their reasoning. Questions targeted under which circumstances the participants would accept AAL. Thereafter, further scenarios were presented and evaluated by the participants.

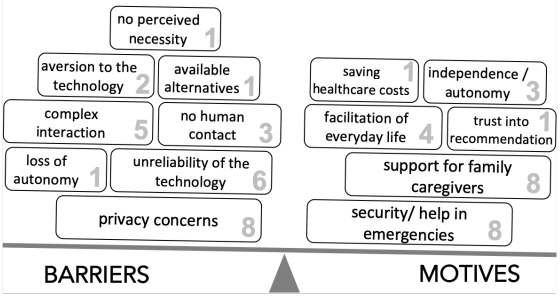

Figure 2: Stated Motives and Barriers for the Acceptance of AAL. Grey Numbers Indicate the Number of Participants Who Mentioned This Topic.

After the interview, the participants were asked to fill out a short questionnaire containing questions about demographic data, experiences with technologies and care, as well as technical self-efficacy (Beier, 1999).

3.2 The Sample

The participants were acquired via the social network of the authors with the aim to have a diverse sample regarding age, gender, and affinity for technology. 10 participants in an age range from 24 to 72 years ($M = 45.5, SD = 15.6$) (50% women) were interviewed. Occupation ranged from students, engineers, teachers, and nurses to pensioners. All participants are regular smartphone users. Their technical self-efficacy varied between 3 and 6 ($M = 4.4, SD = 1.1$; on a scale between 1 (low) and 6 (high)). Eight of ten participants have experienced close relatives to have dementia – the topic of scenario 2.

3.3 The Results

This chapter presents findings about motives and barriers of AAL use as well as conditions of using AAL.

3.3.1 Motives and Barriers

The participants mentioned multiple motives and barriers for the acceptance of AAL, which are depicted in Figure 2. Motives and barriers for the acceptance of AAL have already been widely studied in qualitative and quantitative empirical approaches (Peek et al., 2014; Offermann-van Heek and Ziefle, 2019). Therefore, the focus of this analysis lies on a short summary and on the trade-off arguments between them.

Our results show again, that privacy is the most often mentioned obstacle against AAL use. Interestingly, some participants indicated not to have privacy concerns for two different reasons: Some participants stated, that there is so much data collection from

other technologies that the additional data collection would not matter. Another participant estimated her own vulnerability to privacy risks as very low (the so-called 'optimism bias' (Baek et al., 2014)).

Most important benefits are security and support of family caregivers. One participant just stated that "humanity will benefit from it" (54, female) without specifying benefits.

One main result of the analysis is that the participants clearly weigh between the barriers they see – with privacy concerns being the most prominent one – and the benefits they perceive. The barriers and benefits are not evaluated separately but in relation and in trade-off with other relevant ones (cf. following quotes). This privacy-utility trade-off seems to be the key to understand AAL acceptance and has been studied in other contexts under the label 'privacy calculus' (Dinev and Hart, 2006).

Privacy-utility trade-off: "And if I were the one to decide, I'd think about it: What is more important? That some outsider will tap into the data at some point, or that my father will be monitored every day? Then, despite my reservations, I would opt for the technology." (62, female)

"I see the benefits more than the negative aspects. The benefit is higher than anything else I think." (34, female)

"Of course, it always depends on who you disclose your data to. But if there is a meaningful benefit, I am not that concerned." (36, male)

3.3.2 Conditions for AAL Acceptance

As this paper focuses on the conditions that are posed for AAL acceptance, especially in ethical dilemmas, the results regarding conditions for AAL acceptance are presented in detail in the following. For an overview, the identified categories are depicted in Figures 3 and 4. Many conditions centre around the characteristics and abilities of the technology. Here, one large cluster regards privacy. Other conditions centre around the circumstances of the senior and AAL application and hence show a more situational perspective on AAL acceptance. Especially in the scenarios, the opinion of the senior becomes an important condition.

Technology Centred Conditions: Nine out of ten participants stated that it is very important for privacy WHO HAS ACCESS TO THE COLLECTED DATA and that the patient has the choice. Important is also WHAT KIND OF DATA IS ASSESSED. For example, one participants would accept only 'necessary' data to be collected; others reject videos. Another important factor is the PURPOSE OF DATA USE. TRANSPARENCY and DATA SECURITY should be guaranteed for AAL.

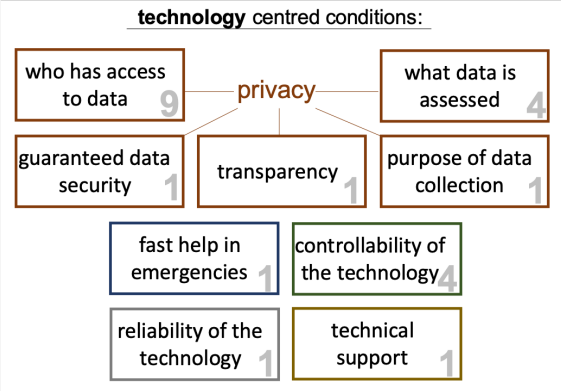

Figure 3: Identified Technology Centred Conditions for AAL Acceptance (Grey Numbers Indicate the Number of Participants Who Mentioned This Topic).

The following quotes of participants illustrate these privacy related conditions:

Who has access to the data: "I'd be worried that maybe strangers might have access to the data. And I don't think that's so nice. Only the children or the doctors or someone like that should have access to it. But no third party." (59, male)

What data is assessed: "There are no videos of it. [...] At most I see some physiological values [of my mother]. And I think that's okay. Or at what time she went to the toilet. That's not so bad." (36, male)

Purpose of data use: "But not that it's being used for advertising purposes." (72, male)

Closely related to privacy is the condition of CONTROLLABILITY OF THE TECHNOLOGY. The participants want to be able to switch off functions, decide whom to grant access to data, and when to send data.

Controllability: "Of course, with the restriction that I still have control over [the technology] myself: That I can switch it off, for example. Let's take Alexa as an example, it should not be the way that she always listens. That's exactly how it shouldn't be with the devices. They should not always be active, but I should have control over when they are switched off and when the data is passed on and when not." (45, male)

Further technology-related conditions are the RELIABILITY OF THE TECHNOLOGY, especially that emergency situations are detected reliably. AAL technologies like fall detection are also only useful if HELP ARRIVES FAST IN EMERGENCIES. Addition-

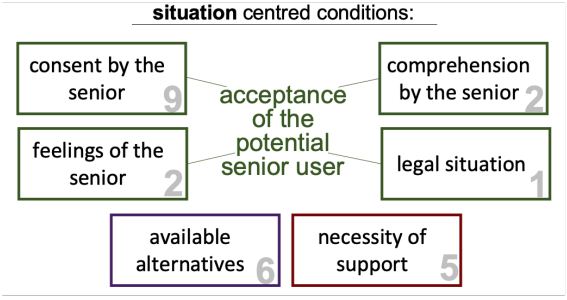

Figure 4: Identified Situation Centred Conditions for the Acceptance of AAL (Grey Numbers Indicate the Number of Participants Who Mentioned This Topic).

ally, a good TECHNICAL SUPPORT should facilitate the interaction with the technology.

This technology centred perspective shows that there are certain limits on what is acceptable, e.g., for privacy invasions, even if the benefit is perceived to outweigh these concerns. Still, these limits vary between individuals and are flexible dependent on other trade-off factors.

Situation Centred Conditions: Looking from a situational perspective which was triggered by the specific scenarios, the OPINION OF THE SENIOR is important for most participants as well as NECESSITY OF SUPPORT and AVAILABLE ALTERNATIVES.

It varies between participants and between scenarios how important the acceptance of the senior is to the participants (hypothetically in the situation of a child deciding for the parent). Most participants want to go along with the consent of the senior – even if the senior's dementia is so advanced that he/she may not be able to fully understand the technology anymore. For others, this depends on how much the senior still comprehends (COMPREHENSION BY THE SENIOR) and how strong resentments against AAL are (FEELINGS OF THE SENIOR). For one participant, the decisive argument is who is legally responsible, e.g. as a legal guardian.

Feelings of the senior: "If it's someone who doesn't mind it, then my opinion is still positive. But if someone suffers from it and feels unwell, one should refrain from the use of AAL." (45, male)

Comprehension by the senior: "If she doesn't notice anything, she won't mind." (62, female)

Legal situation: "Since she then has a legal guardian, who is not arbitrarily decided on, I find it okay [if this guardian decides regardless of her opinion]." (36, male)

If the situation makes a support by AAL technology more necessary (c.f., scenario 3), the security of the senior is taken into account and weighed against his/her acceptance. Important factors are the NECESSITY OF SUPPORT, e.g. how dangerous living alone is for the senior, and whether there are ALTERNATIVES for the care of the senior. Here again, trade-off decisions are made between the benefits of the technology and the perceived barriers.

Necessity of support: "I'd rather do it against her will and try to convince the person than see her suffer alone or vegetate at home." (24, female)

Available alternatives: "The mother can no longer cope completely on her own. What are the alternatives? Is there a nurse, can she go into a nursing home?" (62, female)

Summing up the results, people trade-off between perceived benefits and barriers to decide on acceptance of AAL and pose certain conditions that need to be fulfilled. Most relevant benefits are the improved security for the senior and the support for family caregivers. As barriers, privacy concerns and the reliability of the technologies are foreground. Using the ethical dilemmas in the scenario-based approach emphasised not only technology centred conditions like privacy and reliability, but also a situational perspective. The opinion of the potential senior user, the necessity of support, and available alternatives are important trade-off factors to be considered when deciding about the use of AAL.

With the qualitative approach, we could identify relevant factors of AAL acceptance. All participants evaluated AAL very positively in the interviews and most were also in favour of AAL in the scenarios. Because of the small sample size, these results need to be confirmed using a larger sample to make a general statement. Therefore, in a second step, AAL acceptance in general and in the scenarios was quantified with a larger sample.

4 QUANTIFYING AAL ACCEPTANCE

Based on the interview results, a short survey was developed to assess opinions regarding AAL by a larger sample. In the following, subsections the methodological approach is presented.

4.1 The Questionnaire

After an introduction to the topic AAL, the questionnaire started with demographics (age, gender, and education level). Since the focus of the study covers technology acceptance and privacy is one of the fore-

ground barriers, scales for technology commitment (Neyer et al., 2012), which represents a general attitude and acceptance of technologies, and privacy disposition (Li, 2014) are included, which represents the personality trait of how much one values ones privacy.

In the main part, AAL technologies were introduced and acceptance of AAL in general was assessed on a 1-item scale. In the following section of the questionnaire, the scenarios (cf., Figure 1) were presented and participants were asked again to indicate their acceptance for each scenario. All items were measured using 6-point Likert Scales ranging from 1 (low) to 6 (high). The reliability of the scales technology commitment and privacy disposition was confirmed by calculating Cronbach's Alpha ($\alpha > 0.7$).

4.2 The Sample

In total 177 participants completed the questionnaire. Their age ranged between 15 and 81 years ($M = 37.85, SD = 14.2$). 63% were women. Participants from all education levels were included with a majority having a higher educational attainment (23.7% upper secondary education, 52% university education).

Our sample can be described as having an affinity for technology with a result that is slightly higher than the mean of the scale ($M = 3.89, SD = 0.77$). Additionally findings show that privacy is a relevant topic within our sample. With $M = 4.17, SD = .87$ the score for privacy disposition is rather high.

4.3 The Results

The evaluation of acceptance for AAL in general and within the three scenarios is depicted in Figure 5. The overall result of the study revealed a quite high acceptance of AAL. In all scenarios, at least two thirds evaluate AAL as acceptable.

A closer look on the results shows that 87.6% of participants accept AAL in general. With a higher perceived necessity for support (scenario 1) acceptance is still higher. Only 9% of the sample reject AAL in this case. In contrast, when the potential senior user is not able to comprehend the technology and give consent to its use (scenario 2), AAL is the least accepted. 31.6% reject AAL in that case. With no alternatives of care available (scenario 3), AAL is again more accepted. In this case, more than half of the sample fully accepts AAL with only 12.4% rejecting this technology support as last resort.

These results show how the special circumstances and situational conditions change the acceptability of AAL. Still, the results are overall positive for AAL despite the ethical conflicts.

5 DISCUSSION & CONCLUSION

The fact that we are currently facing a fundamental digitisation within all areas of life leads to the necessity to explore trade-offs in users attitude towards digital services and products. This aspect of understanding users acceptance of technologies is becoming increasingly important, especially considering the capability of digital technologies to mitigate global megachallenges such as the demographic change.

AAL solutions offer the potential to adequately support the care of elderly or frail people in times of declining resources in the health care system. Through the integration of sensors, medical devices and suitable interfaces users homes can become an intelligent living space that can take on tasks and offer services in a targeted manner. However, the integration of sensors, intelligent data processing, and the exploitation of ubiquitous computing principles can also lead to barriers for the acceptance by potential users. Derived from gaps in the understanding of technology acceptance, this paper was focused on the investigation of conditions for the acceptance of AAL technologies. Particularly, the chosen approach focused on ethical dilemmas in the decision for or against AAL technologies. To understand these situation-related aspects and ethical dilemmas – which have been mostly neglected in previous research on acceptance of AAL – is important for a comprehension of the complex genesis of acceptance.

Looking at the results, it can be concluded that the chosen mixed-method design was suitable to answer our research questions and add to the understanding of potential users' decision for or against AAL technologies. In the qualitative interviews, we could, on the one hand, replicate already known findings and, on the other hand, add to a situational understanding of acceptance conditions. Known benefits, such as security for the senior and the relief of relatives as well as barriers like privacy concerns and the reliability of the technologies were confirmed. In addition, our study highlighted the genesis of technology acceptance: It made it possible to observe participants trading off benefits and barriers to come to a final decision for or against AAL technologies. This trade-off process is central to the acceptance decision.

With the use of ethically sensitive dilemmas, two types of conditions were disclosed (technology- and situation-related). Technology-related conditions like reliability, controllability or type of data access have already been discussed before (e.g., (Schomakers and Ziefle, 2019)) and are here analysed in detail. As new stimuli in the context of AAL acceptance, this study put the spotlight on situation-centred conditions that

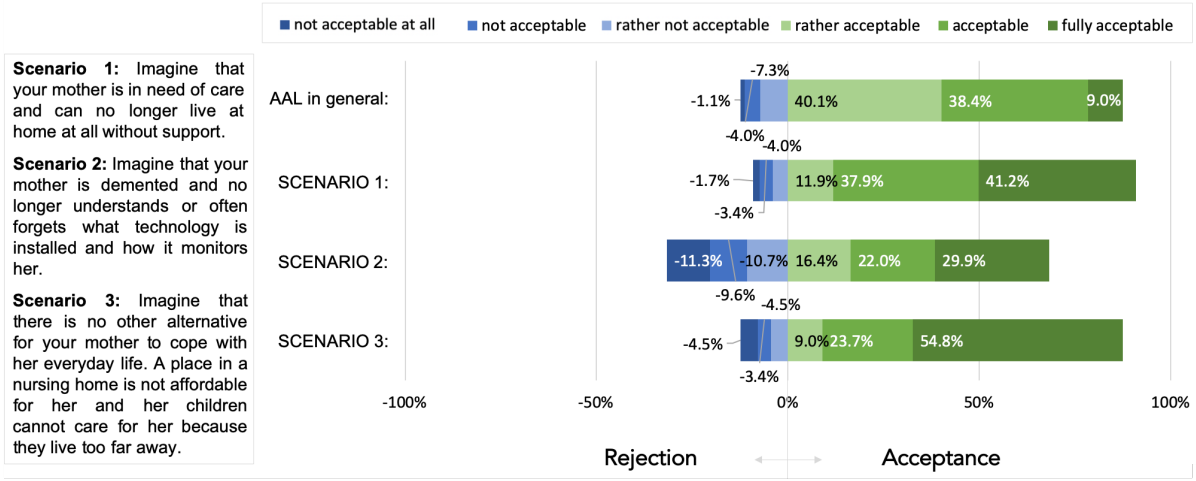

Figure 5: Acceptance of AAL: Percentage of Participants with Agreement to Each Scale Point (N = 177).

have previously been neglected in research. These are the opinion of the potential users, the necessity for support, and the existence of alternatives.

In order to come to an acceptance decision, the participants weighed positive and negative aspects of AAL use against each other. These trade-off between different conflicting factors, e.g., the support of the senior by AAL vs. the seniors rejection of AAL vs. available alternatives of care, are central to acceptance decisions. The ability to weigh the conflicting arguments for ethical reasoning is developed in childhood and throughout life (Kohlberg, 1971). Considering the ongoing digitisation and corresponding ethical dilemmas of technology use, education should support young people in learning to make these decisions and to reach an advanced level of ethical reasoning.

The quantitative survey approach could confirm the positive attitude towards AAL technologies that was also indicated by the interviews. Moreover, the influence of situation and ethical dilemma was depicted by the shifts in acceptance between the scenarios and ethical dilemmas. Most accepted is AAL when there is a high necessity for support. Resentment by the senior using the technology reduces acceptance. But still even in this scenario, more than two thirds of the participants would accept AAL technologies for their relatives. This result emphasises how important a discourse about the application of AAL in different situations and ethical dilemmas is. Also, the relevance of available alternatives of care for seniors highlights another aspect: for life in dignity and according to individual standards and wishes of each senior, the available alternatives of care should not be reduced to technological options. It is the opinion of the authors, that each senior should have alternatives to choose from how she wants to grow old and be cared for. There will always be differences in what each individual can afford. But in our opinion, seniors with less monetary resources should still be able to age in a self-determined and dignified way.

In addition to the discussion of the findings and their applicability, restrictions should also be pointed out at this point: It is obvious that the study presented can only be understood as a first step. Future work will have to go more into detail, consider the impact of diversity factors, e.g., age or gender, and check whether the trade-offs are the same in reality in contrast to our scenario-based approach. Additionally, the acceptance and trade-offs regarding specific AAL technologies in contrast to our general approach needs to be assessed. It will also be necessary to examine to what extent cultural differences have an influence on the trade-off process.

All in all, we would like to use this study to stimulate a differentiated, user-focused examination of the acceptance process, including ethical components which are an inherent part of people's living environment. With the development of technologies like AAL a discourse about the benefits and drawbacks of technology use should be aimed at. Despite other benefits, AAL should be used to improve the users quality of life and enable seniors a life in dignity. What this means and how this can be achieved is one task of user-centred research. Only if we create a deep understanding of the acceptance genesis and the influences and conditions for technology acceptance we will be able to develop suitable technologies. If one has a reliable state of knowledge on influencing factors, it would be conceivable, for example, to advise affected persons, relatives, but also professional stakeholders

in the decision-making process in order to alleviate, for example, the psychological burden on relatives as a result of decisions.

In the context of cognitive decline or dementia, concepts similar to those of living wills are conceivable. Why should one not be allowed to decide in advance on wishes and personal borders for the use of digital assistive technologies? This would relieve burdens from relatives and caregivers in times when the senior can no longer decide on her own.

This research in the special context of AAL which deals with intimacy, privacy, ageing and care highlights the importance to consider situational and ethical aspects for the adoption of digital technologies. However, this should not only be applied to AAL technologies, but to digital technologies in general. A constructive discourse on how to deal with new digital technologies is important to guide technological developments and roll-outs. Profound understanding of decision processes, influencing factors and conditions is essential for this.

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