Assessment of Expectations and Needs of a Sensor Network to Promote Elderly's Sense of Safety and Security

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***Abstract*—Many new technologies claiming to support independent living and prolonged possibilities of aging in place have been developed. To support independent living and increase the sense of safety and security both for the elderly themselves and for their relatives, the technologies have to be easily adaptable to match the divergent users personal expectations and needs. The study reported in this paper was conducted as seven case studies where a sensor network was deployed in homes of people with a self-perceived memory decline. We describe problems related to adaptive personalization of such technology in real settings and discuss what consequences these problems may have for the elderly people's and their relatives willingness to use the technology. Our results indicate that a lack of sufficient possibilities to adaptive personalization of the system makes it difficult to address individual user's expectations and needs. This, in turn, leads to a decreased trustworthiness of the technology and a risk of unwillingness to use the technology.**

Keywords–Ambient Assisted Living; Adaptive Personalization; Safety; User Expectations.

I. INTRODUCTION

Being able to feel safe and secure are perhaps two of the fundamental requirements for enabling elderly to continue living independently. In this respect, safety and security involve physical, psychological and existential aspects on well-being, all of which are fundamental when coping with daily life. Associated with feeling unsafe and insecure are feelings such as: worry, fear, anxiety and perhaps even panic according to the Swedish National Board of Health and Welfare [1]. For special groups, such as the elderly, their ability to stay independent at home does not only depend on whether they feel safe and secure at home. It is equally important that the social networks around them, e.g., family, spouses or caregivers feel that their loved ones are safe and secure. Aspects such as safety and security may affect the social structures (roles) in families over time. Children may become caregivers who make decisions on behalf of their parents, a role which may be stressful for the family caregivers [2]. Taking the role as a family caregiver is also associated with a need to balance the care giving with other activities, e.g., work and leisure [2]. Therefore, the new role may have an effect on psychosocial well-being [3], but also have negative consequences on the caregivers themselves, e.g., sleep disturbances [4] and increased blood pressure [5].

Many new technologies claiming to support independent living and prolonged possibilities of aging in place make use of sensor networks and/or mobile robotic telepresence [6]. While most of them can be installed with little changes in the home infrastructure, little is known about whether they lead to an increased sense of safety and security, either for the elderly themselves, or for their family caregivers. Technologies which cannot deliver an increased sense of safety and security will likely have no large impact on the growing market of assistive technologies for an elderly population. Therefore, it is of interest to increase the knowledge on what affects the sense of safety and security. Commonly, commercial sensor networks offer solutions such as alarms, reminders of turning electrical devices off (e.g., the stove or the coffee brewer), but sensor networks can also be used to monitor activities [7][8]. Yet, a key question is whether the solutions support adaptive personalization and whether they can support independent living and aging in place and whether they increase the elderly people's and the family caregivers' sense of safety and security.

This paper describes the first step in a longitudinal study aiming at developing a methodology to measure how an Information and Communication Technology (ICT) affects the sense of safety and security. In the study, we apply the methodology to study how a sensor network deployed in homes of seven people with self-perceived memory decline affects not only these people's but also their spouses' perceived safety and security. The longitudinal study can be divided into three main steps: (1) finding test persons who are suitable for testing the system and deploying the sensor network, (2) evaluation while living with the sensor network, and (3) evaluation after the sensor network has been removed. The results presented in this paper focus on the results from the first step and describes the expectations and the profiles of each of the users. We find that sensor network solutions need to be highly adaptive to the user's personal needs.

The paper is structured as follows. Section II provides a description of the sensor network deployed in this study. Section III outlines the methodology used during the first step of the longitudinal study. Information is provided on how the participants were selected, how they were informed about the project and the sensor network, how each deployment was prepared and how the deployments were made. The results of the first step in the longitudinal study are presented in Section IV. Finally, a discussion and conclusion is provided in Section V.

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II. System Description

The sensor network deployed in this study is Abilia's Homebasic [9], which is a "safety and security" package for those who need a combination of time and memory support, environmental monitoring and alarm functionalities. Homebasic is an advanced cognitive support that aims to support independent living and increase the possibility to age in place. The individuals targeted have a cognitive decline and may be in need of orientation in time, support and structure of daily tasks, reminders for handling electronics in the home (e.g., the stove, coffee brewer, lamps) and reminders when leaving the home. The cognitive decline supported by Homebasic ranges from developmental disorders to Alzheimer.

The core of the system is the digital calendar, Memoplanner (MP, see Figure 1(a)). The MP is a touch-PC that can be hung on the wall or placed in a guitar stand. It is recommended that MP is installed in a room in which the user spends a lot of time during day-time. The MP has several functions:

- F1 Information of time.
- F2 Calendar to provide support and structure of daily tasks. The user (or a remote user) can add new events to the calendar. Each event can consist of sub events.
- F3 Reminders about upcoming events. These can also be sent as SMS reminders.
- F4 Skype

The MP connects to the Internet via WiFi or a LAN-connection to a Vera Gateway [10]. Included in Homebasic are also a number of sensors which are connected to the gateway using the Z-Wave protocol [11]. The MP warns the user with an image and a pre-recorded instruction or a reminder when a sensor is triggered. The solution is marketed as being easy to use, easy to install in all kinds of homes and to be re-used in other homes.

The sensors and actuators included in Homebasic are two motion sensors (see Figure 1(b)), one on/off sensor (see Figure 1(c)), one oven/stove sensor, from here on called stove sensor, one door sensor (see Figure 1(d)), and a lamp actuator.

(a) Memoplanner (b) Motion sensor (c) On/off sensor (d) Door sensor

Figure 1: Examples of Abilia Homebasic components.

The manufacturer recommends that each sensor is plugged to an electric socket rather than running on battery. This means that the stove sensor needs to be connected not only to the stove's electric cord but also to a standard electric socket. Here follows a description of what functions that are provided using the sensors:

A. Kitchen

Situated in the kitchen are typically one motion sensor, one stove sensor and one on/off sensor. The MP issues a warning when:

- F5 The stove is on but no motion has been detected in the kitchen during the past x minutes.
- F6 A chosen electronic device, e.g., a coffee brewer is left turned on during x minutes.

B. Bedroom

Aiming at preventing falls, one motion sensor and one lamp actuator are situated in the bedroom. The motion sensor detects when the user places his/her feet beside the bed. When detecting motion, a lamp is turned on automatically [F7], either for a chosen period of time or until the user turns the lamp off. In case there is no need for an on/off sensor in the kitchen, the sensor can also be used to turn on an additional lamp anywhere in the home.

C. Hallway

Typically, the included door sensor is placed on the entrance door. It can be used to detect that the door has been opened and issue a warning via the MP if:

- F8 The stove is on.
- F9 The door is opened. This function can be used with several options, either it can be always active and remind the user to, e.g., lock the door. Alternatively, it can be active during a specific time of the day and tell the user that it is not an appropriate time to go out.

D. System summary

The functionalities provided by Abilia Homebasic can also be divided into five categories (sensor-based reminders, sensor-based actuation, calendar-based reminders, calendar visualization and communication). Table I summarizes the functionalities of Abilia's Homebasic into categories.

III. Method for preparing deployment of system

The longitudinal study was conducted as seven case studies [12]. The first step of this study, described in this paper, focused on finding people who were suitable for testing the system and deploying the sensor network.

A. Selection of participants

The participants for the project were selected through the Örebro municipality's "Minnesmottagning" (memory center). Every year, several hundred people contact the memory center for consultation and help when they have concerns regarding their own or their relative's memory. We informed the personnel at the memory centers about the project and asked them to help us finding possible participants. The selection criteria for the participants were: they should be 65 or older, live in ordinary housing/private residence outside nursing homes, have self-perceived memory problems, appoint a relative interested in participating in the project and have an Internet

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TABLE I: SUMMARY OF FUNCTIONALITIES OF ABILIA'S HOMEBASIC.

Sensor-based reminders	Sensor-based actuation	Calendar reminders	Calendar visualization	Communication
F5 Stove on but no motion in kitchen for x minutes. F6 An electronic device has been turned on for x minutes. F8 The entrance door is opened while the stove is on. F9 The entrance door is opened. Can be used to remind the user to, e.g., lock the door or to tell the user that it is not an appropriate time to go out.	F7 Lamp automatically turned on when motion beside bed.	F3 Reminders about upcoming events.	F1 Information of time. F2 Calendar for structuring daily tasks.	F4 Skype

connection (3G is ok but only if connected to a router). All the interested people were men (for details, see Section IV). This outcome was rather surprising since according to the personnel at the memory center, men are not in majority among people consulting the center and information about the project was directed to both men and women. We could find two possible explanations for this outcome. Firstly, in all age categories, men use modern ICT to a greater extent than women [13]. Since the project focuses on using new technology, men could be more attracted to participate in the project than women. Secondly, women are affected by dementia and memory decline later in life than men [14]. This means that women consulting memory centers are older than men. Statistics [13] show that interest and usage of technology decrease with age. This might be another reason for why only men were interested in participating in the project.

B. Information about the project

All people showing interest were contacted by phone. During this first contact, we explained the aim of the project and shortly described Abilia Homebasic. Since receiving a description of the system by phone was experienced as abstract and difficult to understand, we invited the people interested in the project and their assigned relatives to a Research and Innovation Apartment in which the system was installed and could be demonstrated. We met each potential participant together with their relatives in the apartment. During the meetings, which lasted approximately one hour, we explained the aim of the project and demonstrated and explained key functionalities of Homebasic. We also distributed fliers including the most important information about the project. During these meetings, all the invited people agreed to participate in the project. Thus, we scheduled meetings with the participants in their homes with the aim to collect necessary information before the deployment.

C. Deployment preparation

We visited each test person in his home. During the visit, the test person and his relative signed the informed consents and were interviewed about their needs and expectations regarding the sensor network. They were also asked about their requests regarding the installation of Homebasic according to a questionnaire (installation scheme) provided by Abilia. To collect data about user's needs and expectations regarding the sensor network, we used the well-known instrument, Individually Prioritized Problem Assessment (IPPA) [15]. IPPA is a long term instrument that supports collecting data through interviews. The test person is asked to identify the up to seven most important problems that he/she hopes will be reduced by using the tool. The interviewee is also asked to estimate how important the problems are and how difficult it is to perform daily activities related to this problem on likert scales. We used IPPA also to collect information from relatives. For each problem identified, they were asked to estimate how important the problem was and how difficult it was for their test person. Additionally, they were asked to what extent they thought that Homebasic could minimize the problem. Using IPPA and the installation scheme, we were able to identify what expectations and needs that the test persons and their relatives had regarding the sensor network. After all homes had been visited, we scheduled the physical installations of the sensor networks.

D. Deployment and training

The physical installations were done by Abilia's technicians according to the requests collected during the home visits which were summarized in installation schemes (for details on expected deployments, see Section IV). During the installations, we were responsible for introducing the test persons on how to use the MP. Most of the users were quite inexperienced in using this kind of tool. Hence, the introduction focused on the basic functionalities of the MP. In the situations where we could see that the users comprehended the basics, we introduced additional functions. Otherwise, we stayed at the basic level and appointed time for additional training. All test persons were provided with manuals where they could learn more about Abilia Homebasic and its functionality.

IV. RESULTS

Table II provides information about the seven test persons ($\mu = 71.6$ years old), their type of accommodation and about relatives ($\mu = 65.7$ years old). All test persons are men and all "relatives" are wives who live with the test persons. All test persons and five of the relatives are retired. Two wives are balancing work and caring for their husbands. The type of accommodation varies, but typically the accommodations are quite large.

In the following subsections, details on each test site are provided. First, the test person is described. Secondly, a table describes what functionalities that the test person expected that the system would have and what functionalities that were actually deployed. In reality, some expectations on functionalities could not be met. Hence, the results for each test site outline also when expectations could not be met.

TABLE II: DESCRIPTION OF STUDY SAMPLE TP = TEST PERSON R = RELATIVE

Test site	Accommodation	Internet	Age tp	Age r
1	Five room apartment	Cable	77	68
2	Three room apartment	3G/4G	74	69
3	Three room apartment	Cable	82	82
4	Two story detached house	Fiber	54	54
5	Two story summer residence	3G/4G	71	68
6	Four room row house	3G/4G	75	66
7	Three room apartment	Fiber	68	53
μ			71.6	65.7

Finally, a summary of the results from the conducted IPPA-interviews, the expected deployments and actual deployments is provided.

A. Test site 1

The test person experiences a memory disturbance (short term and speech). His expectations on the system relate mostly to the MP. In particular, he hopes that the MP calendar function will make him feel more comfortable while communicating with others. As an effect of having problems expressing himself, he says that his self-confidence has decreased. Due to the fact that the test person and his wife have a summer house, they plan to bring the calendar there over the summer. Table III summarizes the expected deployment and actual deployment for test site 1.

B. Test site 2

The test person who has had a number of strokes feels that his short term memory is a bit weakened. Similarly to the aforementioned couple, this test person and his wife have a summer house to which they plan to bring the calendar over the summer. Table IV summarizes the expected deployment and actual deployment for test site 2.

C. Test site 3

The test person has problems with his back and hip and it often happens that he forgets things (keys, wallet, phone, etc.) when he goes out. Additionally, this is a suitable user for F7 as the test person is occasionally dizzy. The MP is expected to be useful as the person has difficulties writing things down by hand. Table V summarizes the expected deployment and actual deployment for test site 3.

D. Test site 4

The test person lives with his wife and children in a two story detached house. The wife is still working. Prior to being informed about the possibility to participate in the project, the test person is already using an analogous version of the MP. Seen from the wife's perspective, she expects that it will be more time efficient for her to use the digital MP, particularly when scheduling repetitive events, which can be done in a way which is similar to scheduling events occurring only one time. Using the analogous version, she has to continuously add and remove events which do not occur every day. The test person has problems with balance, hence there is a risk of falling, especially in the stairs. For this reason, the test person is a suitable user of F7. The couple has a summer house and plans to bring the MP there. Table VI summarizes the expected deployment and actual deployment for test site 4.

E. Test site 5

The test person has a memory decline. He always carries the calendar with him but according to the wife, it is not sufficient since he does not always know what day it is. Overall, the wife feels that the problems are larger than the test person seems to be aware of. The couple lives in their summer house from May-October; hence, the Homebasic will be installed there. It occasionally happens that the coffee brewer and the oven/stove are left turned on without surveillance. Additionally, the test person often feels unsure about whether or not he has locked the door when leaving the summer house. Table VII summarizes the expected deployment and actual deployment for test site 5.

F. Test site 6

The test person has a declined muscle power and bad balance and is in need of F7. Additionally, he experiences a memory disturbance (short term). The extent of the problem is perceived as larger by the wife than by the test person. Table VIII summarizes the expected deployment and actual deployment for test site 6.

G. Test site 7

The test person lives with his wife who is still working full time. Prior to being informed about the possibility to participate in the project, the test person is already using an analogous version of the MP. The couple has turned off the analogous MP during night time due to it making it too light. Seen from the wife's perspective, she expects that it will be more time efficient for her to use the digital MP, particularly when scheduling repetitive events, which can be done in a way which is similar to scheduling events occurring only one time. Using the analogous version, she has to continuously add and remove events which do not occur every day. Additionally, the MP will enable her the possibility to check whether activities have been done when she is at work. She is currently unsure on whether he showers or remembers to eat when she is working. Table IX summarizes the expected deployment and actual deployment for test site 7.

Table III-IX summarize the expected deployments and actual deployments for each test site. A number of abbreviations are used. E. D. = Expected Deployment, A. D. = Actual Deployment and F1-F9 are the Homebasic functions which are further described in Section II. For each function F1-F8, x = yes and - = no. For F9, a = always active and t = active during time interval. P regards placement of MP (gs = guitar stand or w = wall).

H. Results from Deployment Preparation

Figure 2 provides an overview of the results from the IPPA-interviews. The test persons and wives outlined a total of 28 problems where they expect that Homebasic could be an aid. These problems were divided into the five categories outlined in Section II-D: sensor-based reminders, sensor-based

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TABLE III: SUMMARY OF DEPLOYMENT, TEST SITE 1.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	P
E. D.	x	x	x	x	x	x	-	x	a	gs
A. D.	x	x	x	x	x	x	x	x	a	gs

TABLE IV: SUMMARY OF DEPLOYMENT, TEST SITE 2.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	P
E. D.	-	x	-	-	x	x	x	x	a	gs
A. D.	x	x	x	-	x	x	x	x	a	gs

TABLE V: SUMMARY OF DEPLOYMENT, TEST SITE 3.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	P
E. D.	-	x	x	-	x	-	x	x	a	gs
A. D.	x	x	x	-	-	-	x	-	a	gs

TABLE VI: SUMMARY OF DEPLOYMENT, TEST SITE 4.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	P
E. D.	x	x	x	x	x	x	x	x	t	gs
A. D.	x	x	x	x	-	x	-	-	t	gs

TABLE VII: SUMMARY OF DEPLOYMENT, TEST SITE 5.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	P
E. D.	x	x	x	-	x	x	x	-	t	w
A. D.	x	x	x	-	-	-	x	-	t	w

TABLE VIII: SUMMARY OF DEPLOYMENT, TEST SITE 6.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	P
E. D.	-	x	x	-	x	(x)	x	x	a	gs
A. D.	x	x	x	-	x	x	x	x	a	gs

TABLE IX: SUMMARY OF DEPLOYMENT, TEST SITE 7.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	P
E. D.	x	x	x	-	x	x	x	x	a	w
A. D.	x	x	x	-	x	x	x	x	a	gs

actuation, calendar-based reminders, calendar visualization and communication. The figure shows that users provided with a limited amount of information about Homebasic mainly outline problems with activities related to remembering calendar activities and remembering to turn off electric devices.

Figure 3 provides further information about the perceived importance, difficulty and the system's potential to minimize the problem. The test persons and relatives were asked to: (1) estimate how important the problem is on a likert scale 1-5 where 1 = Not at all important and 5 = Very important and (2) how difficult it is to conduct the activity found problematic on a likert scale 1-5 where 1 = Very easy and 5 = Too difficult to conduct. Additionally, it provides information regarding to what extent the relatives thought that Homebasic could minimize the problems (1 = To a very high degree and 5 = Not at all). For each category, the average value of the response to the respective question is presented. To summarize, large

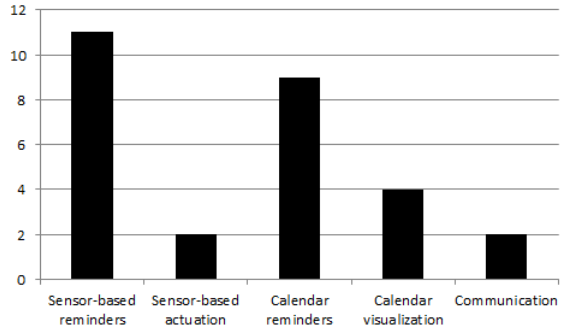

Figure 2: Summary of problems outlined during IPPA-interviews.

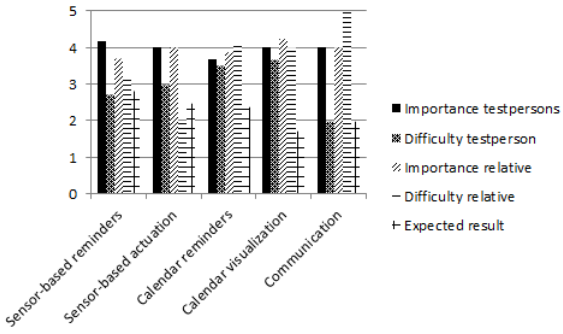

Figure 3: Summary of the importance of problems outlined during IPPA-interviews.

numbers with respect to importance and difficulty indicate a real need and a low number with respect to the potential of minimizing a problem indicates a high expectation. The test persons and relatives perceive that the most difficult activities are related to remembering activities or knowing what day it is. For all categories, except for activities related to sensor-based actuation, the relatives perceive that the test persons have more difficulties than what the test persons perceive themselves.

Figure 4 summarizes the functions that were: (1) expected to be deployed and (2) actually deployed. As can be seen from the figure, the main deviation between the expected and actual deployments was due to the stove sensor which could not be installed at three test sites. According to the IPPA interviews, many expectations on the system relate to sensor-based reminders.

V. Discussion and Conclusion

This paper has focused on presenting a set of tools used to evaluate long term usage of a sensor network at home. The utility of the network in terms of adding a greater sense of safety and security is the ultimate aim of this study. The results so far have provided an indication of which features of the system are more requested when novice users have only a rudimentary exposure to the technology. Most participants valued having sensor-based notifications. Secondly, calendar-based reminders and finally calendar visualization were requested among a subset of the participants. Each test site had further tailored requests regarding which specific events would trigger an alarm, reminder or notification. The variation of requests

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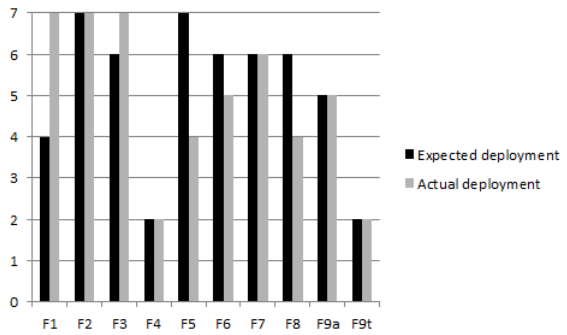

Figure 4: Summary of expected deployments and actual deployments.

from the test sites, despite the relatively homogenous group, indicates that systems such as the one presented in this paper must be highly adaptable. Based on the empirical findings, we identified two areas where adaptation of the system was needed: functionality and environmental aspects.

Functionality : In our case studies, we found that most of the test persons would prefer a lock-switch rather than the door sensor. A lock-switch, indicating if the door is locked or not, would better address the test persons' current needs. A problem that most of the test persons experienced was forgetting to lock the door. To be reminded about it would help them in their everyday life and would increase the sense of safety and security for both the test persons themselves and their relatives. On the other hand, the current functionality implemented together with the door sensor that warns the user that he/she is not supposed to go out at night time was experienced by our test persons as unnecessary. Most of the test persons pointed out that such functionality is rather for people with advance dementia or Alzheimer. This mismatch of functionality in relation to their needs decreased the experienced usefulness of the system. Several of the test persons and their relatives wondered who the system is actually aimed to support. They stressed that the user must still have good cognitive capabilities to be able to understand the warnings from the MP. Yet, the door sensor indicates that the system is for people who do not even recognize if it is day or night.

Another functionality that was experienced as missing in the current solution of Abilia Homebasic was the lack of a possibility to receive sms-warnings when the entrance door is opened or if the coffee brewer and/or stove are on. In the current solution, the MP issues warnings in such situations. Our test persons and their relatives argued that the possibility to receive the warnings by sms when they are not in the neighborhood of the MP would increase their sense of safety and security.

An additional missing functionality was recognized when the system was deployed at test site 7. During the deployment, we identified a need for switching off the light of the MP during the nights. Because the functionality is missing in the current solution, there is a risk that the MP will be installed in locations that are not optimal for it (i.e., where it does not disturb the users but the reminders are not heard) or that it will be switched off during the nights with a risk that the warnings and reminders will not be sent.

Based on our empirical findings, we argue that the lacking functionality lead to decreased sense of safety and security for the elderly and their relatives. We also argue that insufficient adaptability as well as not addressing users' expectations leads to decreased trustworthiness of the system. Additionally, we argue that functionality in a system such as Abilia Homebasic needs to be changeable over time. Abilia Homebasic aims to support people within a wide range of cognitive decline from developmental disorders to Alzheimer. Firstly, this wide range of individuals may have very different needs and thus it has to be possible to adapt the system to the individual user's needs. Secondly, cognitive decline related to dementia and Alzheimer progresses over time. This means that the functionality needs to be adaptable over time to be able to address the user's changed needs.

Environmental aspects : Another category of problems that resulted in mismatch between the users' needs and expectations and the actual installations was related to environmental aspects. As described in Section IV, the desired stove sensor could not be installed in several cases due to: not enough room for the stove sensor when located underneath a cook top, no standard electric socket to which the sensor's adapter could be connected or because the oven was directly connected to the wall. Since the problem occurred in 3 of 7 houses, we consider it as a serious shortcoming in the current solution. Another common problem experienced during the installation was an insufficient WiFi-range of the Vera gateway (4 of 7). One consequence of this problem is that Homebasic cannot be remotely accessed in the case when support is needed. Another consequence is that the MP cannot issue warnings when the entrance door is opened or if the coffee brewer and/or stove are on. Additionally, we found that the MP could not always be placed in the ideal location due to an insufficient WiFi-range or due to no available electric socket nearby the chosen position. Based on our empirical findings, we argue that developers of technologies aimed to support aging in place need to consider the different environmental aspects of the places where the systems may be installed. In our case studies, we could see that the problems with adaptation of the installations to the different environments resulted in an inability to address the users' needs and also in limited functionality of the whole system.

Since the study is based on a small sample of seven test sites, our results cannot be statistically generalized. Even if a number of researchers have argued that case study-based research allows for generalization to theoretical constructs [16][17], our aim is not to generalize the findings from this first step in the longitudinal study. The results from the first step of a longitudinal study which are presented in this paper are of explorative character and describe the expectations and the profiles of each test person. Our aim is to bring to light the importance of understanding and addressing individual user's expectations and needs as well as the importance of enabling sufficient adaptive personalization of the system to these different expectations and needs.

It is argued in literature [12][18] that a case study provides rich context-specific details and in this way reveals important information about the object under study. Using this methodology, we were able to study the users' expectations and needs and the system's possibility to address these needs

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in detail. Despite the relatively homogenous group (common geographical zone, many common characteristics), we found that the requests from the test sites were different and that the environments where the system was deployed were very different. Even though the functionalities of sensor networks may differ from Abilia Homebasic, we argue that systems aiming at supporting aging in place need to be adaptable to different expectations from users and over time in order to address users' changed needs. Thus, although we cannot claim that our findings are valid beyond the cases investigated, we believe that our empirical results highlight sufficient possibilities to adaptive personalization of the system as an important factor to take into account when sensor systems are developed, deployed and used.

Future work will pursue the long term methodology and evaluation at various phases of the usage. In particular, a follow up of the IPPA questionnaire will be conducted and an assessment of the utility of using the sensor network at home will be made. Finally, a series of evaluations will be performed after the sensor network is removed from the home.

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