

Attitude of senior citizens towards smart home technologies: a literature review

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<p>Abstract:</p> <p>Smart home can be of significant importance for positive ageing allowing elderly to maintain independence, functionality, well-being and higher quality of life.</p> <p>Aim: The aim of this thesis is to study attitude of senior citizens towards smart home technologies. Understanding senior citizen's attitude towards current smart home technologies is an important aspect in optimization of the existing technologies as well as in the design of new technologies. The review will aim to find the answers for following re-search questions:</p> <ol style="list-style-type: none"> 1. What is attitude of elderly towards various smart home devices? 2. How can we improve the usage of smart home devices among elderly? <p>Method: This study involves literature review of ten different studies conducted to study attitude and perceptions towards smart home technologies. Articles were collected from reliable data search engines like EBSCO, PUBMED and CINAHL. The theoretical framework used was based on Technology acceptance model.</p> <p>Results: The study suggested positive response towards smart home devices and that smart home technology were willingly accepted by elderly. However, concerns were raised with respect to privacy violation, lack of human responders and user-friendliness. Smart home technologies were significantly useful in providing emergency help, prevention and detection of fall and monitoring physical activities of elderly to access their health status. The key issues challenging adoption of smart home technologies were privacy, trust, stigma, usability, training suitable for elderly people and affordability.</p>	
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2 INTRODUCTION

Human life expectancy has been increasing worldwide with advancements in medical technology as well as improvements in social systems. The proportion of people aged 65 or over in the Finnish population is estimated to rise to 28 per cent by 2060 (Statistics Finland 2015). The increased demand for health and social services poses economical and administrative challenges to the service provider. Finnish policy aims at increasing the stay of elderly people at their own home as long as possible which will save much on long term care cost. The policy aims to increase home based care and improve service quality for the elderly at home as much as possible (MSAH 2008, p.9).

Smart Home technology may help elderly people to enhance, prevent and compensate the declining physical capacities and thus enabling independence (Demiris et al. 2008 p. 33). The risks associated with living alone may be reduced by the use of different smart home technologies at home (Molin et al. 2007 p.92). Use of smart home devices can promote independence levels of the elderly and allow older people to remain at home by coping with age-related difficulties such as falls, isolation, medication management, sensory impairment, and diminished mobility (Mckee et al. 2012 p.2). Furthermore, smart home technology may also create a safer environment and provide comfortable environment for elderly (Rodeschin, 2011 p.524). Therefore, smart home devices may be potential solution for positive ageing to allow elderly to maintain independence, functionality, well-being and increase quality of life (Kalogridis et al. 2011 p.78; Tacken et al. 2005 p.126).

2.1 Motivation

The author was privileged to work with occupational therapist and socionorms and to be able to participate during ‘the process of assessment of living environment’ of one of

the clients. The process introduced the author to different assistive and smart devices installed in the house, their functionality and the usages.

The author also visited toimiva koti, an exhibition center where one can try out smart home devices. The author learned about different assistive technologies that can be built in a house for people with different functional disabilities. Furthermore, during one of the visits, the author noticed that most of the assistive devices in the house were not been used. The client reported that there was too much work in using the equipments. The client's attitude motivated the author to research on the perception and attitude of the elderly people towards use of smart home devices. A major question that the author addresses in this study is whether all the objectives of smart home devices are fulfilled. If not, what can be done to redirect the design of smart devices targeting their core objectives?

2.2 Background

“Smart Home” refers to a home equipped with technology that enables the elderly people to promote independence, enhance functional health, security, safety and increase quality of life of the residents(Graafmans, et.al.1998 p.27). Smart homes are equipped with automated systems for different tasks such as lighting, fall detection, kitchen safety, door switches, movement sensors, individual tracking badges, reminder system and personal household assistant (Morris et al. 2013).

Development of smart technologies for elderly has led to the introduction of new terms such as gerontechnology to describe trends and sub-area in the research. “Gerontechnology” has been the standard term developed in the course of development in the area of smart technology for elderly.

Gerontechnology is a combination of gerontology with the technology which is applied in designing different technologies (including smart home) and environment for the elderly people to live independently and to promote social participation in maintaining good health, comfort and safety. The term gerontechnology was coined by Jan Graafmans at Eindhoven University of Technology in 1989 (Graafmans, et.al.1998 p.27). Different technical group like engineering, sociology, and healthcare have applied their expertise to help with the problem with the ageing to develop smart homes (Graafmans, et.al.1998 p.29).

Lê et al. (2012 p.3) purposed a conceptual framework of smart homes with five different features: namely-Automation, Multi-functionality, Efficiency, Adaptability and Interactivity (Lê et al. 2012 p.3)

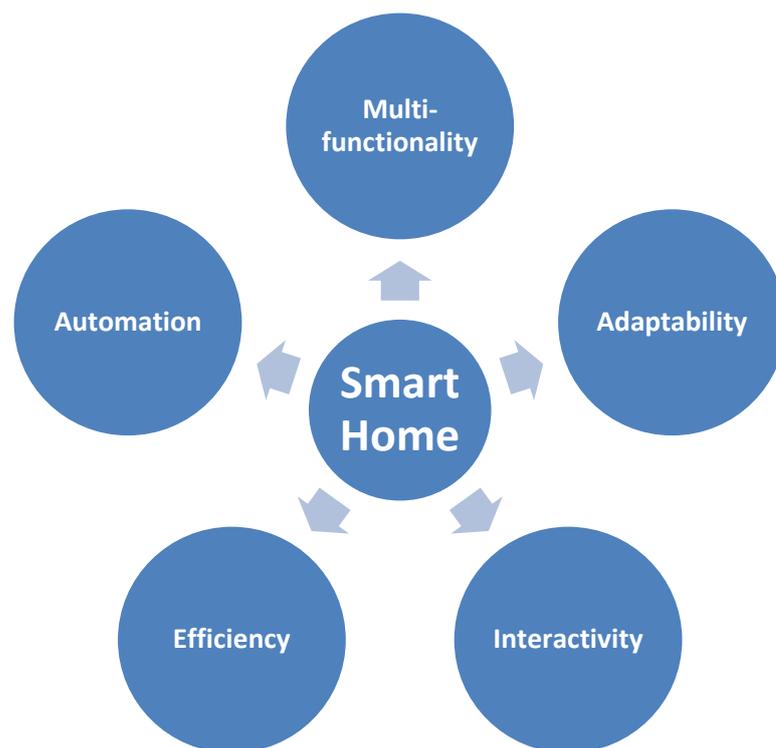


Figure 1 Conceptual framework of smart home (Lê et al. 2012 p.3)

2.3 Earlier studies

Multi- professional teams are constantly working for the design of different technology devices. The multi-professionals assess the circumstances of the older individuals, and based on the evidence based theories and results, the professionals try to design a smart technology for elderly. Knowledge about “ageing, cognition and attention” is necessary for these multi professionals to be able to design devices for elderly (Graafmans, 1998 p. 29). However, it is always difficult to design for the heterogeneous group of elderly. So, it is important to involve elderly in the development of the smart technological device because elderly people are the users of the device and they know better what is good for them.

A research was conducted to focus on the importance of the elderly to be involved in the research for development of different devices. A focus group methodology was used to enable elderly people to recognize and explain problem related to mobility and were asked to put forward different solutions to solve the problems they faced. Bending, reaching objects, climbing stairs were found to be more problematic for the participant elderly. The participants also gave solutions for the problems they faced and the elderly participants were very creative and critical. The study shows that involving elderly people in the development of technology, which later can be used in smart home, can help the designers to effectively develop technology that will be best for the elderly users (Seale et al. 2002).

Furthermore, the involvement of ergonomics in the design of technology can have a particular role in improvement of comfort and safety for elderly people living at home. The article discusses about an ergonomic and technological approach towards the improvement of the relationship between elderly people and the environment they live. The article suggests some specific design in the entrance and kitchen to improve the living environment of the elderly. The study concluded that the combination of technology and ergonomics applied to improve the living condition at home may increase safety for the

elderly people. This shows that quality and efficiency of technological devices at smart home can be improved with the involvement of the ergonomics (Pinto et al. 2000).

It is also essential to assess the living environment of the elderly for promoting independence and quality of life. A research was conducted where a total of 104 frail elderly people living at home in western New York were evaluated for the effectiveness of different technology and environmental intervention to maintain independence to reduce health care cost for frail elderly people. The participants were divided into 2 groups (52 treatments, 52 controls). The treatment group received different technological help along with environmental independence while the control group only received usual care service. Mann, et al. suggested that quality of life may be improved with the use of technological device and this can be a very good initiation for the society to encourage the elderly people to use smart technology to maintain independence in their life (Mann et al. 2008).

The research was conducted to study the perception of older adults living at smart home towards the use of smart technology. Twelve healthy couples were interviewed to know their perception of using different smart technologies when in need of assistance. The couples were over 70 years of age, did not use any smart device until then, and lived in the same place for more than 5 years. All participants showed positive attitude towards the use of smart assistive device. The findings from the interview were categorized under the theme “asset or threat” depending on the caring needs and ability. The asset was that elderly people were happy to use the device with the partners with minimal burden on the partners and the threat was that the elderly would not want to use the assistive device if they were to live alone or without the partners (Harrefors et al. 2010).

Another research was conducted to evaluate the attitude of elderly people living at home towards the smart home technology and the social environment to enable them to cope with their everyday life. The attitude of the elderly towards smart home technology was

compared with an occupational therapists assessment of their needs in relation to social engagement, loneliness and overall contentment with life. The author interviewed 53 elderly people. This article discusses about the attitude that elderly people have towards accepting smart technologies. The author came to a conclusion that attitudes among the elderly towards social and occupational engagement are important in accepting or declining rehabilitation. The main limitation of the article is that the author investigates small sample which might not reflect the attitude of the true larger population. Furthermore, there was more extended result for the interview which made it difficult for author to come to a precise measure (Lilja et al. 2003).

When planning a research on attitude towards the use of smart home technology, it is important to analyze the number of ownership and use of smart technology. A longitudinal research (Dahlin-Ivanoff & Sonn 2005) was conducted for 5 years among older adults in Sweden living at home to identify the changes in use of smart technology overtime and the reaction to dependence in daily activities. A total of 195 older adults of age 85 and 90 took part in the study. The study showed that 50 participants did not use any kind of smart technology at the beginning of the research and when the participants reach the age of 90, 37 out of 50 participants started using some sorts of smart technology. At the end of the study 73% of the total participants were permanent users of smart home technology. The most readily used device were bathing and mobility device followed by toileting and personal care products (Dahlin-Ivanoff & Sonn 2005).

2.4 Aim and research question

The objective of this research is to survey on the attitude and perception of the elderly people towards the use smart home devices. While trying to research about the attitude of elderly people towards certain devices it is very necessary to only include research articles where elderly are either using the devices or should know about the device to

comment. The study will involve literature review, by collecting and summarizing a number of scientific journals and research articles from related research field.

The review will try to find the answers for following research questions.

1. What is attitude of elderly towards smart home?
2. How can we improve the usage of smart home devices among elderly?

2.5 Theoretical framework

The theoretical framework of this research paper is based on Technology Acceptance Model (TAM) by Davis (1989). TAM describes a pathway that shows why a user accepts or rejects a new technology. TAM is based on the “theory of reasoned action” by Davis (1986). The purpose of this theory is to understand the acceptability of various technologies and to identify the modifications which must be brought to the system in order to make it acceptable to users (Davis 1989).

The willingness to accept a new technology depends on two factors: Perceived Usefulness and Perceived Ease of Use (Davis 1989).

2.5.1 Perceived Usefulness:

Perceived Usefulness is defined as “the degree to which a person believes that the use of a system will improve his performance” (Money, et al 2015 p. 4).

2.5.2 Perceived Ease of Use:

Perceived Ease of Use is defined as “the degree to which a person believes that the use of a system will be effortless” (Money, et al 2015 p. 4).

The above mentioned two factors (Sections 1.4.1 and 1.4.2) determine attitude to adopt new technologies. The attitude towards adoption to new technology decides the users' positive or negative behavior in the future concerning new technology.

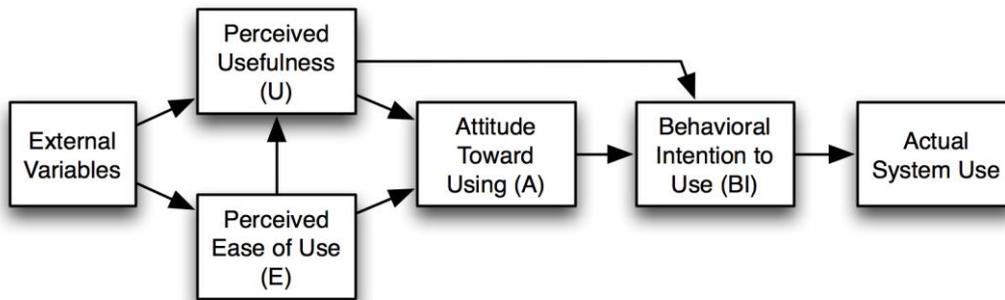


Figure 2 Technology acceptance model (TAM) by Davis 1989 (Davis, et al. 1989, p.985)

According to the Technology Acceptance theory, the use of technology is determined by the behavior intention to use the certain technology but on the contrary the behavior intention is determined by the individuals' attitude towards the use of the technology (Figure 2). (Money, 2015 p. 4) also describes that the attitude of the person is not only the factor that decides the use of technology but is also based on the effect of the technology on the user performance (Figure 2).

2.6 Description of concept

A smart home, in general, is a home that is equipped with electronic devices that can be remotely controlled and programmed with minimal effort. For example, a resident of a smart home who is on vacation in distant location from home can perform several tasks in his or her home like switching on or off appliances, controlling lights, controlling

temperature gauges and many more. The definition of a smart home according to the Smart Homes Foundation is: ‘the integration of technology and services through home networking for a better quality of living.’ Smart home designed particularly for senior citizens are homes that are equipped with devices that ensure safety, security and overall quality of life of the senior citizens. The smart home devices can broadly be classified under following categories (Berlo, 2002 p.80).

2.6.1 Safety and security

One of the important priorities of smart home devices is safety and security of the older residents. Examples of smart home devices meant for safety and security of the older citizens are intruder alarm, smoke alarm, automatic lighting at night, and automatic cooker switch off. Intruder alarm allows the residents to know and recognize anybody willing to enter their apartment before opening the door. This is usually achieved by using remote controlled phone, television or electronic locks on central access door and own apartment door. Smoke detector is usually installed near or in the kitchen. Any detected smoke alarm signal is automatically passed on to call center, which in turn calls the residents for confirmation before taking action. Automatic lightening during night is important for preventing falls among older people. Smart homes are equipped with sensors near or under bed or in the bed mat that detects the movement of legs away from the bed and automatically turns on the lights. Automatic cooker switch is another important device for residents who do cooking. The switch turns off automatically after installed time, for example one hour. (Berlo, 2002 p.80).

2.6.2 Care

Smart homes are equipped with devices that observe activity pattern of the residents in

the home and sends signals to caretakers in case unusual pattern is observed. A common idea is to categorize residents into active person and passive person and provide them respective pendant or bracelets. However, it has been found that active alarm bracelet or pendant is not preferred by older citizens. The installed alarm continuously detects movement of residents and sends warnings if no movement is detected for installed period of time, for example three hours. It is important to consider situations when the residents are sleeping or not at home for which no optimal solution without an action from residents exist so far. In addition to active or passive alarm, other examples of devices under this category are smoke alarm, intruder alarm and fall detection alarm. (Berlo, 2002 p.81).

2.6.3 Comfort

Beside safety, security and care of older residents, smart homes are also equipped with devices that offer comfort in living to the residents. Examples of such smart home devices can be automatic switching on and off lights and other appliances. While comfort is an important aspect that contributes positively to quality of life of older citizens, care should be taken to limit the use of comfort devices in order to ensure sufficient physical activity and exercise by the residents for their better health. (Berlo, 2002 p.82).

2.7 Limitations

The author decided to narrow down the scope by only focusing on the technology used at “smart home” to increase the quality of life for the elderly. Only research paper which was strictly focused on smart home was chosen for literature review.

Furthermore, not being able to access all the new journals was other limitation for the author. There were newer studies on the smart home technologies with the elderly people but because of the inaccessibility to the article, the author could not use that paper for the literature review.

3 METHODOLOGY

Systemic literature review is being used in this study, which assist in providing wide knowledge in the area of study. It also helps to form ideas from the findings and relate them to the theory. Previous scientific research articles written by researchers relevant to the area of study are retrieved from the internet. The information for this study was obtained from data of pre-existing scientific research articles.

3.1 Literature review

The material for the thesis will be carefully chosen in a systemic way for the literature review. A literature review is a compression study and interpretation of article that addresses a specific topic. In literature review, one tries to find the answer to the specific question (Aveyard, 2010 p 5).

The literature review helps the author to identify different theories and previous research that have encouraged choosing the topic. Literature review is an ongoing process, which helps the author to identify the relevant theories and relevant research studies (Ridley,2012 p3).

Literature review is important in research as the literature review helps to summarize the literature of one topic. There are many researches available, so it will be easy for reader to get assimilated information on one certain topic in one place (Aveyard, 2010 p 5).

Systemic literature review is a “a systematic, explicit, comprehensive, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners” (Okoli et al,2010 p.10). Systematic reviews retrieve, appraise, and summarize all the available evidence on a specific health question. Systemic review should be peer reviewed so that when in need can be replicated. In a systemic review, the author should assess the quality of each report, synthesize the findings in an unbiased way and interpret the findings in a balanced and impartial summary (Tacconelli, 2010, p.229).

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3.2 Trustworthiness

The trustworthiness of every stage of the analysis process should be examined to give a clear indication of the overall trustworthiness of the study. The trustworthiness of this work will be inspected using the terms transferability, credibility, dependability, and conformability. In Transferability the findings obtained from the research can be easily

transferred to other settings or groups (Elo et al. 2014 p.7). Transferability of this article is examined as the result obtain from this paper can be easily used with other groups of elderly or in different housing settings.

According to Elo & Kyngäs (2012) Credibility involves ensuring that those participating in research are identified and described accurately and the focus of the researcher is very essential (Elo et al. 2014 p.7). Therefore, the author went through each and every article very precisely making sure correct information is extracted to have accurate findings.

Elo& Kyngäs (2012) indicated that Dependability as stability of data over time and under different conditions which enables a future investigator to repeat the study (Elo et al. 2014 p 7). The dependability of the work can be seen as the author uses references throughout the article and has clearly explained the detailed process of data collection and the result.

To achieve Conformability the researchers must take steps to demonstrate that findings emerge from the data and not their own dependency on the particular condition (Elo et al. 2014 p.7). In general, Conformability refers to the degree to which the results could be confirmed. Here the author will document the procedures for checking and rechecking the data throughout the study.

3.3 Ethical consideration

The author carefully read and reviewed the text written in “Good Scientific Practice in Studies at Arcada” and also signed the agreement form. The short plan for the paper was submitted to be approved before starting the research to the supervisor and the commissioning authority. The author also used scientific writing while writing this article. The author did not collect any new material. All the articles used for the literature review

was published already and was freely available to public. The author documented all procedures and was paraphrased when necessary.

3.4 Search strategy

The database search was mainly through Nelli portal. Medline, pubmed, CINAHL, Ebsco and Google scholar were mostly used. The author also contacted the University of Helsinki to obtain material. Only scholar peer reviewed articles published between 2004-2014 will be included in the thesis. The articles should also be full-text and should in English language. The article should also be readily available without additional payment.

Synonyms for the keywords “smart home” and “elderly” and “attitude or perception” were combined for the search strategy in the databases.

Table 1 Search strategy

Keywords	Synonyms of keywords also used during search strategy.
Smart home	Smart home or ambient assisted living or ubiquitous home or electronic assistive technology.
elderly	Older adult or Older person or senior citizen
attitude	Self-assessment or opinion
Perception	Insight.

3.5 Data selection

For more relevance of the thesis, there will be some exclusion criteria for the published articles. The articles before 2004 will not be considered in literature review because of rapid development in the technology. If the articles were not written by the scholar and should be peer reviewed to be included in the review. The articles do not clearly state the facts needed for the thesis will also be excluded. The selection criteria for the literature review are shown in the table 2.

Table 2 Inclusion and exclusion area

Inclusion	Exclusion
<ul style="list-style-type: none"> ➤ Set in home environment ➤ Assessed smart home technologies ➤ Should be about attitude of seniors ➤ Published in English ➤ In full text scientific articles ➤ Peer-reviewed journals ➤ Published after January 2004 	<ul style="list-style-type: none"> ➤ Set in other environments such as nursing homes or rehabilitations settings ➤ Books, PhD or Masters theses and abstracts from conference presentations

4 SUMMARY OF INCLUDED RESEARCH ARTICLES

Table 3 Study characteristics and outcomes of included studies

Study Reference	Study Design	Population Studied	Main findings

Ziefle, M. et al. (2011)	Qualitative	65 participants, 78 males and 87 females, aged between 17 and 95 years	Majority of the participants were reluctant towards the use of medical technology based on video monitoring system. Privacy and trustfulness of the technology were the two most important reasons for the reluctance.
Demiris, G. et al. (2008)	Qualitative	Nine residents over the age of 65 years	Residents expressed positive attitude towards the sensor technologies installed in their home. No concern regarding privacy and interference in daily activities was expressed.
Demiris, G. et al. (2004)	Qualitative	15 participants, seven male and eight female, over the age of 65	All the participants expressed positive attitude towards the sensors and devices installed in their home. However, concerns were raised with respect to privacy violation, lack of human responders, user-friendliness of the devices and training to the older citizens.
Demiris, G. et al. (2008)	Qualitative	14 participants, five male and nine female, over the age of 65	Most of the participants showed positive attitude towards bed sensor, mat sensor, motion sensor and gait monitor and negative attitude towards video sensor raising the issue of privacy. Stove sensor was considered less useful by most of the participants. The devices were considered useful more for security purpose than for monitoring daily activities.
Chernburoong, S. et al. (2010)		18 participants, 3 male and fourteen female, age ranging from 26 to over 85 years old	Most of the participants showed positive attitude towards all the smart home technologies included in the study. Even though most of the participants considered the technologies to be very useful, willingness for adoption of the technologies shown by the same participants was less. Willingness for adoption of video

			monitoring system was the worst because of privacy concerns
Coughlin, J.F. et al. (2007)	Qualitative	Thirty aging service leaders and aging Policy advocates	<p>technology Design: Inadequate awareness among elderly , advocates and care takers.</p> <p>Ethical Considerations: Significant concerns about privacy and trust.</p> <p>User Perceptions: Loss of privacy, stigma to some elderly.</p> <p>Role of Markets and Public Policy: Concerns regarding distributors and services, and inadequate public policy.</p>
Matlabi, et al. (2011)	Qualitative	60 older people living in extra-care housing	<p>Home Based Technologies and Health Status: No significant relationship between the uses of Home based technology devices and health status of the users (elderly).</p> <p>HBT and Quality of life: Significant improvement in quality of life with the use of home based technology devices</p>
Tomita et al. (2007)	Rando- mized Con- trol trail	46 people participated in the treatment group, and 67 participated in the control group. Minimum of 60 years of age, lived alone, and had difficulty with activities of daily living.	After two years of monitoring, more people from the intervention group were still living at home and their cognition scores were higher compared with controls. The participants showed overall positive attitude and willingness to adopt smart home only those functions that did not fail and that were most suitable and beneficial for them.
Courtney et al.	Qualitative	14 participants (Older people	Overall positive attitude towards the smart home devices despite signifi-

(2008)		living in old homes)	cant privacy concerns specially for video monitoring device.
Hoof et al. (2011)	Qualitative	18 community-dwelling older adults with a complex demand for care.	Most participants showed positive response towards smart home technologies and the participants felt that Smart home technologies could be used to support ageing-in-place and could be beneficial where traditional approaches may fail.

5 RESULTS

The total of 379 articles was obtained with the search keyword "smart home technology". The search hits were further filtered by reading the titles. Articles with terms "attitude", "perception", "Smart home" an "elderly" or any other terms with similar meaning in their title were selected. Further selection was done based on reading abstracts and including only those articles that studied attitude or perception of older people or their care takers towards smart home technology. A total of ten articles that are specifically focused on older people's or their care takers' attitude towards smart home technology, factors that influence the attitude and possible solutions were selected for this thesis.



Figure 3 Yield of studies identified during each step of review.

5.1 Study characteristics

The features of the selected articles are shown in Table 3. Three of the articles studied attitude of older people towards smart home technology, especially sensor technology with regard to improving their quality of life and monitoring their health status (George Demiris, Parker, et al. 2008; George Demiris, Hensel, et al. 2008; Demiris et al. 2004).

Another article included results from survey carried out at a hospital, nursing home and general homes to understand attitude towards six smart home technology devices (Chernbumroong et al. 2010). The six smart home technologies considered in the article were - 1) cooking hob and oven safety control, 2) sleeping pattern monitoring, 3) emergency alarm, 4) automatic lightening system, 5) video monitoring system, and 6) activity monitoring system (Chernbumroong et al. 2010). One of the articles was based

on understanding older people perceptions towards smart home technology by consulting aging advocates and services (Coughlin & D'Ambrosio 2007).

A study conducted by Matlabi, H et al M. et al., 2011 measured correlation of quality of life and health status of older people with smart home technology devices. The article by Ziefle, M. et al., 2011 was focused mainly on attitude of older people towards one of the smart home devices - video monitoring system. One of the articles focused on privacy issue influencing attitude of users towards smart home technology and willingness to adopt the technology(Courtney 2008). The article by van Hoof et al. (2011) surveyed participants about attitude towards smart home technology and its effect on independent living.

5.2 Participant characteristics

In the study conducted by Ziefle, M. et al., 2011, 165 participants were included; of which 78 were males and remaining 87 were females. The participants were of age in range of 17 to 95 years old. Younger participants were included in order to understand age effects on attitude towards smart home technology. The younger participants were university students belonging to different disciplines. The oldest participants were from senior homes. The study found that the younger participants were more familiar with the smart home devices as compared to older participants. However, no difference was observed because of difference in genders.

Demiris, G. et al., (2008) studied attitude of nine participants of age over 65 years towards smart home devices installed in their apartments. The participants were interviewed for total of 75 times during the period of January 2005 to August 2007. A similar study was done in 2004 by Demiris, G. et al. with 15 participants of age over 65 years old. The same research group performed a study in 2008 in a retirement community designed with a goal for aging in place. The community is named as Tiger Place. Fourteen participants of age over 65 were included in the study to understand

their perceived advantages and concerns towards the installed smart home technologies.

In the study conducted by Chernbumroong, S. et al., (2010) participants from a hospital, nursing homes and general population were considered to study participant's attitude towards six different smart home devices. Total number of participants was 18, out of which 14 were female, three were male and one participant did not specify the gender. The age of the participants ranged from 26 to 80 years old. 27.8 % of the participants were not care takers, 22.2 % of the participants were professional care takers, and 50 % of the participants were non-professional care takers (relatives). All the participants were users of personal computers, mobile phones, and computer applications like email, web-browsing, excel and photoshop.

A slightly different approach to study the implications of smart home technology for improving quality of life of older people was taken by Coughlin, et al., 2007. The study was conducted by participating 30 leaders in aging advocacy and aging services from 10 northeastern states of the United States of America. Matlabi., et al., 2011 conducted a study with 160 older people living in extra-care housing schemes selected from 23 schemes in England. The participants were interviewed in their living units. Tomita et al. (2007) conducted a study with 114 community living frail elders for 2 years. A study conducted by Courtney et al., 2008 included 14 older people living in old homes. van Hoof et al., 2011 studied attitude 18 community-dwelling older adults with a complex demand for care.

5.3 Results from qualitative studies

Results from the reviewed articles are summarized in **Table 3**. Participants in all the studies showed positive response towards smart home devices and that smart home

technology were willingly accepted by elderly however, concerns were raised with respect to privacy violation, lack of human responders and user-friendliness Smart home technologies can be useful in providing emergency help, prevention and section of fall and monitoring physical activities of elderly to access their health status (Demiris, et al. 2008 p. 34).

5.4 Attitude towards smart home technologies

Key issues challenging adoption of smart home technologies were highlighted consistently in all the reviewed articles. The key issues are as follows:

5.4.1 Privacy

Privacy is one of the important concerns in adoption of smart home technology (Ziefle et al. 2011 p314.; Demiris, et al. 2008 p.123; Courtney 2008 p.76; Hoof et al. 2011 p.330). Privacy is the biggest concern especially with video monitoring devices installed in a private space (Ziefle et al. 2011 p.313) .Participants, irrespective of gender showed concern for illegal data transfer and alteration or loss of critical data due to technical problems (Ziefle et al. 2011 p.313).Majority of the participants, however, expressed positive attitude for video monitoring system in a condition that the image should be anonymized by depicting only shadows and movements in the cameras (Demiris et al. 2004 p.90). Participant's degree of concern towards privacy violation with installed video monitoring system was also found to be dependent on level of risk that each participant had for fall (Hoof et al. 2011 p 330).

5.4.2 Trust

Ability of the smart home technologies to effectively work during the time of emergency and availability of human responders were another important concern expressed by the participants in almost all the studies considered in this article (Hoof et al. 2011 p. 330; Ziefle et al. 2011 p.313; Courtney 2008 p. 79; Demiris et al. 2004; p. 92, Coughlin et al. 2007 p.1813; Chernbumroong et al. 2010 p.7).Another factor that some participants considered in regard to trust of the technology was false alarm that could be burdensome for both staffs and the elderly (Demiris, et al. 2008 p.123).

5.4.3 Stigma

A fairly common perception about smart home technology is that the devices are designed for very old people with high frailty (Coughlin et al. 2007 p.1813) .The perception poses a great challenge in adoption of smart technologies because only few elderly want to consider themselves as very old and frail (Coughlin et al. 2007 p.1813).Thus, installation of smart home technology might be a stigma to some elderly because not every elderly people think themselves as old and frail. Smart home technology devices must be designed with proper appearance such that they are least visible and do not stand out as age associative device (Tomita et al. 2007 p. 30; Demiris, et al. 2008 p.123, Matlabi et al. 2011 p. 5).

5.4.4 Usability and training

Usability is another factor that plays crucial role in improving adoption of smarty home

technology. The majority of participants in the study conducted by Demiris, G. et al., (2004 p.92) considered that the devices are not simple enough to be handled by elderly and thus functional limitations associated with age were not considered during the design (Demiris, et al. 2008 p.123). Many participants suggested training sessions tailored specifically for elderly (Demiris, G. et al., 2008 p.115). Similarly, in one of the studies, the participants expressed that the devices are too difficult to handle by them (Coughlin et al. 2007 p. 1814)The importance of user friendliness of smart home devices and training sessions were also emphasized in the study by Chernbumroong, S. et al., 2010 p.5.

5.4.5 Affordability

Affordability of the smart home devices is an equally important factor in adoption of the devices for well being of elderly. Concerns were raised by the participants in most of the studies regarding whether the devices will be equally affordable to financially unprivileged elderly(Coughlin et al. 2007 p.1814; Chernbumroong et al. 2010 p.5 ; Hoof et al. 2011 p 319.;Courtney 2008 p. 79).

6 DISCUSSION AND CONCLUSION

Smart homes are homes equipped with technologies that are developed to ensure safety, security and better quality of life for people with compromised physical or mental ability. In this article, smart home technologies designed exclusively for older people were considered. The main focus of this thesis were; a) state-of-the-art smart home

technologies that are currently available for promoting safety, security and quality of life of older people with compromised physical or mental ability, b) attitude of older people and their care takers towards the smart home technologies, c) willingness of older people and their care takers to adopt the technologies, d) factors that discourage older people and their care takers for adopting the smart home technologies, and e) measures that can potentially encourage the adoption of the smart home technologies by older people and their care takers (Ziefle et al. 2011 p.412; Hoof et al. 2011 p.315.; Tomita et al. 2007 p.26; Courtney 2008 p.77; Chernbumroong et al. 2010 p. 1814; Demiris et al. 2004 p. 91; Demiris, et al. 2008 p.115)

All the research articles considered for this thesis were optimal for answering the research question of this thesis. All the articles considered for this thesis are qualitative in design and the main research goal was to understand the attitude of older people and their care takers towards the state-of-the-art smart home technology devices, their willingness to adopt the devices and the key issues that act as barrier for the proper adoption of potentially beneficial devices. While most of the articles were based on responses from older people themselves (Coughlin et al. 2007 p. 1812), few articles included also the significant others of the older people with dementia. However, in all the articles the participants were either interviewed face to face or questionnaires were distributed and their responses towards each of the smart home devices were analyzed.

The results of this review, which is based on pooling of results from ten research articles on same topic, clearly suggests that older people or their care takers have positive attitude towards smart home technology devices. Some of the smart home technology devices, such as stove sensor were considered not useful by most of the participant residents as they did not do cooking by themselves (Demiris, et al. 2008 p.121). This is an example that pre-study and careful planning for using smart home resources in right place as required by the older residents. Installation of potentially useful device like stove sensor in a place where it is not required shows lack of research done on the target

consumers of the technology before actual installation.

An interesting observation in one of the research articles is that most of the participants who considered most of the smart home technology devices included in the study to be useful were not equally willing to adopt the same devices for themselves (Chernbumroong et al. 2010 p.3). This points out three important issues - a) the participants were perhaps physically and mentally fit enough to consider the devices for themselves and they simply did not want to afford their "privacy" and "money", or, b) the participants could not afford the devices even though they needed them, or, c) the participants needed the devices and could even afford but they did not want to trade off their privacy, or, d) stigmatism among the participants.

Installation of smart home technology might be a stigma to some elderly leading them to think older and frailer than other elderly. Smart home technology devices must be designed with proper appearance such that they are least visible and do not stand out as age associative device (Tomita et al. 2007 p. 25; Demiris, et al. 2008 p.121). Mostly, only those elderly have stigma problem that are not necessarily in need of any smart home technology. Those who are in real need will find the technology helpful if the technology has been designed well. Thus, the problem of stigma among elderly concerning smart home technologies is rather a matter of need of a particular technology. However, some devices which are potentially very useful to enhance quality of life among elderly can be designed with customers of broad age group with disabilities. For example spectacles are widely used by all age group with eye problem and there is no stigmatization that only older age group with eye problem uses spectacles.

Privacy is one of the key issues that most of the participants were concerned about with respect to adopting smart home technology devices, more specifically video monitoring

device (Ziefle et al. 2011 p.412). While the privacy might not be a concern for the elderly who are more dependent and are at higher risk of emergencies, for example fall, it is still extremely important to address the issue in order to make the potentially useful device like video monitoring device useful in promoting safety, security and well-being of older people (Demiris et al. 2004 p 92; Courtney 2008 p. 80; Chernbumroong et al. 2010 p. 1817). Possible solutions to privacy issue of smart home devices could be use of unidentifiable graphics in video monitoring device and use of encryption technology in data lifecycle. It is recommended that the image should be anonymized by depicting only shadows and movements in the cameras (Demiris et al. 2004 p.93). Participant's degree of concern towards privacy violation with installed video monitoring system was also found to be dependent on level of risk that each participant had for fall (Hoof et al. 2011 p.315).

Trust of new smart home technology devices was another important concern raised by the participants in most of the articles. Novelty of the devices is the main factor responsible for their distrust among the participants. The reasonably fair concern of whether the smart home devices will function as expected during the time of emergency or not was one of the key obstacles contributing to the degree of willingness of the participants to adopt the devices irrespective of their positive feedback towards the very same devices (Chernbumroong et al. 2010 p.5). An important and potentially useful way of enhancing customer's confidence towards the devices could be to set up a test emergency or abnormal situation in significantly large number of homes and see number of times the devices give correct information. This experimental set up can also be used to optimize the devices to improve their effectiveness and hence improve customer's confidence.

Lack of human responders of the smart home devices was another major concern among the participants (Demiris et al. 2004 p. 92). This extremely important concern relates to elderly health care advocates and the states rather than the engineers. Lack of human responders or lack of systematic and effective management lames the usefulness of

smart home devices. A responsible body must be able to guaranty older people and their care takers on sincere availability of human responders once the smart home devices are installed at homes.

An attitude to avoid modern technology is common among many older people (Tomita et al. 2007 p.28). Understandably, there remains a huge gap between the degree of sophistication of high-tech devices used by younger generation and older generation. Many high-tech devices that are common among younger generation might appear useless to older people. This mentality of older people leads them to avoid high-tech devices in general. Thus, it is important to design devices keeping this mentality of older people in mind, keeping it simple enough to be liked and used by them. In addition, effective training sessions must be arranged to familiarize the older people to high-tech smart home devices.

Other important factors that can implicitly influence the adoptability of smart home devices are the distributors and affordability of the devices. The potential distributors could be pharmaceutical companies; private companies specialized on gerontechnology or the government(Coughlin et al. 2007 p.1812). It is likely that the prices of the smart home devices will depend on the distributors which might raise ethical issues on whether to make the devices available only to rich elderly or equally to all elderly. There is a clear lack of public policies in this regard (Coughlin et al. 2007 p. 1812).

7 FURTHER RECOMMENDATIONS:

Though research had shown that elderly people show positive response towards smart home it is not clear about the time duration of the equipments used. There will be

different response from the user after longer period of time. There will be a very interesting result if there will be longitudinal studies based on person- centered devices used by the elderly for at least 2 years duration. This could yield a better understanding about the attitude as well as the usability of different devices used at home.

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