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Design Aspects for Elderly Using a Health Smart Home

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ABSTRACT

The part of the population above 70 years is increasing rapidly. This will put an immense pressure on the eldercare, with scarce resources to accommodate for such a demographic situation. Therefore the importance of enabling the elderly to live in their own home as long as possible is crucial. The health smart home area is able to facilitate such living. While developers still believe in the potential of such technology, the level of adoption among the elderly is low. This study focuses on discussing some design implications that is of importance for systems addressing this social group. In order to achieve this, five qualitative interviews was conducted with elderly between the ages of 70 and 85. The elderly was asked questions within three main aspects of a health smart home: social robots, health and security. A number of quality attributes were identified in the study and all of them fall under the two major categories, acceptability (Usability, Affordability) and trustworthiness (Safety, Security, Reliability, Privacy). The insight from the study may serve as a basis for further discussions of design implications for the health smart home area.

Keywords

Health Smart Home, Elderly, Home Automation, Social Robots, Design Implications, Health, Security, Quality Attributes

1. INTRODUCTION

The population that is 60 or older is increasing at an alarming rate; it is estimated that by 2050 this particular group will have globally increased over 50% [1]. With such an increase an immense pressure is put on the eldercare. There is a growing importance that retired citizens can live in an own home as long as possible to relieve the eldercare of some pressure from the growing population of elderly.

There has been a noticeable concern about the growing population of elderly. Much of the research has been conducted on giving the elderly better care with the help of health smart homes.

The concept 'Health Smart Home' is defined as an attempt to provide an autonomous life for older people in their own homes instead of being put in an institution by offering various technical supports [2]. The research in this area has been focusing on the technical aspects and had a low level of adoption. Therefore the research area needed to take into consideration the social aspects and use it concurrently with the technology when approaching the health smart home area [3].

According to forecasting institute at Statistics Sweden [4] the life expectancy in Sweden will by 2050 rise with approximately 3 years for the women and 4 years for the men. This increase will be accompanied by a decrease of the working population meaning that fewer people has to take care of more. There will be a problem for the eldercare to accommodate for the increased amount. A possible solution for this recognized problem is to make use of technology in the homes of the elderly to ensure a healthy independent living [5].

Since the mid-1970's, the technology for automating homes that has been available [37] has mainly been used for two major areas. Namely building security reasons in private homes or to remotely and automatically controls the heating of large buildings. The eldercare has depended mostly on telephone services and alarm button for remote supervision of the elderly households, which also was introduced in the 1970's. The eldercare has been branching into the smart home area looking for technologies that can help the elderly to facilitate their living in their last years. During research about how to integrate smart home technology in the eldercare, four main features that is needed for its success has been identified: Improvement treatment compliance, promotion of healthy behaviors, early disease detection, support for informal care giving [6].

The aim of this study is to investigate how elderly perceive health smart homes. The study is based on an interpretive case study where elderly have been interviewed. The insight from the study will serve as a basis to discuss design implications: through related research, reported technological solutions and theory on design aspects. We draw implications from the results of our interviews.

The study does not focus on technical specifications such as specific protocols or platforms; focus is on general design aspects of the software.

The paper is organized as follows: section two presents the related research of the area. Section three describes the research methodology that has been used to conduct this study. Section four lists the results of the interviews that were carried out. Section five discusses the results and the identified design implications with the related research presented in section 2. The 6th section of the paper points out the limitations of the study. The paper is concluded with section 7; which presents the main findings of this study and the design implications.

2. THEORY

We have chosen to focus our research on three different areas in the field of health smart homes. During the study of the literature the majority of the articles was concerning these subjects and most of the papers could be divided into one of them. That is the reason for us to choose the following three areas to focus on: social robots to assist their living, the security factor and the health factor. Finally, a last section presents important design aspects identified in the related research.

2.1 Smart Homes: Social robots

A lot of research has been done regarding animal companionship as providers of emotional and physical well-being for seniors [7]. There are several different prototypes of social robots. Not all of the social robots made breakthroughs since they are mostly implemented with the same functions but with different appearances.

2.1.1 Concerns

Ken Worsley [35] states in his article that most elderly people are not interested in social robots. The elder find them overly-complicated and unpractical. They prefer easier tools with big buttons and loud audio.

A very good example that explains the biggest deficiency with social robots is their ability to not act as competent as a real human [8]. For instance when one walks along a human, they keep a distance from each other to avoid awkward situations and they might stop to chat with people passing them. The robots designed today do not yet have the ability to perform the tasks above and more.

2.1.2 Potentials

The university of Pittsburgh and Carnegie Mellon University has together attempted to develop a robotic creature for elderly and people with disabilities [9]. The robot works as companion for the users and has functionalities that facilitates the living at home for the users. The face of the pet is a LCD screen (Liquid Crystal Display – thin screen made up of any number of color or monochrome pixels [43]) displaying direct contact with family members living in another place [9]. It is noted that the social interaction skills are increasing when elderly are using the pet as help [9].

Matsushita Electric Industrial Co attempted to develop a teddy bear. The teddy bear is 80 cm tall and is connected to server via a LAN cable. It can understand 200 words and reply to 2000 sentence patterns [10]. This tool is however not intended to facilitate living alone when getting older. It is only available in a nursing home for the patients who need a social companion.

There are social robots designed to facilitate the living for both older people and children with disabilities in the market today. The following text presents some of the most widely used social robots:

The type of social robot that has been released mostly is the one that has the purpose to either study the human-robot interaction or to work as an interaction tool with a human [11, 12, 14, 15]. Maggie, another social robot has voice recognition functions. She interacts with humans when they either talk to her or use gestures [16]. Aibo is another social robot designed as a dog for home entertainment. It acts in response to both external stimuli (something around that makes it act accordingly) and according to its own judgment [17]. The use of Aibo facilitates for the elder since it has not the biological needs of a living dog such as eating food or going outside to perform its needs [42]. In a study done in St. Louis [42] 10 robotic dogs (Aibos) was handed out to 10 elderly, in the mean time 10 other elderly received a living dog. The results showed that the group with a living dog showed a higher attachment to the pet but the difference was not statistically significant. The loneliness of the user was improved equally in both cases. One remark is that both patients and personnel were reluctant to interaction with the robot when first presented to it. The results of the study shows that the initial concerns were overcome when some time had been spent with the robot dog.

2.2 Smart Homes: Health

There are techniques out in the market that can help elderly to live the last part of their lives at home. Some of the techniques are to have motion sensors [18] and video surveillance [19] at home that has the function to send signals to a contact person as soon as an unplanned situation occurs. Some of the concerns and potentials regarding the health monitoring of the elderly are described below.

2.2.1 Concerns

A main concern is sudden accidents that occur or might occur [21] the elderly. A questionnaire has been done and answered by a total of 49 elderly people where they answer various questions about their living environment and what they would like to be improved or safer in their respective homes. The largest fear of a sudden accident is a gas accident [21] however the most occurred type of sudden accident is falling [22].

A study in Netherlands [20] acknowledges the fact that the health smart home concept cannot be implemented exclusively with technological innovation. It will need close collaboration with the institution of eldercare to make procedural and organizational changes that will not likely adapt to the use of technology. Instead the systems need to be successfully integrated in the organizational model of the eldercare systems. Such implementation likely requires mutual adaptation between the technology and the eldercare system.

In France there has been a study on a hospital in Toulouse in order to get an insight in the acceptance of a typical health smart home among a group of elderly [19]. The test group was interviewed after using the monitoring system and several comments about the usage of the monitoring systems were given, both positive and negative. The negative comments were that the monitoring system would decrease the human presence around the test person. Some of the persons in the group were also concerned about the general presence of a monitoring computer.

2.2.2 Potentials

Health Smart Homes in Canada is focusing on other ways of facilitating the aging process of the elderly. They for

instance have speaking bathrooms that have a computer screen, which provides guidance with verbal assistance (speaks to the elder whilst he/she is in the bathroom)[23].

The major positive remark in ICOST '06 (International Conference on Smart Homes and Health Telematics) was that the monitoring system would provide confidence for the person because of the fall detection and other monitoring services. It was also said that the patient's family would be relieved of some responsibilities to ensure the health of the elderly.

The main aspect that scientists have focused on is the falling accidents that are the most common accident in the homes. A general approach to this issue is motion sensors [18] (a device containing a physical mechanism or electronic sensor that quantifies motion that can be either integrated with or connected to other devices [45]) and video surveillance (the user is monitored by someone else, for instance an institution, hospital or family members which allows them to easily step in if something happens to the elderly) [19][24]. This in order to be able to monitor and alarm a supervisor if a situation occurs. Some of the prototypes [24] also make use of pulse (displays the systolic and diastolic values where the results are shown directly at another place) and blood pressure monitoring at a regular basis. There are also ideas [27] where the patients gets an electronic scale installed which then can assure that the system can identify risks and diseases at an early point. The tool that enables the scale installation is a pulse oximeter that reads pulse and blood oxygen levels with just a simple device that clamps onto a finger. The challenges with the tool are that it requires reliability and security since it requires network communication of sensitive health data.

2.3 Smart Homes: Security

Security in Health Smart Homes not only concerns the personal health but also the home itself and security aspects of similar kinds. There are for instance devices that checks whether the doors are locked. This section presents some of the standard home automation security features since it is an area in the field of smart homes that the elder could benefit from.

2.3.1 Concerns

The implications of the violations in the security functionalities in smart homes are a big concern. The support in devices designed for elderly and impaired people is also a concern since it still is an open research area [6]. The areas of concern that the house owner should be aware of are detection of intrusions, gas/smoke/water leaks, medical alert and controlling of the doors/windows.

Since the systems that are monitoring the lives of the elderly are carrying data of vital importance, it is important that the systems are secure and that they are confidential [40]. Furthermore, the elderly may need to perform a set of commands which may lead to improper usage, health smart homes must ensure the safety of the elderly, therefore designers must envision ways of avoiding software, hardware and network malfunctions to mitigate harmful consequences [3].

2.3.2 Potentials

Although many of the aspects of the systems are striving to create a healthier life for the elderly there are also aims against security issues. There are several examples like gas, smoke and water sensors [24](devices that measures a physical quantity and converts it into a signal which can be read by an observer or an instrument [45]) which strive to make the user aware of dangers instantly as they appear. There is a solution for the health monitoring, which is that, the results of the blood and pulse pressure results are sent directly to a nursing home.

There are functions regarding the security of the house that allow a person who is concerned whether or not the house is secure to control the issue, the user can ask the mobile phone if the house is secure and gets back a response by voice [25].

Intelligent carpets, using RFID (Radio-frequency identification) technology, which may be a part of the surveillance system, could be used to ensure that the elderly is still alive capturing motion and other behavioral patterns [18].

Prototype	Concerns	Potentials
Social robots	• Overly-complicated, hard to use and maintain • Unpractical, does not act as a human at all points	• Works as a companion • Facilitates living at home • Direct contact with family members • Increased social interaction skills
Health	• Decreased human presence • General presence of a monitoring computer	• Verbal assistance to facilitate the stay and inform what to do for those who tend to forget • Grown confidence thanks to the fall detection and monitoring services
Security	• Improper usage of the systems that monitors the elderly	• Awareness of dangers before they occur • Able to check whether the door is locked or not

Table 1 - Keyword table from theory section

2.4 Considerations when designing/installing a health smart home

As there are many ideas constantly being formed in the area, there are also some main points that a health smart system needs to strive towards [3]:

Trustworthiness

Trustworthiness concerns the safety aspects and the personal integrity of a user.

- **Privacy/Security**

The user should not feel that he/she is surveyed. Without restrictions in the surveillance the users are unprotected from abuses. It is also important to keep the safety high with all the wireless communication; confidential information should be kept private in order to ensure the systems confidentiality.

- **Reliability/Safety**

If the user performs a set of commands with the system, he/she runs the risk of utilizing the system improperly and cause damages not only in the house but also in to the user himself/herself or someone in their surroundings areas. Software bugs or hardware malfunctions might make the system act unpredictable and therefore damage equipment or harm occupants.

Acceptability

Acceptability concerns requirements associated with the users acceptance of the system.

- **Usability**

The usability of Health Smart Homes is a big concern. Efforts should therefore be made to guarantee interfaces of the systems that the stakeholders easier can learn and adapt to. The systems should also be resilient to errors to satisfy the users. Another important aspect is that the system should try to be as invisible as possible. It should strive to have its components hidden throughout the household in mirrors, walls and home appliances. For example, it "should follow high-level design requirements such as being unobtrusive, personalized, adaptive and anticipatory" [3].

- **Affordability**

Affordability is not mentioned in the Bartolomeu paper but it is however mentioned in a study made in France [19]. The study has performed interviews with a number of elderly who mention that for them to consider a Health Smart Home it needs to be 100% refundable.

3. RESEARCH APPROACH

This study is conducted to investigate how elderly perceive Health Smart Homes. It will discuss important design aspect with related research, theory on design aspects and reported technological solutions. We draw implications from the interviews conducted, which can serve as help for future software engineers addressing the area. The question we strive to answer through this paper is the following:

- What design aspects are needed for elderly to consider using a health smart home?

3.1 Method

Our study is based on an interpretive case study [36]. The interpretive school is suitable for our study since it is not only based on facts. The results are instead based on the interpretations the researcher has made through his experiences of situations or through interviews, which will be the case in this study. The interpretive school also acknowledges the fact that none of the results will be totally objective but will instead be influenced by the researchers own opinions and cultural backgrounds [29].

The case study process is an exploration of a closed entity, which can be a program, an event, an activity or individuals [30]. The exploration is done over a period of time with collection of in-depth data, which are rich in context from a number of sources. Our case consists of five elderly between 70-85 years old who are living on their own. Three of the elderly was approached through a contact at the eldercare unit in Kungälv's municipality and two was contacted through personal contacts.

Since the fact that little was known about the feelings of senior citizens in Sweden about the areas that is studied we felt that the best-suited approach would be to perform qualitative interviews [28] on the issue. The questions we strive to answer in this study are trying to get an understanding of elderly peoples feelings of possible technical solutions to problems in their surroundings and how they should be design to be appreciated of its users, this was a reason for us to choose a qualitative approach. The need for more in-depth knowledge and insight of the elderly arose and the qualitative interviews were the best way to retrieve it.

3.2 Data collection

The data collection was conducted through semi-structured interviews [28] covering different areas. This means that the interviews was not following any specific questions but was allowed to drift within the areas. The areas were derived from the literature such as studies and interviews done by other researchers, the areas were: social robots, health & security, which is seen as a deductive research process [33]. The interviews were conducted as qualitative interviews on five people in the age between 70-85. This group was chosen since a younger person might not be in need of the help and older persons are probably too old to live by themselves. We are however aware of that this might not be the intended generation for such a system and

that the issues might change over time. All the interviewees are living in an own home in the Gothenburg area.

In order to make the interviews as useful as possible we conducted the first interview together and discussed it thoroughly in order to get a clear view of the difficulties and good approaches for the interviews. This proved to be important since the first interview did not result in the way we hoped although it gave valuable input. It proved to be difficult to talk about the technological aspects of the systems with the elderly since they were unable to grasp the technology. The second interview was an improvement and tried to address the problems and issues instead of feeding the interviewee with technological solutions. After that interview we proceeded to conduct the rest of the interviews individually and separately. One thing we learned from the first two interviews was that when the questions about the social robot were arisen we showed the later participants a picture of Sony's robot dog AIBO [17]. In order to help the interviewees to understand we used technical aspects from the different solutions presented in the theory section such as video surveillance and motion sensors. We also asked if such a technique would violate their integrity or not. This helped the interviewee to get a better idea of what we talked about and the approach was chosen after we had experienced the difficulty for the elderly to imagine the solutions we mentioned.

All interviews were recorded to eliminate the need to write comments during the interview and be perceived as distant and/or not interested in the answers. The qualitative interview form was used to provide us with more in-depth information [31] and the fact that it was performed in a semi structured fashion gave us some room to receive angles that was not thought of from the beginning. It also allowed us change the interviews as they were conducted in order to engage the new information and change the upcoming interviews to better fit with the information unfolded.

The data collection phase resulted in five recorded interviews and with duration of approximately 15 minutes apiece.

3.3 Data Analysis

Due to time pressure we did not make complete transcriptions of the data. Instead we conducted iterative listening to the tapes while taking notes. This might have resulted in missing of important aspects but when thoroughly done we believed that would not be a problem. All relevant keywords, sentences and quotes were written down in the order they were said. These comments were arranged into groups named after the different interviewees. Because of this it was easier to identify who said what. The data was then sorted through a deductive process [33] following the concepts used in the data collection (social robots, health and security); each area was then divided into potentials and concerns. This was done in order to discover meanings and major concerns. We chose to do it with deductive reasoning in order to bring structure and meaning to the data.

We also identified what depth the interviews had in order to see the need for more interviews if there was one. In order to validate the interpretations of the data the interviews was listened to and analyzed by both researchers, this was done individually and independently. We both divided the key aspects found into the pre-mentioned themes. These findings were then triangulated [34] within the realism paradigm where several views of the same reality are compared; this was done to increase the validity and minimizing the effect of the researchers backgrounds affecting the results. If both had the same comment then they were merged but if one hade a unique comment, then it was discussed until we unanimously agree to that the subject has been mentioned in the interviews. This would also minimize the effects of the choice to analyze the recorded interviews directly instead of transcribing them. In order to get a deeper understanding of what the interviewee were feeling and the meanings of this, we approached the subject through a hermeneutic circle [41]. By iterating between looking at small parts of the answers and the whole interview, we sought to better understand the needs of the interviewee. During the analysis we also identified what comments and answers could help us to shape our design implications, which is presented in the discussion section.

4. RESULTS

This section will be arranged in a similar way as the theory section in order to make it easier for the reader to identify the comparisons made in later sections.

The results of the qualitative interviews show us that most of our interviewees are not familiar with the technology that is available for the elderly. Most of them were positive towards technology to be used at their places but some kept insisting that they could manage without it. However it was noticeable that they were not against the technology and its possibilities. They were intimidated by the fact that they would have to deal with technical solutions.

4.1 Smart Homes: Social Robots

4.1.1 Concerns

The elderly expressed initial hesitance to the picture of the robot when it is shown to them. The expressed concern was that it is a dead gadget and can never replace a real dog. They are worried that it will not resemble a dog in any way and cannot be a social companion. They also say that they cannot take care of a dog since it needs maintenance such as taking it for a walk. The group that is the most resistant to the thought is the ones over 80 years. Another reason for not wanting a robot is that they are not feeling alone and thinks it would be an unnecessary gadget since they have a

lot of other activities to attend. They also mention that sometimes they want to spend time on their own.

4.1.2 Potentials

They like the idea to have a dog without being compelled to go out with it. They were at the beginning very uncertain whether they want a robot dog or not. Mostly because they did not know that it does not need to be maintained. Furthermore, the elderly thinks that it would be lovely to have something to speak to and get response back during evenings and nights since they meet other people only at daytime. According to them, the evenings are very unpleasant and lonely, and therefore a robot dog would be something that they really would enjoy. Finally, they love the fact that they would not have to get tied up with the robot dog as one would need to do with a real dog, they like the fact that they can "play" with it whenever they want.

4.2 Smart Homes: Health

4.2.1 Concerns

The concerns that the interviewees bring forward regarding their health are very varying. They mention that they are afraid to get hurt and not get help fast enough. "I am afraid of technical solutions, I do not think I can manage them by myself" – was a statement by an interviewee. All of the interviewees mention that the most dangerous room in their house is the bathroom and kitchen.

4.2.2 Potentials

They liked that there could be a video camera surveillance system that monitors them at all time if anything happens to them. During an interview, it was stated that the user would love to have video surveillance in her home since she had a stroke before and nobody helped her since she could not inform someone about it. However she added that she would like the video surveillance system to be mute, meaning that an observer would not be able hear what's going on in the home, but has visibility. They also liked the fact that they could be safe in their house without having to think about who will help them if they fall down or something sudden occurs to them. The elderly that we interviewed liked the idea of blood and pulse pressure sensors and mentioned that they primarily would want the healthcare to be contacted first in case of emergency, since they have the needed equipment to treat patients. However not all wanted the health care to be contacted, some wanted their children to be the first ones to get informed if something occurred to them. Furthermore they added that verbal assistance is something that will simplify their stay in the bathroom since they tend to forget to turn off the running water or turn the lights off. A quote from one of the interviews regarding the health is "I would use all kinds of technological solutions to monitor my health".

4.3 Smart Homes: Security

4.3.1 Concerns

During the first interview there emerged a security aspect that had not been foreseen while doing the literature study. The interviewees said that many of their friends had been experiencing situations where strangers had forced their way into their homes and stolen all of their belongings. This was possible due to the lack of strength the elderly had. Many of the elderly were very hesitant to open their doors and were always using a security chain and spy hole to check who was at the door. Due to the large extent the interviewees spoke about this, we decided to ask about this in upcoming interviews. The elderly states that they think both once and twice before opening the door for a stranger.

The door lock is something the elder tend to forget but on the question of a system controlling this they are very hesitant. What if the door accidentally unlocks due to a malfunction? That such a situation would be disastrous is something the elderly expressed.

Another thing that the elderly brings forward was a worry that such a system would not be secure against outsiders. They expressed that the information the system would be gathering is confidential and they are reluctant to the solutions because of this. A requirement stated by the elderly for it to be interesting is that the information is protected from both outsiders trying to intercept the data and unauthorized persons at the authorities.

4.3.2 Potentials

The interviewees say that an easier solution for both alarming and preventing strangers to force themselves in would be useful. As mention before the elderly express difficulties to see who is at the door just through the spy hole. They would like a more precise tool to identify the person on the other side of the door.

There arose another subject during the interviews; the fact that the elderly worries about whether or not they had turned of the stove or not. They mention that an aid for either turning it of automatically when leaving the house or maybe after a few hours. When explaining that there were solutions for checking the status of the stove and door locks from a mobile device they were very interested. The fear to forget things was most noticeable among the oldest people of the test group.

The following table shows the keywords gathered from the interviews regarding concerns and potentials for each prototype as the one in the theory section.

Prototype	Concerns	Potentials
Social robots	• Hesitant to the picture of a robot • Dead gadget, cannot replace a real dog • Cannot resemble a real dog.	• The fact that it does not need to be maintained makes it more attractive to the elderly • Likes it during the night since they usually are alone at that time
Health	•Afraid to be to much dependent on a system if its not working at some point •Feels uncomfortable because of the cameras.	• The fact that their blood and pulse pressure are monitored at all time gives them a feeling of safety • Verbal assistance will make them more satisfied when leaving the house knowing they have not forgotten anything • Grown confidence thanks to the cameras and the sensors of all sort.
Security	• Worried how the information is sent and if it can be intercepted • Do not want their locks controlled by a computer, what if it accidently unlocks them	•Feels more secure with a precise tool that shows who is on the other side of the outside door. •Feels less worried since they can check whether the doors and stoves are looked/off

Table 2 - Keywords from results

5. DISCUSSION

This section will discuss the results of the study in contrast to the theory studied in earlier sections.

After having interviewed the elderly, we discuss outcomes of the study with related research. Based on the insight from the study we make an attempt to draw some design implications that can serve as a basis to further inform the software engineering field of how to address this area. We will follow the same structure as the theory and the results sections.

5.1 Social Robots

The elderly in our study were hesitant when the picture of the Aibo [17] was shown. The study in St. Louis [42] shows however that such reluctance does not have to affect the results of the usage of a social robot. There is an importance of overcoming the first threshold when introducing social robots to elderly and it is essential for it to be used at all. The advantage of not having to maintain the robot as much as a real dog has been identified in both the literature [42] and in our interviews. For dog lovers who are unable to own a real dog due to health issues a solution like this one could be a blessing.

All persons are different however and there have been comments in our interviews saying that a social robot will never be as competent as its biological counterpart. This is also supported in the literature, which states that a social robot will not be able to perform in the ways a human or animal can [9]. The fact that the robots do not perform equally to a dog does not have to be a problem and when approaching the subject openly and not seeing it as a substitution for something real it can be a welcomed companion.

In previous field studies a main concern has been stated widely; the elderly are worried that a system for monitoring them will substitute the personal contact with the eldercare personnel [19]. This is however not a comment which arose during our interviews. The Swedish elderly seem to feel confident in their eldercare institutions and instead of replacing them, they see the robot more as company during those hours when the personnel is not present.

A problem in Sweden has been that many of the eldercare units have different persons taking care of the elderly for every session [44]. This creates a situation where the patient does not know what to expect from each day since the persons will treat them differently and not knowing what was said the previous day. This is where the social robot has its major advantage in social terms; it will be a social companion who will not change and which the patients can get attached to [42].

5.2 Health

As mentioned in the previous section our interviews did not point out any concerns about a system would replace the personal contact with the eldercare. Instead of having to check the person's vital sign and health issues a system doing this for them could enable the personnel to spend more time socializing with the elderly. This was mentioned as the main thing the elderly appreciated with the visits from the eldercare and the need for socialization was noticeable during our interviews since they wanted to talk to us about everything in their lives.

Video surveillance is a technique, which has been presented [19] as good in order to monitor the elderly if something has happened. We anticipated that this would be perceived with dislike from the interviewees and that they would feel that this would violate their integrity. We where proven wrong, the elderly did not feel like the ones in the study presenting the video surveillance technology to a group of elderly [19]. The elderly that we interviewed saw no problems in being surveyed and felt like they had nothing to hide. The comments we received about the video surveillance was more about how they would look not wanting any unaesthetic cameras hanging from the ceiling. So nicely designed we believe that video surveillance would not be a problem to implement.

Most elderly were afraid of falling and not getting help fast enough. We got a comment saying that she thought that everyone above 70 thinks about it from time to time. Although many would need help they are too proud to ask for it and wants to take care of themselves. The motion sensors are a way to approach this group where they do not need to feel as a burden for persons but instead their help is covered by electronics. Another important aspect we found was that elderly who had been in contact with help of any kind (visiting eldercare, alarm buttons) were more positive to any new solution presented to them. It was also noticeable that they were more open if they had knowledge of a technological aid before being introduced to it. These two aspects is important for especially marketers to address when introducing a system to the elderly, they need the information to be provided widely and especially target the "proud" group with the advantages of a system like theirs.

5.3 Security

An issue that was mentioned in our interviews was that they would want a technique for identifying who is at the door when someone rings the bell. At the moment they use the spy hole to achieve this, which has a very narrow visual angle and some distortions to the picture. This is a concern that has not been mentioned in any of the papers we have read in this study and can be connected to the story's about people in the surroundings of the elderly had been exposed to intrusions in their homes. The elderly also came with solutions to this and suggested that a camera just outside the door to provide a wider visual area.

Many alarms were mentioned in the theory section: gas, smoke and flood sensors [24]. Gas and flood sensors were nothing that the elderly saw as something they would need but they did mention that they have a worry that they might not have switched of the stove. They say that a gadget for reminding them to switch it off would be appreciated but if they did forget and was not home, it might burn down anyways. An alarm that directly contacts a supervisory company is very feasible and could be integrated into the smart home system.

The fact that the elderly tend to forget is mentioned during the interviews and also that they worry if they had done something or not. This is especially true for the locks on the door. Although they identify this as a problem this is not something they would want a technological solution for. They are worried about that a lock like that would accidently unlock itself. A solution like this would demand vast efforts in the reliability attribute.

5.4 Design Implications

After having done the interviews and gathered the results, we could map the results to a number of quality attributes, which the developers should consider revising before developing a Health Smart Home.

Based on the results and some common sense, we mapped the outcomes of the interviews to the following quality attributes:

Acceptability/Usability

The interviewees mentioned that they want the systems to be as invisible as possible which is also stated in the literature [3]. They don't want to see that the video surveillance systems and the motion sensors are monitoring them; they just want to know that they are there which makes them comfortable. Furthermore, they mention that they would like interfaces that are easy to understand which also is stated in the literature as a usability aspect. In distinction to the literature, our interviewees mentioned that they would not want any kind of interaction with the system at all. However in comparison the elderly that we interviewed shared the opinion and points out that they want the systems to be as invincible as possible, meaning that the system should be hidden behind mirrors or any kind of object.

Affordability

The interviewee's mention that they have limited amount of money left after all the payments such as rent, electric bills etc. They also mention that they are aware of the cost of having the current solutions available but are afraid that they cannot afford it. As it is stated in the literature, that the health smart homes should be 100% refundable [19], is appropriate amongst the elders we have interviewed which means that the government or another institution should stand for the installation and maintenance of the systems that are being installed in an elderly persons house.

Security/Privacy

In distinction to the literature who states that it should be avoided to make the elderly feel watched [3], the elderly that we interviewed did not see any problems with having video cameras installed for them at their houses. They mention that it would only help them and everything that helps them is desired. They would not feel that their integrity would be violated with having such systems installed at their houses. They also added that they do not want any sound recordings in the video surveillance system. They feel that video is sufficient and that audio would not have the advantages outweighing the intrusions of their privacy.

Safety/Reliability

The developers should minimize the interaction level with the systems so that the users do not push the wrong button, which might lead to software bugs since the elderly we have interviewed all have a low level of technical skills, and tend to forget what to do at certain times. Since the systems are carrying information of vital importance, it is important that the information that the system is carrying is protected from intrusions and is only received by the intended person. This should be considered when designing

a health smart home. The systems should be fault-tolerant which means that they still operate at a reduced level rather than crashing completely.

6. CONCLUSION

This paper has presented an interpretive study on the aspects of health smart homes for elderly. The study was based on qualitative interviews conducted on elderly in Sweden. The aim of the study has been to investigate how elderly perceive health smart home solutions. With this insight we have discussed some design implications that can serve as a basis in future approaches to this area. The main two aspects that should be considered are that the system should be user friendly in both design and interaction and secure/reliable. Preferably the system should not be interactive by the user at all. It should be secure and reliable since it concerns human lives, which are to a degree dependent on the system. These issues might change when generations switch and the elderly will have more experience in technology. Only time can tell.

"Advances in technology will continue to reach far into every sector of our economy. Future job and economic growth in industry, defense, transportation, agriculture, health care, and life sciences is directly related to scientific advancement."
- *Christopher Bond*

7. LIMITATIONS

There are some limitations of this study, which will be presented in this section. The interviews were performed in a somewhat brief way. They only resulted in approximately fifteen minutes of recorded audio each. The interviews did not provide enough information for us to provide comprehensive design implications. The fact that the interviews where so short were an effect of our inexperience as interviewers. We did not dwell into each question deep enough and did not ask for explanations of every answer. We had problems getting through to many of the elderly of what we were talking about, they did not seem to understand what the system could do and how. A more experienced interviewer might have excluded the technology from the beginning and received more significant information from the interviews. Since we did not have exactly the same aim when doing the interviews as we ended up with, we could with earlier settling on the aim have gathered results more applicable to the aim. We also reduced the number of interviews to five. With more interviews the results could have corresponded with a wider range of people, this would have provided more nuanced results.

We are aware that the target group of this study will change before a system can be released on the market. The issues of the users might change when the generations shift and the new groups of elderly has more experience of technology. We could have targeted the group that might be the future users but they would not have been able to picture themselves in the situation for needing any aids. The elderly in our study stated that 10 years ago they could never have imagined felling as helpless as they do now.

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