Factors influencing trust in Ambient Assisted Living Technology: A scenario-based analysis

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Demographic aging in Germany and the related structural change in the health care sector enable a market for assistive technologies for elderly people in a home living environment. The objective of this study is a scenario-based analysis regarding trust in Ambient Assisted Living (AAL). A standardized questionnaire survey with 292 participants from 50 to 93 years of age was conducted in Germany. Two different interview groups, people who need support in daily life due to different kinds of impairment and people without need for care, have been considered. The analysis was using correlation and stepwise regression analysis. As an important finding, a strong relationship between trust in AAL and an intention to use AAL can be highlighted. The significant influencing factors on trust are expected reliability, perceived ease of use, and perceived usefulness of AAL. Information procurement, interest in technology, and perceived health status are further variables which directly influence the end-user intention to use. People with need for care showed lower trust and intention to use values than people without need for care. The analyses show additionally that younger as well as participants with better perceived health status have higher trust values and more intention to use AAL based on the two scenarios. In contrast to a former study in the AAL context, gender has no significant influence on trust. In the future, further experimental studies with focus on elderly persons' trust in AAL will be performed. These experiments will include, on the one hand, personal remote assistance for the end-user and, on the other hand, variation of actual reliability of AAL technology.

Keywords: AAL, ambient assisted living, assistive technology, older adults, trust

Demographic aging is one of the biggest challenges for society and economy worldwide[1]. In particular, Germany is affected by an aging population. In 2011, Germany has the highest percentage rate of persons aged 65 years and older within the European Union[2]. At the same time, the number of people needing care and the associated demand for home care services will increase continuously. This development is amongst others caused by the desire of more than 80% of elderly people who want to remain in their familiar surroundings despite age-related limitations and diseases[3]. Simultaneously, the effects of demographic change linked with a declining number of working people will be perceptible in the care sector. Accordingly, the increasing demand for appropriate care with home care services stands in contradiction to an acute shortage of qualified nurses[4].

Against this background in ambulatory health care, new services are needed. These services should be equipped to respond to the changing demands of elderly people to meet the highest level of autonomy and quality of care in their own homes. Beyond that, these services should also consider the future social and economic changes. Ambient Assisted Living (AAL) describes the development of concepts, products and services, using innovative information and communication technologies, to ensure and increase the quality of the users' life[5]. In outpatient care, age-appropriate, intelligent assistance systems in combination with local help services can be useful for elderly persons in need of assistance and nursing care to achieve a longer and even more self-determined life and ensure the quality of care in their familiar home environment. "The AAL domain concentrates on innovative utilization of ICT [Information and Communication Technologies], new ways of user interaction or new types of value chains for independent living services"[6] . ICT-based solutions offer a wide spectrum, beginning with the usage of social media technologies via television, tablet computer or smartphone, to strengthen social interaction and relationships[7-9]. Self-management by measuring physiological parameters such as

blood pressure and body weight at home with the aim of an application is supported by an AAL solution[10]. Also, biologically inspired stereo vision sensors and the development of algorithms for the detection of falls in the home environment belong to the area of AAL technology[11].

In addition, the use of AAL technologies by caregivers may have a supporting or relieving effect, and contributes to a cost reduction in the health and care system. To ensure the success of AAL technologies and systems, besides economic and technical aspects, the needs of the user group and several barriers need to be considered[12,13]. Furthermore, end-user trust will play a significant role in the success and use of intelligent assistance systems. For this purpose, it is essential to explore and eliminate the barriers of trust and intention to use AAL.

In this context, the present article answers the research question: What are the main determinants affecting end-users' trust in AAL systems and intention to use? To answer this question, the article is structured as follows: The background section considers the influence of demographic aging and the growing importance of technology-based support as given by AAL. Additionally, trust in automation is presented and a brief description of the Technology Acceptance Model (TAM) is given. Subsequently, the derivation of the hypotheses as well as the methodology section, including questionnaire construction, pre-test information, scale description, and sampling and procedure details, is demonstrated. Descriptive statistics, correlation and regression analysis can be found in the results section. Finally, a comprehensive discussion including hypotheses verification as well as conclusion, limitations and a presentation of further research round the article.

Background

This section starts with information about the development of AAL as a reaction to demographic aging and the care level classification according to German law. Furthermore, an introduction of trust in automation and TAM is given.

Demography and AAL

Over the past four decades, the demographic change in Germany and its impact on society and the economy have become increasingly important. This development results from the steady increase in life expectancy and a stagnating low-level fertility rate[14]. According to the German Federal Statistical Office, a population decline of up to 17 million people (20%) is expected for Germany by the year 2060. In addition to that, the low birth rate and rising life expectancy lead to a demographic shift of the population. Thus, the proportion of people aged 65 and older will increase from almost 20% in 2008 to about 29% in 2030. Following this forecast, one of three people will be aged 65 and above in 2060[15].

Changes of the age structure also have an impact on the proportion of the working population and, thus, on the German health system. In future, growing health care expenditures due to the increasing demand for health services, especially for older people, are expected[14,16]. In 2007, 5% of people aged between 70 and 74 years were in need of care, whereas 62% of people aged over 90 years were needy. In view of the aging society, a rise in long-term care is anticipated[17]. By definition of the German Federal Ministry of Health, people with need for care are assigned to one of three care levels depending on the extent of assistance. According to the German care law, persons of all ages who need permanent or at least six months of substantial assistance in personal hygiene, nutrition, mobility, and domestic help are in need of care[18].

Care level 1 (CL1) can be defined as the existence of considerable nursing care. More precisely, at least once daily, support in two or more tasks in (one or more) areas of basic care (personal hygiene, nutrition and mobility) is necessary. In addition, several times a week, support in domestic help is required. A daily average of at least 90 minutes for assistance including not less than 45 minutes for basic care occurs in CL1. In care level 2, however, personal help in basic care is needed at least three times a day. Moreover, the time spent per week amounts to a daily average of at least three hours (including two hours for basis care). Care level 3 (CL3) exists for persons who require full-time assistance, including nightly support. At least four hours of support in basic care on daily average and five hours in total will be allocated for CL3. In addition, domestic help is required several times a week in CL2 and CL3[19].

The majority of people needing care want to stay in their familiar surroundings as long as possible. In order to postpone or avoid a transfer to a residential care facility, seniors prefer to be supported by outpatient services in their own households. In 2007, 68% of the dependants in Germany were supplied at home[17]. Housing is one of the basic needs of human beings. Because of physical and mental impairments or diseases, elderly people are often reduced in their mobility. This has the consequence that the environment of individuals aged 65 years and older is largely confined to their home and direct neighborhood[12,20]. The need for age-designed homes

continues to increase[21-23]. In addition to structural alterations of housing stock and the creation of a barrier-free living environment, new technologies open the potential to increase the autonomy of the elderly. "AAL refers to intelligent systems of assistance for a better, healthier and safer life in the preferred living environment and covers concepts, products and services that interlink and improve new technologies and the social environment"[24] . Furthermore, several other definitions of AAL exist[25-27].

AAL applications are based on the use of modern information and communication technologies (e.g., sensors and actuators, wireless LAN, applications) in the immediate life and living environment of the end-user. By adapting the system to the specific needs of its users, AAL applications aim at improving the quality of life, irrespective of age and context of use[28]. In addition, AAL systems contribute to the compensation of health-related restrictions and shall allow a self-determined life. To counteract loneliness in old age, AAL solutions are developed to improve social interaction and participation[29].

The target group for AAL usage is very heterogeneous[30]. The Ambient Assisted Living Joint Programme categorized end-users into primary, secondary and tertiary users[31]. The primary end-user is actually using the AAL technology and benefits by an increasing quality of life. Persons or organizations which are directly in contact with the primary end-user (e.g., family members, friends, care organizations or neighbors) are called secondary end-users. Private or public organizations and institutions (e.g., public sector service organizers, insurance companies or social security systems) are tertiary end-users of AAL. This type of end-user is not directly using AAL but benefits "from increased efficiency and effectiveness which result in saving expenses or by not having to increase expenses in the mid and long term"[31].

AAL can ensure an adequate supply to improve health care systems in the health sector as well as costs savings[32]. AAL is characterized by a high degree of complexity that results from the different needs of users. This complexity is not tangible for the end-user, as only the visible user interface is necessary for using. Despite of that, the user has to trust that AAL technology works reliably.

Trust in automation

The core function of trust should be the reduction of complexity and uncertainty despite a lack of information. Trust enables the capacity to act in risky and uncertain situations[33]. In addition, trust plays an important role in overcoming the perceived risks and uncertainties associated with the use of new technologies[34]. Against this background, trust seems fundamentally important, especially in the course of increasing environmental complexity and uncertainty. As seen by Lee and See: "Trust in automation guides reliance when the complexity of the automation makes a complete understanding impractical"[35].

In addition, the calibration of trust plays an essential role in the use of automation[35]. Several studies have shown that people are more willing to rely on automation they trust and reject automation they distrust[35,36]. Thus, according to Lee and Moray[37,38], the use of automation is positively influenced by users' trust. Moreover, it should be added that individual differences in personality and perception mediate the connection between characteristics of a machine and users' trust[39]. Unless the user is not aware of the true performance of the system, overreliance, rejection of technology, as well as improper use are possible outcomes[40]. Research shows that trust perceptions vary quite dramatically as a function of reliability[41].

Various areas have a long tradition in research of automated systems and trust. Trust in automotive[42-44], aviation[45-47], combat identification[48-50], supervisory control systems[37,51,52] or human-robot interaction (HRI)[52-54] is a focus of attention in science. In contrast, trust in medical technology, and especially AAL, is still in its infancy. By performing a literature review, a large number of factors within studies regarding trust in healthcare and assistance systems can be identified[50]. Besides trust, technology characteristics like reliability, ease of use or perceived usefulness were detected and need to be analyzed in more detail.

Due to the high degree of complexity and the fact that in crucial situations like falls or fire AAL is installed to rescue a person's life, end-users' presence of trust is essential. "Trust in Ambient Assisted Living (AAL) can be defined as the attitude that an assistive technology supports an impaired person within [its] social environment in an uncertain and vulnerable situation"[55].

The success of new technologies in terms of use behavior depends on technological and trust issues[56]. A previous requirement analysis of 50 elderly people in the AAL context revealed high trust values, especially for sensors in the accommodation. Moreover, the constructs of reliability and perceived ease of use were mentioned by the elderly as highly important for the existence of trust in AAL[57]. Following these results as well as the knowledge of the literature review, the variables of the TAM[58] seem to have an influence on trust in AAL. For this reason the TAM

and further developments are introduced and afterwards used to build the hypotheses.

Technology Acceptance Model

The Technology Acceptance Model (TAM) was developed by Davis[58] and addresses the assumption that user acceptance is the crucial factor for success of new information systems. TAM is also evolved to provide implications for practitioners regarding the design of system characteristics in order to improve user acceptance[59]. Aligned with the Theory of Reasoned Action (TRA) which was proposed by Fishbein and Ajzen[60], the model examines the causal relationships between external stimuli, cognitive response, affective response, and behavioral response. It specifies perceived usefulness and perceived ease of use as the two most important determinants of user acceptance[61]. As defined by Davis[61], perceived usefulness is an indicator for the extent of job performance improvement perceived by a person who applies the new system. Perceived ease of use, however, measures the degree to which the person assumes that the new information system can be used nearly without effort. Both factors determine the attitude toward using the system. For the definition of the attitude toward using, principles from the TRA are employed[60]. According to the authors' findings, attitude toward using measures "the degree of evaluative affect that an individual associates with using the target system in his or her job"[59]. The attitude toward usage affects the behavioral intention to use, which leads to actual usage. The model not only confirms direct causal effects which external stimuli have on perceived usefulness, perceived ease of use, and attitude toward using, but also specifies a significant impact of perceived ease of use on perceived usefulness. Instead, usefulness does not influence ease of use, but rather the behavioral intention to use[62]. However, caution should be exercised by interpreting the results of the model because it is an instrument to measure perceived use and not actual usage[63,64].

The TAM was developed over time and has been applied and modified in different application fields[65-67]. For example, Hu et al. [68] examined the applicability of the TAM in explaining physicians' decisions to accept telemedicine technology in a health care context. Pavlou[56] and Grefen et al. [69] applied the TAM in the field of electronic commerce and modified the model by integrating trust issues. Additionally, the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. [70] assessed eight theoretical models which focused on intention to use respectively, with usage being the dependent variable. In context of assistive social agent technology, the UTAUT was used for testing the acceptance of older people[71]. The present study is not aimed at a further development of TAM or UTAUT. Instead, the trust factor is at the center of interest in this investigation. The aim is to highlight the influence of variables on trust of older people in AAL technology and also to assess the impact on the intention to use. For that purpose, both variables of the TAM and additional variables are used. These variables are explained as follows.

Hypothesis development

The present study analyzes different influencing factors on trust in AAL technology (T_{AAL}) and intention to use (IU). Various demographics and personal factors as well as the differentiation between persons with care level 1 (CL1) and without care level (WCL) have been considered.

First of all, the interconnection between T_{AAL} and IU will be clarified by means of the main hypothesis (H1). These two variables are then examined by the split into the CL1 and WCL groups. Afterwards, eight further variables are introduced and taken into account for the consideration of T_{AAL}. To begin with, the three variables chronological age (CA), perceived health status (PHS) and gender (G) are considered. Additionally, the external variables perceived usefulness (PU), perceived ease of use (PEOU), expected reliability (ER), interest in technology (IT), and information procurement (IP) are investigated.

Intention to use (IU)

Intention to use as a variable is adapted from the TAM variable behavioral intention to use and upstream to the actual system use[61]. Intention to use AAL technologies characterizes the determination of a person to use the technology. The usage of AAL is a joint target for developers and service providers. As seen before, three different end-user types participate in actual usage of AAL. Altogether, multiple variables cause the actual usage. Within this study, the importance of primary end-users' trust in AAL will be analyzed. The construct of trust itself is influenced by further variables which are presented in detail afterwards. Summarizing, it can be expected that if an impaired person trusts an assistive technology, there will be a higher intention to use. Therefore, the main hypothesis can be stated:

H1. *Intention to use is positively influenced by trust in AAL technology.*

Care Level 1 (CL1)

Persons with physical, mental or psychological illness or disability can be assigned to care levels 1 to 3[18]. As defined by BMG, people who need

support in domestic help several times a week and, furthermore, assistance in areas of basic care such as personal hygiene, nutrition and mobility for at least 45 minutes per day might apply for CL1[19]. As seen, persons with CL1 have different kinds of impairments and form a heterogeneous group, but everyone with CL1 is receiving support in daily life. This fact is accompanied by an awareness of support. People with CL1 know about the importance of personal care and are able to imagine how technological assistance could improve their housing situation. Thus, the second hypothesis to be tested is:

H2. *Trust (a) and intention to use (b) are positively influenced by care level 1.*

Chronological age (CA)
Chronological age means age measured by the date of birth, which can differ from biological, psychological or social age[72]. In literature, the elderly are often divided into third and fourth age[73-76] or into terms such as young-old, old-old as well as very-old or oldest-old[77-80]. Additional to these distinctions, cohort effects influence social age. As seen in Robinson and Jackson, a nonlinear cohort effect seems to exist in the United States. Trust increases from younger to middle age and then stabilizes[81].

The process of aging is often associated with stigma to disease and, consequently, with loss of independence. Technical solutions raise awareness of one's disability. Thus, older people are often reluctant to admit their disability and, therefore, reject technological innovations. Moreover, one can expect that lack of technical knowledge reinforces the mentioned anxieties. Therefore, an introduction in new technologies by personal assistance or an age-appropriate manual is useful. As seen in various studies, elderly people rather trust in technological devices compared to younger people[82-85]. Regarding the complexity and, thus, the necessity of older persons' trust in automation, it can be assumed that:

H3. *Trust in AAL technology (a) as well as intention to use (b) are positively influenced by chronological age.*

Perceived health status (PHS)
"Health is a state of complete physical, mental and social well-being and not merely absence of disease"[86]. The perceived health status designated the individual's perception of health. Preservation of health and the associated long life at home is a basic need which cannot be achieved without support from many people. Technical support by AAL systems offers a possibility for a self-determined life in a home environment. Dependent on the current perceived health status, elderly people have the ability to deal with new technology or to get help from their relatives. For people with a lower perceived health status, trust in other people who provide care as well as assistive technology is gaining importance. Therefore, the following hypothesis can be suggested:

H4. *Trust (a) and intention to use (b) are negatively influenced by the perceived health status.*

Gender (G)
The next variable - gender - could be of interest in the development of AAL technology. Due to the fact that women have a higher life expectancy than men and more often live alone in old age[87], AAL should be designed considering female special demands. Despite this fact, Steinke et al.[57] found out which men have higher trust scores in AAL sensors than women. Following this former result, the next hypothesis can be assumed:

H5. *Trust (a) and intention to use (b) are positively influenced by the male gender.*

Perceived ease of use (PEOU)
Perceived ease of use is "the degree to which a person believes that using a particular system would be free of effort"[61]. End-users who have little or no experience with technical devices need an understandable and user-friendly design to build trust. The appearance of technology, an understandable manual or self-explanatory device as well as the personification of interfaces increase technological trust[88-90]. Moreover, positive automation etiquette[45] and notes during the usage of the technology may intensify technological trust[50,91,92]. An example could be a green lamp which signalizes the correct functionality of the device. Based on the existing literature, the hypothesis is set up as follows:

H6. *Trust in AAL technology is positively influenced by perceived ease of use.*

Perceived usefulness (PU)
The next variable, which also results from the TAM, is perceived usefulness. According to Davis[61], perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance". In the original TAM, perceived usefulness is significantly influenced by PEOU, but not vice versa. As noticed by Pohlmeyer [93], the perceived usefulness of a computer system is the main factor for elderly persons to use the system. In context of AAL, perceived usefulness is reflected by the chance for a longer and more independent life at home as well as a higher

quality of living. Following these ideas, H7 can be suggested:

H7. *Trust in AAL technology is positively influenced by perceived usefulness*.

Expected reliability (ER)
Perceived reliability of an automation influences trust in technologies[51,89,90,94,95]. End-user perception of the device's function depends on the number of occurred errors and often differs from the actual reliability of the technology. Actual reliability describes the actual performance of the technology[96-101]. Within this study, reliability should be considered expected reliability[102]. In case of medical and emergency support systems, a perfect actual reliability of the technology would be preferable in case of an emergency.

H8. *Trust in AAL technology is positively influenced by expected reliability.*

Interest and Information Procurement (IP)
The variable interest in technology (IT) describes whether the elderly enjoy testing or like to possess (new) electronic devices (*Appendix 1*). The importance of ICT in everyday life and within AAL technology ascends[6]. The study by Sayago and Blat[103] focused on everyday e-mail usage of about 400 elderly people. The key elements for e-mail usage are socialization, inclusion, and independence. The interest of using a technology additionally depends on personal interest, particularly on social circles which use the technology as well. As a well-known example, the introduction of the telephone saw interest of each person rise with an increasing number of end-users. People who are more interested in new technologies tend to use AAL technology.

The term information procurement (IP) in this paper reflects the needs of inexperienced users, to obtain information on new technologies. The additional information gained by information procurement should allow a better understanding of the product. Depending on the consequences of a wrong decision, the user "has to weigh the costs and benefits of information procurement"[104] to make a proper decision. People who are not informed about AAL technology can use various sources like friends and relatives to get informed. Summarizing, people who tend to ask their friends and relatives before purchasing new technology seem to have a higher intention to use. Thus, the last hypothesis is:

H9. *Intention to use is positively influenced by (a) interest in technology and (b) information procurement*.

Methodology

As stated above, end-user trust could play a significant role in the success and use of intelligent assistance systems. The present study attempts to determine which factors affect T_{AAL} as well as IU.

Questionnaire construction
The questionnaire considers the different influence factors on T_{AAL} and IU, which are specified in the hypotheses. The questionnaire was especially designed for a survey with the elderly. Since participants with a care level and more than 80 years old were targeted for the survey, the items from the original scales needed to be reduced with consideration of reliability and variance values. Otherwise not all influence factors could have been investigated due to the long duration which would have been unreasonable for the participants. For this reason a focus group discussion was conducted to evaluate the existing constructs. The adapted questionnaire with a total of approximately 50 questions was tested in a pre-test with older people without a care level.

The items of all scales were adjusted by using seven-point Likert-type scales. Items on the scales are anchored at 1=strongly disagree, 2=moderately disagree, 3=somewhat disagree, 4=neutral (neither disagree nor agree), 5=somewhat agree, 6=moderately agree, and 7=strongly agree. The questionnaire also collected demographic data. Nearly all scales were translated from English into German and the tense of the items was changed.

The questionnaire was supported by two different scenarios in a domestic environment in order to illustrate the topic for respondents. The scenario technique is used as a standard method for usability testing[105]. The questionnaire was designed and used in German language.

The first scenario describes an emergency situation in a household in which a person falls in his accommodation, hurts his hip and cannot stand up by himself anymore. The installed AAL technology (combination of sensors and a smartphone application) is presented as a solution to the emergency case. The second scenario describes a situation in an accommodation in which a person forgets to turn off the stove and gets reminded by the AAL technology (*Appendix 2*).

Pre-test
In March 2012, a pre-test with 64 persons aged 40 to 90 years was carried out to test the questionnaire. Participants were recruited through home care services. Participants' average age was 63.28 (SD=10.03; range=40–90). The majority of 44 respondents (69.8%) were female and a minority of 19 respondents (29.7%) male.

One person (1.6%) did not respond to this question. With respect to the housing situation, 16 respondents (25.0%) were living alone, while 48 respondents (75.0%) were living together with other persons.

The results of the pre-test showed medium to very high Cronbach Alpha values' for all scales ranging from 0.748 to 0.976. The percentage of explained variances in the principal component analysis (PCA) of the eight scales lay between 57.3% (PHS) and 92.5% (IU). Six calculated percentage variances could be assigned to the Kaiser-Meyer-Olkin (KMO) measure with values above 0.7 ('moderate to good' defined by Kaiser and Rice[106]). Two calculated percentage variances (PHS and PEOU) showed moderate to poor values between 0.5 and 0.69.

As a result of the pre-test, linguistic adaptions and a more substantial instruction of the questionnaire were made. The response format was supplemented by a 'don't know' box. Slight modifications of three scales have been made.

Scale description

The scale for T_{AAL} was adapted from Jian et al.[107]. The authors originally identified 12 potential factors of trust between people and automated systems and used these factors to develop a scale in order to measure trust in automation. Prior research in trust and automation indicated that the scale was particularly suitable for adaption in the AAL context. Seven items that represent trust in AAL technology were selected. After the pre-test, two items — "The system behaves in an underhanded manner" and "The system has integrity" — were removed from the scale, so that five items for T_{AAL} finally remained.

The construct for IU as a predictor of actual usage is based on Kornmeier[108]. The author analyzed influence factors on the acceptance of mobile communication-based payment systems. The original questionnaire comprised six indicators which were reduced to three items in the context of AAL. The only linguistic adjustment was the change of the target object by the term 'assistive technology'.

The scales PEOU and PU were based on the scales by Davis[61]. The initial scale items for PEOU contained 14 items. Half of the items turned out to be unsuitable to describe the AAL technology and have been removed for this reason. The remaining seven items were modified to suit the context of the study, e.g., the target object was changed from electronic mail system to assistive technology. No need for adjustments was indicated by the pre-test.

The original PU scale also contained 14 items. Just like the items of the PEOU scale, more than half of the items of the PU scale turned out to be unsuitable to describe AAL technology. For this reason only five items were remaining. These items were also modified to suit the context of AAL technology by changing the target object from electronic mail system to assistive technology. Furthermore, the scale was supplemented by two additional items regarding comfort and reputation after the pre-test.

The measure for ER was adapted from Montague[109]. The author developed and validated an instrument for measuring the patient's trust in medical technology. The initial scale comprised about 80 items. 31 items referred to the target object technology, with the other items including statements to health care providers. Only the sufficiently reliable items of these 31 items were included into the questionnaire. Thus, six items of those were selected and the target object was changed.

The scale measuring interest in technology (IT) is based on Karrer et al.[110]. A German questionnaire to obtain the user's handling of, and attitude toward electronic devices was developed. The questionnaire comprised a total of 19 items. Technical affinity is measured by four subscales. The subscales are enthusiasm in dealing with technology, subjective competence, perceived positive consequences of technology, and perceived negative consequences of technology. For the purposes of the present study, the scale enthusiasm in dealing with technology with five questions was selected and included in the questionnaire without further adjustments.

The scale for IP was adapted from Pütz[111]. The author examined the effects of word-of-mouth recommendations from wary recipients. To determine IP, the information procurement scale was considered suitable for the survey. Four of eight items were appropriate to determine technology knowledge. After the pre-test the wording was adjusted and an additional self-created item - "I generally buy only products that my friends or acquaintances buy" - was integrated as a control item.

The four items of the PHS scale were selected from the internationally accepted SF-36 Health Survey in German language[112]. The SF-36 is a multi-purpose, short-form health survey with 36 questions. The subscale 'general health' comprised five items which are appropriate for determining the participants' current perceived health status. Four out of these five subscale items were adapted without further adjustments to the questionnaire (*Appendix 1*).

Sampling and procedure
The actual questioning was carried out between April and June 2012. The survey included persons aged 50 years and older with and without care level 1. Afterwards, the sample was split into two groups. The first group included persons with care level 1 (CL1) and the second group persons without care level (WCL). For the purpose of the survey, persons with CL1 were selected exclusively, as these persons are less dependent on outside help in activities of daily living compared to persons with a higher care level. The participants were recruited through home care services, nursing homes, assisted-living residences, and senior clubs.

All statistical analysis was conducted using SPSS Statistics version 17.

Results

The following section describes the results of the survey. First, the descriptive statistics and validation of reliability and validity are presented. Afterwards, the findings of a correlation and regression analysis are shown.

Descriptive statistics
A total of 550 questionnaires were forwarded of which 292 participants (53%) completed the survey. Among the group CL1, 140 of 281 respondents (49%) finished the survey and 152 of 269 (56.5%) respondents of the group WCL.

The participants' average age was 74.4 (SD=10.0 median=75; range=50–93). Of the 292 respondents 190 were female (65.1%) and a minority of 95 respondents (32.5%) were male. Another 7 respondents (2.4%) left this field blank.

Among the group CL1, the number of female participants was 96 (70.1%) and that of male participants was 41 (29.9%).

A look at the sample split according to the need for care showed a slightly higher proportion of females and slightly lower proportion of males in group CL1 than in group WCL. Moreover, the persons with a need for care were on average about eight years older and lived almost twice as often alone compared to the WCL group (*Table 1*).

Validation of reliability and validity
The values of all measurement scales showed medium to very high reliability, with Cronbach's Alpha coefficient being between 0.719 and 0.961. It should be noted that the highest reliability coefficient belonged to the scale expected reliability and the lowest value to the PHS scale (*Table 2*). For verifying the validity of the individual scales also a PCA in the questionnaire study was performed. Within this PCA for T_{AAL} two factors with an eigenvalue of more than one could be extracted. Together these factors explained 78.9 % of the total variance. The loadings of the individual items on this factor ranged from 0.669 to 0.777. The scale IU reveals exactly one factor that explained 86.8 % of the variance. The factor loadings of the three items were between 0.906 and 0.951. Moreover, for both scales PEOU and ER one factor could be extracted. For PEOU the one factor explained 66.2 % (charges of the individual items on this factor ranging from 0.607 to 0.891) and for ER 83.8 % of the total variance (values between 0.871 and 0.948). The items of the scale PU all loaded on a single fac-

Table 1. Descriptive statistics of 140 participants in group CL1 (participants with care level 1) and 152 in group WCL (participants without care level)

Parameter		n		
		CL1	WCL	Total
Gender	Male	41	54	95
	Female	96	94	190
	Unknown	3	4	7
Education	No official Graduation	2	2	4
	Secondary school degree	71	58	129
	Intermediate school degree	42	44	86
	High school diploma	7	19	26
	University degree	13	22	35
	PhD	0	3	3
	Unknown	5	4	9
Profession	Technical	23	37	60
	Commercial	49	46	95
	Social / care	22	25	47
	Other	45	33	78
	Unknown	1	11	12
Housing	Alone	89	48	137
	With other persons	49	92	141
	Unknown	2	12	14
Smartphone owned	Yes	3	21	24
	No	136	127	263
	Unknown	1	4	5
Age	Mean±SD	78.2±9.5	70.9±9.1	74.4±10.0
	n Age known	139	148	287
	n Age unknown	1	4	5

Table 2. Cronbach's α and total variance explained of the eight scales used; T_{AAL}=Trust in AAL; PEOU=Perceived Ease of Use; PU=Perceived Usefulness; ER=Expected Reliability; IU=Intention to Use; IT=Interest in Technology; IP=Information Procurement; PHS=Perceived Health Status

Scale	Pre-test		Survey	
	α	Variance	α	Variance
PEOU	0.908	65.86	0.913	66.21
PU	0.965	87.79	0.927	73.32
ER	0.976	89.74	0.961	83.84
T_{AAL}	0.916	76.87	0.864	78.94
IU	0.959	92.50	0.924	86.79
IT	0.894	71.24	0.930	78.61
IP	0.867	75.50	0.914	74.85
PHS	0.748	57.30	0.719	54.51

tor which explained 73.3% of the total variance. The results of high reliability and validity were consistent with the results of the pre-test.

Correlation analysis

A correlation analysis has been conducted to obtain a first overview of the significant correlations between the variables, particularly of T_{AAL} and IU. The high correlations between the different variables indicate multicollinearity (*Table 3*). To identify multicollinearity between these variables and a causal connection, two stepwise regression analyses were conducted in the next step.

Regression analysis

The first analysis (*Table 4*) included PU, PEOU, ER, IT, IP, PHS, gender, age, and CL1 as predictors and T_{AAL} as the dependent variable. The results showed that only the variables ER (t=8.90, p<0.01), PEOU (t=4.46, p<0.1) and PU (t=2.48, p<0.05) were statistically significant. They explained 50.4% of the variance of the dependent variable T_{AAL} (adjusted R^2=0.504, p<0.01).

The second analysis (*Table 4*) included T_{AAL} and the variables IT, IP, PHS, gender, age, and CL1 as predictors and IU as the dependent variable. The results showed that the variables T_{AAL} (t=7.50, p<0.01), IT (t=5.98, p<0.01), IP (t=3.88, p<0.01), and PHS (t=-2.07, p<0.05) were statistically significant. They explained 40.1% of the variance of the dependent variable IU (adjusted R^2=.401, p=<o.01). The variables gender, age and CL1 were excluded due to the insignificant correlation with IU.

The connections between the variables and T_{AAL} as well as IU could be visualized (*Figure 1*).

Table 3. Correlation matrix of included parameters with two-tailed tests of significance; T_{AAL}=Trust in AAL; PEOU=Perceived Ease of Use; PU=Perceived Usefulness; ER=Expected Reliability; IU=Intention to Use; IT=Interest in Technology; IP=Information Procurement; PHS=Perceived Health Status; CL1=Care Level 1; HS=Housing situation; in bold: p<0.01; in italic: 0.01<p<0.05

	T_{AAL}	PEOU	PU	ER	IU	IT	IP	PHS	CL1	Male	Age
PEOU	**0.49**										
PU	**0.50**	**0.31**									
ER	**0.63**	**0.40**	**0.62**								
IU	**0.51**	**0.32**	**0.70**	**0.57**							
IT	**0.34**	**0.32**	**0.46**	**0.36**	**0.54**						
IP	-0.04	**-0.25**	**0.22**	0.08	**0.19**	*0.14*					
PHS	**0.20**	**0.25**	*0.14*	**0.24**	*0.13*	0.09	**-0.33**				
CL1	*-0.12*	*-0.12*	**-0.15**	-0.11	**-0.23**	**-0.27**	0.07	**-0.32**			
Male	-0.01	0.00	-0.05	-0.05	-0.04	**0.18**	0.04	-0.11	-0.07		
Age	**-0.20**	**-0.36**	-0.08	-0.08	-0.11	**-0.26**	**0.27**	**-0.27**	**0.39**	-0.04	
HS	0.12	**0.25**	0.06	-0.03	0.04	0.11	**-0.20**	**0.17**	**-0.30**	**0.23**	**-0.45**

Table 4. Stepwise regression in model 1 of T_{AAL} (Trust in AAL) and IU (Intention to Use); ER=Expected Reliability.; IP=Information Procurement; IT=Interest in Technology.; PEOU=Perceived Ease of Use; PHS=Perceived Health Status; PU=Perceived Usefulness

Predictor	Coefficients			t	p
	B	SD	ß		
DEPENDENT VARIABLE: T_{AAL} (TRUST IN AAL)					
(Constant)	1.136	0.254		4.47	0.000
ER_Mean	0.459	0.052	0.509	8.90	0.000
PEOU Mean	0.173	0.039	0.218	4.46	0.000
PU_Mean	0.125	0.050	0.135	2.48	0.014
DEPENDENT VARIABLE: IU (INTENTION TO USE)					
(Constant)	-0.015	0.459		-0.032	0.974
T_{AAL}_Mean	0.489	0.065	0.386	7.50	0.000
IT_Mean	0.304	0.051	0.308	5.98	0.000
IP_Mean	0.212	0.055	0.195	3.88	0.000
PHS_Mean	0.122	0.059	0.105	2.07	0.040

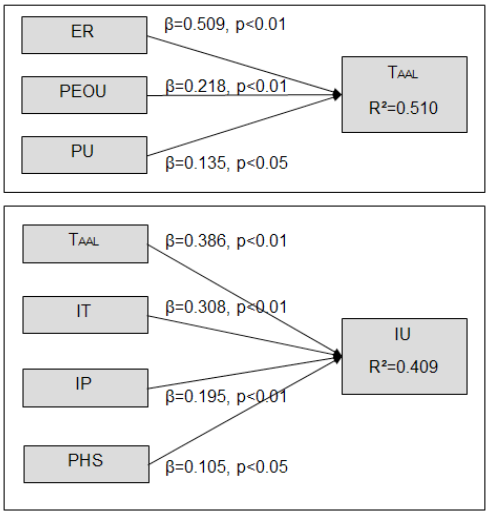

Figure 1. Visualization of the Regression Analysis on TAAL (Trust in AAL); ER=Expected Reliability; PEOU=Perceived Ease of Use; PU=Perceived Usefulness) and IU (Intention to Use; TAAL=Trust in AAL; IT=Interest in Technology; IP=Information Procurement; PHS=Perceived Health Status)

Discussion

First of all, it seems to be useful to visualize the outcomes of the hypothesis test for a structured interpretation (*Table 5*). With the aim of our hypotheses, the above-introduced research question - "What are the main determinants affecting end-users' trust in AAL systems and intention to use?" - will be answered.

Starting with the main hypothesis (H1), it can be clarified that there exists a strong significant positive relationship between trust in AAL technology and usage intention of the two described AAL solutions. As expected, elderly people who trust AAL are more willing to use the technology in a second step. This result is analogous to previous studies[56] which show a positive relation between these two constructs. Despite of these findings, it should be qualified that intention to use as a prediction is not automatically actual usage.

The next hypotheses regarding care level 1 (H2a; H2b), chronological age (H3a; H3b) and perceived health status (H4a; H4b) can be rejected. As seen in the results, the care level 1 factor has a significant negative correlation on trust and intention to use. This means that people without care level 1 have higher trust and an intention to use AAL technology. Moreover, younger participants and people with better perceived health status show higher trust and intention to use values. It should be mentioned that as seen by the descriptive statistics, the mean age of persons with care level 1 is nearly eight years higher than the group without a care level. The analysis revealed that chronological age is related to care level 1 and also with perceived health status. It can be expected that age, as integrated within these two variables, has an indirect influence on trust and intention to use. These results are contradictory not only to the hypotheses but also to the original idea of AAL. The present study highlighted that younger people with a better perceived health condition are more willing to use AAL.

Moreover, gender has no effect on either trust or on intention to use AAL. The previous results which show that men have higher trust in AAL sensors[57] cannot withstand in the larger sample. Thus, H5a and 5b can be rejected.

The three influencing factors perceived ease of use, perceived usefulness and expected reliability are positively connected with trust. Furthermore, hypotheses H6, H7 and H8 can be verified. Perceived ease of use is highly correlated with trust and the results are analogous to previous studies[56,57]. If older people have the feeling of an easy handling of the application, this can subserve building trust. Moreover, perceived usefulness by the AAL solution was positively influencing trust. In the original TAM[61], perceived usefulness was directly connected with intention to use. In this study, trust seems to serve as a mediator. Experimental studies need to investigate this connection further. Due to the importance of AAL for maintenance of health, it is comprehensible that

Table 5. Supported (is) and not-supported (is not) hypotheses on trust in AAL technology (TAAL) and the intention to use it (IU)

Parameter 1	Influence		On parameter 2	Hypothesis code
	positive	negative		
TAAL	is		Perceived ease of use	H6
	is		Perceived usefulness	H7
	is		Expected reliability	H8
	is not		Chronological age	H3a
	is not		Male gender	H5a
	is not		Care level 1	H2a
		is not	Perceived health status	H4a
IU	is		Trust in AAL	H1
	is		Interest in technology	H9a
	is		Information procurement	H9b
	is not		Chronological age	H3b
	is not		Male gender	H5b
	is not		Care level 1	H2b
		is not	Perceived health status	H4b

expected reliability influences trust. Reliability and the impact of perfect vs. imperfect automation can be found in other multiple areas as an influencing factor for trust as well[35,92,97].

Interest in technology and information procurement are further variables with a positive influence on AAL intention usage. People who are interested in new technologies have a higher intention to use AAL. Information procurement as an influencing factor is also positively correlated with intention to use. Thus, H9a and H9b can be verified.

Conclusion

Summarizing, the present study revealed perceived ease of use, perceived usefulness, and expected reliability as determinants for older people's trust in AAL technology. Furthermore, trust as well as interest in technology and information procurement influenced the intention to use AAL. Counter to the idea of developers of AAL products, people without a care level, who do not need support by public or private organizations, showed higher values for trust and intention to use. In contrast, the sub-sample comprising CL1 people of a higher age on average showed lower values.

In total, AAL technology is not well known in society today. Based on the results of the present study, some implications for marketing of AAL and the health care market can be derived. Reliability of AAL is an extremely important factor to generate trust. Moreover, perceived ease of use, for example, was increased by tablets, which are simple to handle, or well-written manuals, and perceived usefulness by enhancement of older people's involvement could lead to higher trust in AAL.

Trust as an influencing factor with the highest explanatory value for intention to use should be moved into focus. These results should be taken into consideration during development of AAL products; not only at the moment at which the advertising campaigns start, but much more earlier, the requirements of the target group must be taken into account. Regardless of gender, marketing activities for AAL should inform relatives and children, since information procurement also influences intention to use. Target group-specific information management can increase the social relevance of AAL. Within the health care market, assistive technology which supports human care givers is already growing in importance. Focusing on the trust factor in AAL could help to achieve a better reputation. Currently, there is no established market for AAL technology in Germany. Assuming that in future Germany's population is ageing furthermore and will also have a greater affinity for technology, it can be recommended to reinforce and expand the AAL market. However, beside economic and technical aspects, the special needs and requirements of each user group should be considered to ensure a successful implementation of AAL. The success of AAL is strongly dependent on whether user barriers are taken into account.

Limitations

Although the first part of the questionnaire introduced the AAL technology as well as the terms 'smartphone' and 'sensor', some respondents have indicated that they were not able to imagine how the technology works. This was not only due to the fact that the operation of the technology was not understandable, but might also be due to general attitudes of older people. This leads to the question on which knowledge base some of the participants have answered the questionnaire.

Furthermore, it is relevant to note that the used survey instrument was extensive with eleven pages. Therefore, the question arises as to what extent the accuracy of the item response was negatively affected by the time required. Some responses might also be arbitrary. Additionally, high numbers of missing values (n=77 to n=93) in the scale 'expected reliability' were found. These findings may indicate that the items were difficult to understand or due to a lack of understanding concerning the new technology not being sufficient to assess by the questionnaire.

However, a negative attitude toward the support technology has been observed in some participants. Especially, the planned use of sensors to support (health) risk situations met with strong reservations of some people. This follows on to the fact that external factors and personality traits are further determinants which influence the responses. Due to the participants' age and the length of the already existing questionnaire, no further variables could be explored.

Further research

As seen in the previously performed literature review, the key finding was that the examination of trust in context of AAL technology needs to intensify[55]. This paper deals with 292 participants over 50 years old and, therefore, a large sample compared to previous studies. By using a scenario-based approach for measuring trust in AAL, a broadened spectrum of the technology was considered. The described scenarios 'A fall' and 'The stove' are analyzed as the most critical issues for elderly people dealing with AAL.

In a next step, we plan to transfer the knowledge from the survey to an experimental setting. On

the one hand, this setting should be inspired by the results of the survey; on the other hand, a non-hazardous scenario must be chosen. Moreover, in a real-life emergency situation, an impaired person has to trust the system in absence of suitable alternatives. According to these deliberations, the following two experiments will consider situations in which participants have to handle AAL by an application on a tablet computer. The first experiment differentiates between personal remote assistance by voice over IP support and an embedded technical assistance. The second experiment examines the variation of reliability in AAL technology. In order to establish reliable information concerning the relationship of trust, use intention and actual usage, a long-term study would be needed. For this study, AAL actuators and sensors should be integrated into the home of participants and actual use should be controlled over a period of several months.

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Appendix 1. Questionnaire used in this study (in German) with a translation into English

#	Questions used	Translation
1	Mit diesen Fragen möchte ich herausfinden, wie Sie die Benutzerfreundlichkeit der Unterstützungstechnik anhand der Geschichte einschätzen würden.	With these questions, I want to find out how you estimate the ease of use of the assistive technology based on the present story.
	a Ich denke, es würde mich verwirren die Unterstützungstechnik zu verwenden.	I think it would confuse me to use the assistive technology.
	b Ich denke, ich würde häufig Fehler bei der Anwendung der Unterstützungstechnik machen.	I think I would often make errors when using the assistive technology.
	c Ich denke, der Umgang mit der Unterstützungstechnik würde mich frustrieren.	I think the handling of the assistive technology is frustrating.
	d Ich denke, ich würde bei der Nutzung der Unterstützungstechnik häufig das Handbuch benötigen	I think I would often need the manual when using the assistive technology.
	e Ich denke, der Umgang mit der Unterstützungstechnik erfordert eine Menge meiner geistigen Anstrengung.	I think interacting with the assistive technology requires a lot of my mental effort.
	f Ich denke, ich würde es umständlich finden, die Unterstützungstechnik zu verwenden.	I think I would find it cumbersome to use the assistive technology.
	g Insgesamt denke ich, würde die Unterstützungstechnik einfach zu bedienen sein.	Overall, I think that the assistive technology would be easy to use.
2	Mit diesen Fragen möchte ich herausfinden, wie Sie die Nützlichkeit der Unterstützungstechnik anhand der Geschichte bewerten würden.	With these questions, I want to find out how you estimate the usefulness of the assistive technology based on the present story.
	a Die Unterstützungstechnik verbessert die Qualität des Wohnens im eigenen Haushalt.	The assistive technology improves the quality of living in your own household.
	b Ich würde es als komfortabel empfinden, von der Unterstützungstechnik im häuslichen Umfeld unterstützt zu werden.	I would find it convenient to be supported by the assistive technology in my home environment.
	c Die Unterstützungstechnik unterstützt das Leben in meinem eigenen Haushalt.	The assistive technology supports living in my own household.
	d Die Unterstützungstechnik ermöglicht mir, länger in meinem eigenen Haushalt zu leben, als dies sonst möglich wäre.	The assistive technology allows me to live longer in my own household than I would otherwise be able to.
	e Der Besitz der Unterstützungstechnik erhöht mein Ansehen in meinem Umfeld.	The possession of the assistive technology increases my reputation in my environment.
	f Die Unterstützungstechnik macht es mir einfacher, länger in meinem eigenen Haushalt zu leben.	The assistive technology makes it easier to extend living in my own household.
	g Insgesamt würde ich die Unterstützungstechnik in meinem eigenen Haushalt sinnvoll finden.	Overall, I would consider having the assistive technology in my own household as useful.
3	Die folgenden Fragen zielen darauf ab herauszufinden, wie Sie die Zuverlässigkeit der Unterstützungstechnik anhand der Geschichte einschätzen würden	The following questions aim to find out how you would estimate the reliability of the assistive technology based on the present story.
	a Die Unterstützungstechnik erscheint mir zuverlässig.	The assistive technology appears to be reliable.
	b Die Unterstützungstechnik erscheint mir präzise.	The assistive technology appears to be precise.
	c Die Unterstützungstechnik erscheint mir sicher.	The assistive technology appears to be safe.
	d Die Unterstützungstechnik erscheint mir ehrlich.	The assistive technology appears to be honest.
	e Ich denke, die Unterstützungstechnik wird fehlerfrei arbeiten.	I think the assistive technology will work correctly.
	f Die Unterstützungstechnik weist für mich Zuverlässigkeit auf.	The assistive technology shows reliability for me.

Appendix 1 (continued)

#	Questions used	Translation
4	Mit diesen Fragen möchte ich herausfinden, wie Sie ihr Vertrauen in die Unterstützungstechnik anhand der Geschichte einschätzen würden.	With these questions, I want to find out how you estimate your trust into the assistive technology based on the present story.
	a Die Unterstützungstechnik würde mir trügerisch erscheinen.	The assistive technology would appear deceptive to me.
	b Ich würde darauf vertrauen, dass mir die Unterstützungstechnik Sicherheit bietet.	I would trust that the assistive technology provides security to me.
	c Ich würde gegenüber der Unterstützungstechnik misstrauisch sein.	I would be wary of the assistive technology.
	d Ich würde der Unterstützungstechnik vertrauen.	I would rely in the assistive technology.
	e Ich misstraue den Absichten, Handlungen oder Folgen der Unterstützungstechnik.	I am suspicious of the intentions, actions or consequences of the assistive technology.
	f Die Aktivitäten der Unterstützungstechnik werden eine schädliche oder schädigende Folge haben.	The activities of the assistive technology will have a harmful or injurious outcome.
	g Ich vertraue auf die Unterstützungstechnik.	I trust in the assistive technology.
5	Mit diesen Fragen möchte ich herausfinden, wie stark Ihre Absichten sein würden, die vorgestellte Unterstützungstechnik zu nutzen.	With these questions, I want to find out how strong your intentions to use the presented assistive technology would be.
	a Es ist wahrscheinlich, dass ich die Technologie verwenden würde.	It is probably that I would use the technology.
	b Ich würde auf jeden Fall einmal ausprobieren, die Technologie zu nutzen.	I would at least try to use the technology.
	c Sobald die Möglichkeit besteht, würde ich die Technologie nutzen.	As soon as the opportunity arises, I would use the technology.
6	Mit diesen Fragen möchte ich ermitteln, wie Sie Ihr Interesse an technischen Geräten einschätzen würden.	With these questions, I want to determine how you would evaluate your interest in technical devices.
	a Ich informiere mich über elektronische Geräte, auch wenn ich keine Kaufabsicht habe.	I inform myself about electronic devices even if I do not have any buying intention.
	b Ich liebe es, neue elektronische Geräte zu besitzen.	I love to have new electronic devices.
	c Ich bin begeistert, wenn ein neues elektronisches Gerät auf den Markt kommt.	I am excited when a new electronic device enters the market.
	d Ich gehe gern in den Fachhandel für elektronische Geräte.	I like to go to dealers specializing in electronic devices.
	e Es macht mir Spaß, ein elektronisches Gerät auszuprobieren.	I have fun trying an electronic device.
7	Diese Fragen zielen darauf ab herauszufinden, wie Sie sich Informationen über ein elektronisches Gerät beschaffen würden.	These questions aim to find out how you would obtain information about an electronic device.
	a Ich höre auf den Rat von Freunden und Bekannten, um das beste elektronische Gerät zu finden.	I heed the advice of friends and acquaintances to find the best electronic device.
	b Ich kaufe generell nur Produkte, die meine Freunde oder Bekannten auch kaufen.	I generally buy only products that my friends or acquaintances buy
	c Ich informiere mich über ein elektronisches Gerät bei Freunden oder Familienmitgliedern, bevor ich es kaufe.	I ask friends and relatives to inform myself about an electronic device before I buy it.
	d Wenn ich nur wenig Erfahrung mit einem Produkt habe, befrage ich meine Freunde über dieses Produkt.	If I am short on experience about a product, I ask my friends about this product.
	e Um Enttäuschungen mit einem Produkt zu vermeiden, orientiere mich an den Produkten, die Andere gekauft haben.	To prevent disappointment about a product, I orientate myself towards products which others bought as well.

Appendix 1 (continued)

#	Questions used	Translation
8	Die folgenden Fragen zielen darauf ab, wie Sie Ihren aktuellen Gesundheitszustand einschätzen.	The following questions aim to find out how you would estimate your current health status.
	a Ich scheine etwas leichter als andere krank zu werden.	I seem to become ill little easier than others.
	b Ich bin genauso gesund wie alle anderen, die ich kenne.	I am as healthy as everyone I know.
	c Ich erwarte, dass meine Gesundheit nachlässt.	I expect that my health declines.
	d Ich erfreue mich ausgezeichneter Gesundheit.	I enjoy good health.
Welches Geschlecht haben Sie? [ ] weiblich [ ] männlich		What is your gender? [ ] female [ ] male
Wie alt sind Sie? Ich bin _____ Jahre alt.		How old are you? I am ____ years old.
Welchen Bildungsabschluss haben Sie? Bitte wählen Sie den höchsten Bildungsabschluss, den Sie bisher erreicht haben.		Which educational attainment do you have? Please select the highest educational attainment you achieved to date.
[ ] kein offizieller Schulabschluss		No official educational attainment
[ ] Haupt-/ Volkshochschulabschluss		Secondary modern school/community college
[ ] Mittlere Reife, Realschulabschluss		Middle school
[ ] Abitur / Fachabitur		High-school diploma
[ ] Hochschul-/ Fachhochschulabschluss		University/polytechnic degree
[ ] Promotion		Doctorate
In welchem Bereich haben Sie zuletzt gearbeitet?		In which area did you worked last?
[ ] technischer Bereich		Technical
[ ] kaufmännischer Bereich		Sales/Clerk
[ ] sozialer / pflegerischer Bereich		Social/Nursing
[ ] sonstiger Bereich		Other
Wohnen Sie alleine oder mit anderen Personen zusammen?		Do you live alone or together with other people?
[ ] alleine		Alone
[ ] zusammen mit anderen Personen		With other people
Wie hoch ist Ihr monatliches Nettoeinkommen ungefähr? Gemeint ist der Betrag, der sich aus allen Einkünften zusammensetzt und nach Abzug der Steuern und Sozialversicherungen übrig bleibt.		What is your monthly net income? This means the amount composed of all proceeds which remain after deduction of taxes and social insurance.
_____ € netto		_____ € net
[ ] keine Angabe		Prefer not to say
Besitzen Sie ein Smartphone?		Do you own a smart phone?
[ ] ja		Yes
[ ] nein		No
Vielen Dank für Ihre Teilnahme		Thank you for your participation

Appendix 2. Scenarios used with author translations of the original German text

A fall	**The stove**
Imagine you are alone in your house or apartment. You are sitting at the kitchen table and eating. After lunch you want to bring the dishes to the sink. You have felt uncomfortable all day long and you are not very steady on your feet. On the way to the sink, you fall and hurt your hip. You cannot get up by yourself anymore. As a result, you are no longer able to make an emergency call. Although you call out for help, no one will notice you. Fortunately, you have installed appropriate sensors in your home that detect the fall and automatically send an alert to your smartphone. Your phone recognizes the emergency situation and sets an emergency call. An emergency physician in your area has now been called. You hear that a distress call was initiated because the device will beep three times aloud. In addition, the display lights up. This process takes place without your active participation. You do not need to hold your smartphone in your hand. It is sufficient if the unit is turned on in the apartment. The informed emergency physician can now help you and save your life in an emergency.	Imagine you want to leave your apartment after lunch to go to the doctor. Accidentally, you forget to turn off the stove. You did not notice it when leaving the apartment. So there would be the risk of domestic fire. Fortunately, you have installed sensors on your stove and your front door. Once you leave the front door, the sensors detect that the oven is not turned off and send an alert to your smartphone. This process takes place without your active participation. At the front door you will be automatically reminded to turn off the stove by a very loud beep and a flashing of your smartphone. However, it is necessary to have the smartphone turned on and to carry it with you. Reminded by the smartphone, you go back to the kitchen and turn off the stove. The use of the support technology therefore ensures that no damage occurs in your home during your absence.