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TIRTHA MAYA TAMANG
USER-CENTERED DESIGN OF AN INTERACTIVE SOCIAL
SERVICE CONCEPT FOR ELDERLY PEOPLE

Master of Science thesis

ABSTRACT

TIRTHA MAYA TAMANG: User-Centered Design of an Interactive Social Service Concept for Elderly People
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The population is greying rapidly. Technologies are booming to maintain independence and wellbeing of the elderly people. Many designs and researches are particularly focused on physiological and safety needs of the elderly people. Though technologies have capabilities to affect the social aspects of the elderly people in a positive way, there are fewer researches commenced to date. The main purpose of this thesis work is to find out the needs of the elderly people and design appropriate technological solution for the elderly people addressing those needs using User Centered Design Approach.

Various data collection methods such as semi-structured thematic interviews, observation and diary method were utilized to collect user needs. Then user data were consolidated using affinity diagram and the needs were classified using Maslow's Hierarchy of Needs. Based on the user studies and the literature review of existing technologies, the need for social technology was figured out and the design phase involved the development of Social TV prototype. The design process was iterative in terms of creating scenarios and storyboards as well as User Environment Design to attain simplicity in design. Then the mid-fidelity prototype of social TV named ElderTV was developed to demonstrate the concept. The evaluation of the prototype was conducted utilizing sociability heuristics for social TV where the designed prototype was compared against each heuristics rules and these rules served as design guidelines during the design phase of the prototype.

The resulted social TV concept for elderly people is designed to address elderly peoples' needs to strengthen the existing social ties. The concept is expected to extend TV viewing activity of the elderly people into shared experience by allowing them to communicate with a circle of friends and families. The prototype is intended to illustrate how elderly people can share feeling of togetherness while watching television and alleviate the loneliness and isolation of the elderly.

PREFACE

First of all, I would like to express my sincere gratitude to my supervisor Thomas Olsson for providing me with constant inspiration and motivation, his invaluable suggestions and advice right from coming up with the thesis topic. Thank you for possessing immense patience and understanding and helping me to complete this thesis work. I would also like to thank Pradthana Jarusriboonchai for instructing and providing valuable comments and feedback throughout this thesis. This thesis topic seeded after several meetings with Thomas and Pradthana while discussing the potential topic for thesis work on social technology.

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I am greatly indebted to my boss, Anja Danska without which the project would not have existed. Working closely with her as a personal assistant helped me to understand the needs of the elderly people on which this thesis is based.

Thank you Aki Mäkinen and Felipe Ludena for helping me conduct the interviews in Finnish, which was one of the important method utilized in this thesis work for collecting relevant information.

I would love to thank my parents for their love and support throughout my life. I would also love to thank my siblings and all the dear ones who have always been there by my side.

My immense love for Nepal!!!

Finally, Cheers Finland!!! I inhale the air of independence!!!

Tampere 3.7.2015

Tirtha Maya Tamang

CONTENTS

LIST OF SYMBOLS AND ABBREVIATIONS

ADLs	Activities of Daily Livings
AT	assistive technologies
ElderTV	design concept of Social TV in this thesis work
HCI	Human Computer Interaction
iADLs	instrumental Activities of Daily Livings
PR	PresenceRemote
TUT	Tampere University of Technology
UCD	User-Centered Design
UED	User Environment Design
WWW	World Wide Web

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1. INTRODUCTION

1.1 Background and motivation

Elderly population is the fastest growing population in the world (World Health Organization 2002). The population of Finland is aging more rapidly than the other EU countries where 19.8% of the total population is the elderly people of 65 years or above (Finland Demographics Profile 2014). Figure 1 adapted from (Finland Demographics Profile 2014) represents a population pyramid illustrating age and gender of Finland's population in 2014. By 2050, 27% of the Finnish population will be over the age of 65 and 11% of the population will be over the age of 80 (OECD 2013). Longer life spans, declining birth rate are some of the reasons behind growing elderly population.
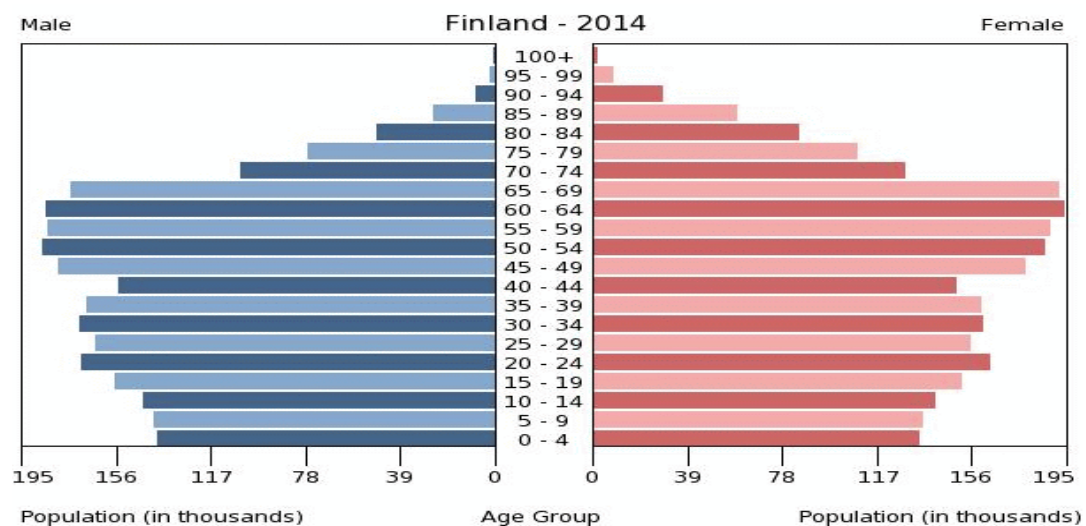
Figure 1. *Population pyramid of Finland-2014 (Finland Demographics Profile 2014)*

Elderly people may become more vulnerable and live at risk because of cognitive, psychosocial, and/or physical problems (Paveza *et al.* 2008). As the elderly have twice as many disabilities and four times as many physical limitations as people less than 60 years of age, it imposes more challenges to help elderly people maintain a healthy, independent and active life (Rimmer 1994).

These limitations restrict elderly people from performing activities of daily living (ADLs) and are reasons for elderly people to seek help from outsiders, such as carers or relatives, or to move to elderly homes. Supportive social relationships and frequent social interaction have helped elderly people achieve psychological and physical well-being (Czaja *et al.* 1993). The support provided for the elderly people especially from close

family members and friends can help them perceive meaning in life such as the sense of order, coherence and setting the goals as well as the sense of fulfillment accompanied by attaining goals. (Krause 2007). On the other hand, a longitudinal study suggests that less social interaction and poor social ties have negative impact in elderly people's life causing higher risk of cognitive decline (Zunzunegui *et al* 2003), slower recovery from illness, and even early death (Lubben and Gironda 2003).

However, the social network of elderly people is limited to family members, carers and people living in the proximity. Shrinkage of the social network is mainly due to the family breakdown (Help The Aged 2007), the loss of spouse and relatives due to death, retirement from work and the mobility limitations of elderly people due to frailty causing elderly people more isolated and lonely (van Dijk *et al.* 2010).

Despite having functional limitations, a study indicates that elderly people value on keeping their ability of independence and autonomy (Independence 2004). They want to be involved in decision making in their daily activities and want to be valued in what they decide. Elderly people receiving care now were once caregivers and are often worried to be burden to the society. However aging is not just marked by physical and cognitive disabilities and poor social capital but instead, as in earlier stages of life, it is a phase of life, which involves development, activity, and growth (Laslett 1991). In this phase, they can be involved in practicing hobbies, participating in intergenerational communication such as interacting with adult children and grandchildren as well as with old friends and create new contacts and reflect on one's life.

Proper help or support from other people provide emotional security and control over daily activities, hence enhancing independent living. In Finland, the Ministry of Social Affairs and Health is responsible for the arranging social and health services for elderly people (MSAH 2013). Since elderly people are perceived by many as dependent and weak, rather than those who contribute for society, the care services are often limited. Despite having functional limitations, a study indicates that elderly people value on keeping their ability of independence and autonomy (Independence 2004). They want to be involved in decision making in their daily activities and want to be valued in what they decide. Elderly people receiving care now were once caregivers and are often worried to be the burden to the society. However aging is not just marked by physical and cognitive disabilities and poor social capital but instead, as in earlier stages of life, it is a phase of life, which involves development, activity, and growth (Laslett 1991). In this phase, they can be involved in practicing hobbies, participating in intergenerational communication such as interacting with adult children and grandchildren as well as with old friends and create new contacts and reflect on one's life. Changing our perception of elderly people as dependent and frail is important for various aspects of life of elderly people.

While there are plenty of problems, there are also opportunities, and technologies are booming in order to help elderly people maintain independent living in their homes. The

technologies for elderly people often known as "gerontechnologies" (Bouma *et al* 2007), "pervasive technologies for elderly people", "smart home technologies" (Harper 2003), "assistive technologies for elderly people", "ubiquitous care technologies"(Haux *et al.* 2008) or "ambient technologies" (Rogers and Fisk 2010) are concerned to improve health and well-being of elderly people. For instances, there are technological solutions that help elderly people to remind of their medications, remote monitoring system, wearable devices to call for safety and measure their physiological parameters, reminiscing tools, communication devices. Furthermore, communication technologies to address social issues and help elderly people integrate in wider community. Moreover, there are researches that confirm technology aid elderly people in attaining self-esteem and independence (Lustbader 1997).

It is important to figure out the needs of the target group in the first place as adoption of technology is based on the needs of technology perceived by the user (Demiris and Hansel 2008). Moreover, literature reviews on gerontology suggest understanding the values and attitudes of elderly people towards technology. However, while designing technology for elderly people, less effort has been commenced understanding the types of needs and underlying challenges faced by them (Thielke et al. 2011).

As a personal assistant to an elderly lady, I am aware of the needs and challenges faced by the elderly people during day to day activities. As I work closely, I am well aware of the difficulties faced by the elderly people to various ageing related functional disabilities. The social setting and the isolation and frustration visible in elderly people are one of the major issues which affect the well-being of the elderly people. The main motives behind this thesis work are to explore the needs of the elderly people considering both functional limitations as well as the social dynamics of the elderly people and contribute to existing research works for the design of interactive social TV. The design solution should address both functional limitations and social needs of the elderly people thus increasing self-esteem and enhancing the quality of life of the elderly people.

Despite the experience of working as a personal assistant, my observation and perception of elderly people will not affect the research work. The needs of the elderly people will be realized by utilizing a design methodology where various methods are involved for user data collection.

1.2 Purpose and Objectives/Goal

The main purpose of this thesis is to understand the underlying needs of the elderly people and design an appropriate technological solution to address them.

The research questions of the thesis are as follows:

1. What help do elderly people need in their daily activities?

2. How do they get help and support from caregivers, neighbors, family members or strangers?

3. What existing technologies do they use to satisfy their needs?

4. What kind of interactive social technology service concept could be designed to help elderly people with their social issues?

1.3 Research Methodology

Literature review for this thesis is collected from the research papers such as journals, conference papers and other papers from the fields of Human Computer Interaction (HCI) and human factors, gerontology and psychology. HCI deals with the studies of how people use any computational system or device and how those systems can be more useful or usable (McCarthy & Wright 2004).

User-Centered Design (UCD) is utilized in this thesis work as a design methodology to fulfil the goal of the research. It is a practice which includes the active involvement of users for a clear understanding of user and task requirements, iterative design and evaluation, and a multi-disciplinary approach (Vredenburg et al. 2002). It involves various methods to carry out UCD activities of data gathering, data analysis and interpretation, designing and evaluating the design.

The data gathering phase involved interviewing 9 elderly people, observation and diary filled by a caregiver (Chapter 4). The user data collected from data gathering phase is analysed, interpreted and consolidated using Affinity Diagram and Maslow's Hierarchy of Needs to understand the needs of the target group (Chapter 5). Affinity diagram is the tool to organize ideas and data (Beyer and Holtzblatt 1998) whereas Maslow's Hierarchy of Needs is one of the best known model to depict various needs in hierarchy (Maslow 1945).

Based on the needs of the elderly people from the result and literature review on existing technologies, interactive service concept is designed fulfilling the goals of the research. Then, the concept is evaluated using Heuristic evaluation (Chapter 6). Heuristic evaluation is one of the effective evaluation methods to find out problems in early phase of development at low cost and is easy to perform. It is performed by one or more experts that utilizes a list of rules called heuristics or usability principles to determine the user-friendliness of the system (Nielsen 1994).

1.4 Organization of the Thesis

The thesis is divided into 6 parts. Following brief background introduction of the elderly people and their conditions:

Chapter 2 gives further insight on elderly people on which the thesis is based on. It involves age related factors of elderly people, design implications and reviews on existing technologies relevant to elderly people.

Chapter 3 describes the user-centered design approach. Various ethnographic data collection method, analysis method and design method are described as part of user-centered design process.

Chapter 4 continues with the detailed user-centered design methodology conducted during the thesis. It includes interviews, observation and diary method as data collection method. Similarly, data analysis and interpretation is done employing affinity diagram.

Chapter 5 deals with the presentation of results based on Maslow's Hierarchy of Needs.

Chapter 6 deals with the design of the prototype based on the priority of the needs of the elderly people and the heuristics evaluation of the prototype.

Chapter 7 deals with the overall summary of the thesis work, discusses methodological reflection as well as concludes the thesis with the future work.

2. ELDERLY PEOPLE AND AGE-RELATED FUNCTIONAL LIMITATIONS

This chapter describes the elderly people and ageing on which the thesis is directed. Similarly, age-related functional limitations associated with ageing and the design considerations for elderly people are stated. A brief explanation of Maslow's Hierarchy of Needs is presented as it is utilized as a framework to understand the needs and classify the existing technologies fulfilling the needs of the elderly people.

2.1 Elderly people and ageing

Elderly people are referred to as old people, seniors or senior citizens. There is no standard definition for elderly people, however the UN refer 60+ years as an older or elderly population (WHO Defining Old 2014). The definition does not adapt well in all countries as the socioeconomic condition varies between developed and underdeveloped countries. The standardization of age-group becomes difficult where birth records are not properly maintained in some underdeveloped countries (WHO Defining Old 2014).

Traditionally aging is a natural phenomenon of becoming aged where an individual undergoes decline in health, the loss of roles and responsibilities, reduction in income and a decline in social circle. Contrary to this traditional definition of aging, the Activity theory suggests that elderly people can pursue active life by engaging in meaningful activities (Havighurst 1963).

The WHO used the term "Active Ageing" to denote the concept of ageing in terms of social participation by allowing elderly people to engage in meaningful activities thus improving elderly people's quality of life (WHO 2010). However, the ageing is considered successful, if the goals and motives of elderly people are reshaped in order to cope with the inevitable difficulties which come along with ageing. The model of "Selective Optimization with Compensation" explains that "people increasingly tend to focus their limited energy on activities and domains that they perceive as being the most essential and valuable in their lives." (Baltes and Baltes 1990). Hence, the tendency to utilize limited time to engage in emotionally meaningful relationships and meaningful activities, while maintaining the sense of being valued and needed is evident among elderly people.

2.2 Maslow's Hierarchy of Needs

Design Council states "the central premise of user-centered design is that the best-designed products and services result from understanding the needs of the people who

will use them." (Design Council 2006). There are various theories to identify needs though the definition of needs lack the common ground or agreement. Among these theories, Maslow's hierarchy of needs proposed by Abraham Maslow (1945) is considered one of the best known models of human needs.

Several prior researches have utilized Maslow's Hierarchy as the conceptual framework. Demiris and Hensel (2008) categorized technologies based on safety, physiological monitoring, security, social interaction while reviewing smart home applications. Similarly, Thielke *et al.* (2011) illustrated technological adoption based on elderly people's behavior employing Maslow's model.

Maslow's hierarchy of needs can be basis to understand elderly people needs. Maslow (1945) defines deficiency needs (D-needs) which are physical needs, the needs for safety and security, the needs for love and belonging and the needs for self-esteem. On the top of hierarchy, there is self-actualization or growth needs (G-needs). People progressively pursue to fulfill higher level needs, starting from the lowest human needs, that is, physical needs. According to Maslow, the lower level needs must be satisfied in order to achieve higher lever needs. Figure 2 illustrates the hierarchy of needs as proposed by Maslow.

The physiological needs such as food, shelter and clothing are obvious and fundamental needs to all human beings for survival. However, the physical frailty and disabilities of elderly people might restrict to attain these needs on their own but assistance from people near to them can assist them to fulfill these needs. After physiological needs are fulfilled, elderly people seek for safety as they are more vulnerable due to physical and functional changes. People seek protection from physical or emotional safety when they recognize that their safety has been threatened. The safety and security of elderly people can be ensured by monitoring remotely or through the use of assistive technologies. However, elderly people can feel their loss of independence while they are monitored or intervened for the sake of safety and security (Stip and Rialle 2005).

Everyone wants to be connected with other people and build new relationships and feel accepted. Similarly, for elderly people, connectivity to friends, families and community fulfill the needs for love and belonging and assure self-fulfillment and quality of life. Many elderly people value intergenerational communication and are involved in meaningful connections which are achieved through different channel and technological assistance across physical and social distance.

Self-esteem is one of the important aspects of elderly people as they correlate it with the sense of respect from others and independence. Desire to be independent in human being is developed at early age and lasts a life time. Actively participating in learning new things and being able to do or complete the task or activities can make them feel valued and respected. It in turn, assists elderly people to be mentally and emotionally strong in spite of physical and cognitive decline.

Once, the above mentioned deficiency needs are fulfilled, human being shift their focus to self-actualization need. Elderly people are aware of who they are and their abilities. Letting them regenerate and share their knowledge accumulated throughout their lives help them attain the self-actualization or the sense of self. Participating in meaningful activities (for instance, hobbies) provide elderly people with the sense of self. According to Maslow, the need for self-actualization is satisfied when all the mentioned prior needs have been satisfied.

Though vastly used in commercial and academic researches, Maslow's model has been criticized for not being empirically evident (Thielke *et al.* 2011). Many theories including Maslow's theory have claimed that self-actualization, love and belongings and self-esteem emerge as universal and important needs in every phase of life. However, the relative importance of these needs depends upon the preference, culture and context and hence the ordering of needs is not always strictly hierarchical (Sheldon *et al.* 2001) as Maslow suggested.
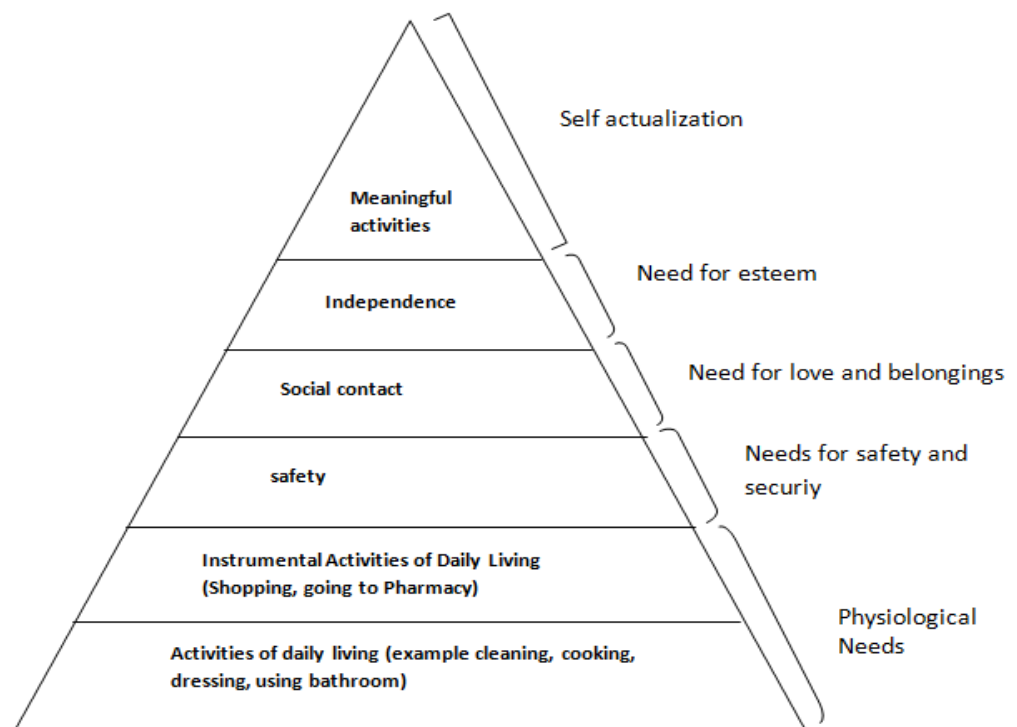

Figure 2. Maslow's Hierarchy of needs

Maslow's Hierarchy of needs is utilized in this thesis to present existing technologies for elderly people based on each level of needs (see chapter 2.5). Furthermore, it is used as criteria to analyze the data collected from ethnographic studies and identify and categorize the needs of the participants involved in this thesis project.

2.3 Age-related Functional Limitations

As people grow older, there are changes in abilities which include decline in cognitive, motor, sensory functions, each of which will decline at different rates for each individual. Hence besides chronological aging, diversity is visible in this age-group which defines 'elderly' and diversity imposes more challenges towards design (Heller *et al.* 2001). In order to design technologies to attend the needs of elderly people, changes in their functional capabilities is to be scrutinized carefully (Czaja & Lee 2001). Besides these, other aspects such as socio-cultural factor should also be contemplated while delivering technological solution for elderly people.

Table 1 (Silva *et al.* 2014) list various human factors and changes in abilities as people grow older.

Table 1. Functional limitations related to aging (Silva et al. 2014)

Factors	Difficulties
Vision	- reduced visual acuity - decreased brightness perception - decreased focus on near objects - reduced light Sensitivity - reduced contrast Sensitivity - different color
Hearing	- Decline in Hearing high frequency sound starts around middle age(Sensory 2014)
Motor skills	- Decrease in speed of movement - inability to perform fine movements - decline in strength and endurance - tremor - muscle pain
Cognitive	- Decline in memory - slow in learning new information - reduced capacity to process complex information
Social	- Decline in Social Capital(Help The Aged 2007) - Changes in Social role - Retirement from work - Isolated and lonely - loss of loved ones - self acceptance

2.4 Design Considerations for Elderly People

Elderly people are reluctant in adopting technology because of the lack of experience or not being familiar with controlling them, the fear of unknown (Hawthorn 2007) or lack

of confidence (Marquie *et al.* 2002). Moreover, the anxieties often incurred by the cost of technology and security and privacy issues are other possible reasons for technophobia. However, the skeptical attitude towards adopting technologies by elderly is not only due to lack of experience or skills but failing to perceive possible advantages from the use of technologies (Melenhorst & Rogers 2001). The awareness of high benefits is therefore an essential factor to motivate the usage of a new technology. On the other hand, while considering elderly people's need for designing technology, the expressed needs might not be the real ones due to their denial of getting older and hence possibly reject technology meant for them. With the technologies advancing exponentially, many people as well as elderly people are unaware of them. Hence, elderly people might be unwilling to keep up with technological changes which lead to the gap in accessing information and technological innovation. This is often referred to as age-related digital divide gap.

The inevitable disabilities in motor, cognitive and sensory performance affect using technologies. For example, icons are difficult to interpret, texts are hard to read and information can be hard to locate in complex screens for elderly people due to reduced visual acuity. Synthetic sound from devices might be hard to hear for elderly people (Ijsselsteijn *et al.* 2007) and hence it is preferred to provide information through various modalities such as voice, tactile, text messaging, etc. Similarly, elderly people find it difficult to be steady with the input devices, for instance, using mouse is hard for them as continuous movement becomes difficult due to decline in motor abilities. Moreover, remembering complex information from screen is difficult due to limit of attention and working memory (Czaja & Lee 2007). There is even decline in their ability to learn the new concept and skills. Hence, these changes in abilities should be carefully considered while designing technological solutions for elderly.

Simplicity is the major factor while designing technology for elderly people; however, overly simplistic design may lead to have limited functionalities subsequently leading to poor usability. According to Donald Norman, simplicity proposes the challenge in developing tools which offers more services with more usability (Norman 2011). Issues regarding technology usage are related to usability problems and the usability problems could be solved by improving the design and providing training to the users. This is in fact bolstered by user studies conducted among elderly people by Fisk et al. (2004). The design should not only consider the physical or cognitive aspects but should also be based on the relationship between users and the technology which is influenced by context such as socio-cultural , environmental and physiological aspects of the users (Selwyn 2004). Incorporating the context of users makes technologies familiar, that is, the design should be relevant to their day-to-day life. Technology should be adaptive such that it fulfills individual requirements of the target group which is heterogeneous in nature (Fuchsberger 2008). Similarly, the aesthetics of the technological devices affect the adoption as the preference of the look and feel of the design is different for all ages.

The elderly people now, who are often considered baby boomers, are different from the cohort of elderly people in the past. Though elderly people are late adopters of technology, the trend is gradually shifting as they are pursing towards adopting new technologies, thus narrowing the gap between their capabilities and context as well as the age-related digital divide.

2.5 Review of Existing Technologies for Elderly People

For each Maslow's level of needs, there are implications of technologies for elderly people. Many researches are particularly focused on the design of assistive technologies and monitoring systems based on elderly people's physiological and safety needs. However, recently research studies have shifted their focus on designing to enhance social interaction in intergenerational context, peer-to-peer communication context enabling elderly people to maintain old relations as well as create new social contacts. This chapter briefly describes existing technologies for elderly based on Maslow's hierarchy of needs.

2.5.1 Technologies for Physiological and Safety Needs

Elderly people are able to satisfy physiological needs such as activities of daily living and instrumental activities of daily living either through the assistance of careers or through the use of assistive technologies (AT). AT consist of devices that help individual with disabilities to live independently by helping them to perform a task or preventing from injuries (IDEA 1990). They can be categorized into Computer-based and Non-computer-based assistive technologies. Computer-based-assistive technologies include voice recognition software, monitoring and alerting system. Some of the examples of non-computer-based assistive technologies are mobility aids such as wheelchairs, walker, stick, can opener, grabber, etc. Figure 3 depicts some of the example of assistive technologies

The categorization can be based on how technology interacts with the users. If the technologies directly interact with the user then they are active technologies. For example, wheelchair and large-button cell phones are examples of active technologies whereas smart homes that use motion sensors are passive technologies. The use of AT depends upon the severity of disability and age (McCafferty 1994).

Several studies mention the benefits of AT in terms of ease of performing activities of daily living and safety in different context like home, work, transportation, social activities and health care; hence enabling them to stay longer independently in their community (Heywood 2001;Bamford 2001).

After physiological needs are satisfied, people look forward to fulfill safety and security needs. One way of achieving safety by elderly people is either through remote monitoring by tele-communications (Fisk 2004) or home-networking such as smart-floors that detects

if the elderly people have fallen or needs assistance (Johnson *et el*. 2007). AT provide peace of mind to the caregivers of elderly people such as family members or careers by ensuring that the elderly people are safe. One of the recent examples of monitoring technologies is Lively System which utilizes sensors to keep track of elderly people without sharing too much. Similarly, the medical alert system can ensure safety by reminding to take medication in time.

Despite benefits of AT, there are issues regarding adoption by its potential users as elderly peoples' psychological and social-emotional needs conflict with use of AT (Bright *et al.* 2013).

Figure 3. *Picture depicting some of the assistive technologies for physiological and safety needs*

2.5.2 Technologies for the Needs of Love and Belongings

This chapter explores the technologies that fulfill higher level of needs of the elderly people such as the needs for love and belongings, needs for self-esteem and actualization needs.

As discussed previously, human beings fulfill the needs for love and belongings through connectivity with friends and families. Elderly people desire to engage in meaningful relationships especially between family members and this is attained by communication. Modern communication technologies have allowed relating elderly people with others over time and space through various home located ubiquitous technologies, social robots or social networking platform or intergenerational communication technologies. This chapter lists some of the existing technologies which supports the Needs of Love and Belongings.

Home located ubiquitous technology

There are technologies to provide virtual presence or family awareness through familiar home located displays. Some of the examples which support and catalyze social

connection through distributed ubiquitous computing are Intentional Presence Lamp which utilizes decorative objects (lamp or wooden picture frame) for awareness representations. This prototype indicated users' presence to their friends and families by making the decorative objects glow depending upon more activities from users (Hindus 2001). The studies revealed that the IPL was well-received and showed how familiar home artifacts or objects can be compelling to convey unfamiliar concepts. Moreover, the social communication was not imposed on users as there was no need of obligation to be in touch.

Similarly, the Georgia Tech picture frame supports family awareness by employing sensors to cluster the current activity of the users with iconic imagery displayed in the digital picture framework and sharing between extended family members across long distances. The pilot study of the evaluation of the design suggested that the intergenerational communication between grandparents and grandchildren were strengthened by sharing their daily aspects of life and interpreting the meaning behind the picture. The result indicated that the picture frame complimented the phone calls as phone calls seem too rushed whereas picture frames can be viewed multiple times a day. (Mynatt and Rowan 2000).

Tlatoque, a digital picture frame, is a ubiquitous system that displays family photographs and status updates uploaded to Facebook by elderly people's family members and allows elderly people to express their feelings through feedback services. It supports offline interactions with their family members. The user evaluation of Tlatoque resulted that it provided the alternative way of communication for elderly people with their relatives, enriched social experience and offline interactions such as telephone conversations triggered by the content displayed in the picture frame. Furthermore, the result highlighted that it prevented isolation and provided conversational context for elderly people (Cornejo *et al.* 2013).

Lilsys (Begole *et al.* 2004) promotes asynchronous communication as it employs sensors to gather information and based on the cues, it tries to figure out if the user is available to receive telephone calls or messages and delivers that information to other users of the system. It uses traffic light signal to indicate unavailability to the prospective caller. Lilsys tries to simulate face-to-face situations where the initiation of contact involves both the caller and the receiver.

Piper et al. (2014) introduces audio-enhanced paper photos enabled by digital pen technology that supports emotional well-being in the context of communication therapy and promotes the social interaction of the elderly people with aphasia and those with memory loss issues. Audio-enhanced paper photos are physically printed photos where audio messages are linked to the particular regions of a printed photo and can be played back by using digital pen. Pen-based authoring software enables therapists and family members to create audio-enhanced paper photos to encourage elderly people for social

interaction and evoke positive emotion. The paper reports the use of paper-digital photo album by an elderly aged 105, her family and nursing staff over a five-month field study. The photo album was interactive, accessible, easy to use and engage Ethel. Moreover, the photo album provides context for communication and triggers meaningful emotion and improved Ethel's social interaction.

Intergenerational communication technology

Taking intergeneration communication into account, there are technologies to connect elderly people with their grandchildren. For example, the "Family story play" system (Raffle et al. 2010) allows social interaction for grandparents and young grandchildren. It allows grandparents to read books together with their grandchildren over the internet. The Family story play prototype encourages dialogic reading activities linked with literacy development for children taking long distance family relationships into context. It supports traditional reading patterns such as turning physical page and fitting into bedtime reading schedule. The system is simplistic in nature and is designed to meet the needs of both young and elderly people. Users are automatically logged in, the story play video conferencing application coordinates the page number by displaying an icon of the remote reader's page current page. The system included special features to train elderly people how to engage children with dialogic reading. Thus this improves the quality of interaction between grandchildren and grandparents and the shared context which is possible by page coordination of book at distance and supports shared experience.

Similarly, Virtual Box System (Davis et al. 2007) is a hide and seek game which mediates intimacy between grandparents and grandchildren through virtual and physical play. Parents or grandparents add content to a virtual box and hide it in a virtual floor plan. Then the grandchildren search the hidden box using PDA in physical location. The application on the PDA displays an indicator of proximity and looping sound plays to provide a constant feedback of the relative distance to the hidden box. Hence the search of virtual box becomes engaging. When creating and hiding virtual boxes for the children, the parents or grandparents expressed a strong feeling of presence even in absence and felt closer with the children while engaging in the act of creating and hiding virtual boxes. The setting up of the virtual box was a creative process as they stated that they thought of the person for whom they are creating the box and hence chose the meaningful and positive content such as meaningful pictures and messages.

Socially assistive robots

Similarly, elderly people's need for attachment and belongings can be met by socially assistive robots. Zoomorphic robot resembling animals are focused on providing pet-like companionship for the elderly people. For instance, seal robot Paro modeled on a baby harp seal is used to improve the lives of elderly. The research conducted by Wada and Shibata (2007) in the public area of care house of elderly residents explores the

psychological and social effects of Paro. It encouraged elderly residents to communicate with each other. In addition, the introduction of Paro in care center made elderly people happier and less lonely (Calo *et al.* 2012). Moreover, Paro is seen to comfort dementia patient and promotes social behavior and calm the distressed patients (Wada *et el.* 2007, ParoUK 2014). Figure 4 depicts the elderly people enjoying the companionship of Paro.

Figure 4. *Elderly people at nursing home being happy with Paro[1]*

Another example is robot dog AIBO that uses body language such as wagging its tale and generates simple musical melodies to communicate with people. As a real dog, it requests to tickle under its chin and stroke its back. A study suggested that AIBO was reassuring and companionable as a real dog for the elderly people residing in nursing home and alleviated loneliness and caused attachment (Banks *et al.* 2008).

Another novel way of involving elderly people in social activities is Maltilda (Khosla *et el.* 2012). It is an assistive multimodal social robot; embodied with various multimodal attributes such as voice vocalization and recognition, gestures, music, dance, emotions, motion and movement, face tracking and registrations, touch sensor for modeling group based and one-to-one interaction in nursing homes. Elderly people wanted Maltida to be involved in the group activities such as playing card games where Maltida can visually display the cards called by elderly people. Elderly people with various disabilities were able to participate in social activities. Moreover, Maltida's gestures and music accompanied by dance movements were accepted by elderly people and improved social interaction among them.

Social Networking Platform

Strong social networks enhance the quality of life of elderly people (Giles et al. 2005). There are efforts to connect elderly people with others through ambient social networking

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[1] http://app.emaze.com/@AOOOZFTZ/paro-presentation-project#7

sites. AAL project FoSIBLE (Fostering Social Interactions for a Better Life of the Elderly) has taken initial steps for developing TV based services to foster social interactions among old people (Alaoui *et al*. 2012). FoSIBLE uses smart TV platform using the Hybrid Broadcast Broadband Televison which merges TV features with web services. Users can select different functionalities in their TV set such as WatchTV, Play, Stay in Touch and Participate in clubs (Figure 5). Users can see their buddy list and interact as well as recommend programs and look at the recommended programs when they chose WatchTV functionality. Thus FoSIBLE focuses in increasing the self-esteem of elderly people by encouraging them to participate in active life style and prevent loneliness.

*Figure 5. AAL FoSIBLE Mockup (*Alaoui *et al*. 2012*)*

Go-myLife (Go-myLife 2014) project helps in social connectedness by creating a social networking platform to strengthen the network of the elderly. It is a gateway through which elderly people can interact with traditional online social networks as facebook[2] or twitter[3] easily hence enabling them to interact with their families and friends.

From the Go-myLife platform, a user who does not have an account in other social networks can view the status, comments and contents shared by their friends posted in other social networks as well as comment or interact with the content. Moreover, the platform provides enhanced contextual awareness of whom and what are around the user and thus prompts users for spontaneous meetings with friends and families. The user evaluation of Go-myLife conducted among 36 people suggested that the elderly people felt safer to post news and organize different events and enhance and deepen the relationships with local community.

Social TV facilitates communication with context. Senior Cloud is a research project in which a social TV system "Simple Teleda" was developed to stimulate communication and build a community among the elderly people of Japan using TV program based SNS

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[2] https://www.facebook.com/?_rdr=p
[3] https://twitter.com/

(Miyazaki *et al.* 2013). Figure 6 shows the concept of "Simple Teleda" and the picture depicts smart TV screen and application running on the tablet. This system provides various functionalities of communication and viewing of TV programs, user's TV viewing history and preferences through a simple interface. The display of other persons' profile page and location of their residences on a map bolster the sense of security of to communicate with strangers in SNS. A field trial conducted in 2010 within the same project revealed that communication involving TV programs is popular among the elderly people.

Figure 6. *Smart TV system for elderly (Miyazaki et al. 2013)*

Similarly, Svensson and Sokoler (2008) mentioned that TV watching experience could be turned into potential ticket-to-talk – a resource that may open up discussions during social encounters within the community. As a result, they came with the concept of PresenceRemote (PR). The simple preliminary sketch of PR with the functionalities of the system is depicted in Figure 7. It is an enhanced TV remote control that allows users to notice others and be noticed by others within the neighborhood while watching TV (Svensson and Sokoler 2008). Design-oriented workshops where the concept of PresenceRemote, in the form of sketch, was put forward among the group of elderly people revealed that they acknowledged that PR could mediate the sense of belongings and connectedness with friends and neighbors in local community.
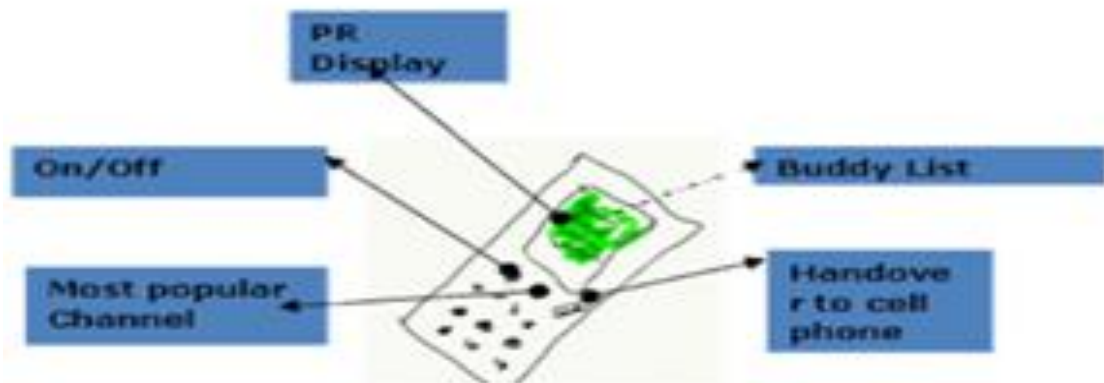
Figure 7. Sketch of PresenceRemote (*Svensson and Sokoler 2008)*

CommuCity (He *et al*. 2014) is a system that helps nonresident elderly of China, who are lonely in new city, to discover the potential connections. CommuCity collects the information of non-resident elderly citizens and based upon the matching results with those information, social connection is made. Those who have the highest degree of correlation are most likely to be friends and are encouraged to meet together in natural setting. The end user of community is not elderly people themselves but the various other sectors such as healthcare centers, or community service centers. CommuCity was proposed as potential solution to address the loneliness of the new residents in the old city; however its actual effect is not studied.

Technology promoting face-to-face social interaction

Some research have attempted to face-to-face social interaction between elderly people and their peers where they share their life experiences with each other. Several research prototypes which employ interactive tabletop exist.

SharePic (Trent *et al*. 2006) is a multi-user, multi-touch, gestural, collaborative digital photograph sharing application for elderly employing tabletop enhancing photo talk and sharing of experience through photographs. It allows users to move, rotate, resize and copy photographs and control objects, as well as generates new photographs from copies of whole photos, parts of photos or a layout of multiple photos. One of the scenarios involves the creation of the postcard by sorting several photographs.

Similarly, DanceAlong (Keyani et al. 2005) supporting peer interaction is an augmented dancing environment that provides elderly people opportunities for entertainment and exercise. The evaluation of DanceAlong in a holiday celebration in a local community center suggested that it was energizing, entertaining and promoted social exchange and were comfortable dancing together as a group.

2.5.3 Technologies for the Needs of Self-esteem and Self-actualization

Not only the technologies described above fulfill the needs of belongings but also they could provide elderly people with the sense of self-esteem- feeling that they can achieve or handle tasks on their own. Moreover, designs that allow the elderly people to maintain a role within the family and to return the help they receive as well as regular communication with family members can make them feel valued and respected (Lindley et al. 2008).

A research study examining elderly people and technology concluded that elderly people who are engaged with technology have higher self-esteem. However, this is refuted by some studies. Adoptions of smart home technologies make some elderly people realize their disabilities and threaten their self-esteem (Courtney *et al*. 2008).

The effect of technology on esteem is not salient in the technology itself but depends upon the intent of the users. The technology to boost the self-esteem should fulfill the personal goal of the users (Thielke 2011). For instance, the simple reward messages such as "Well done" or "Successful completion of this level" displayed by system interface can boost the esteem of the elderly people.

Finally, the highest level of human needs, self-actualization, occurs when people are motivated to gain new experiences by learning new ideas and skills. New technologies especially computers allow people to gather, document and share information and experiences as well as help them to learn and explore the world thus, contributing progressively to their personal growth (Phang *et al*. 2006). Elderly people can involve in creative personal projects such as documenting and reflecting on one's life, making gifts, organizing events and playing games to actualize the self. Kanainen and Lehtinen (2011) suggested the use of interactive media technology for elderly people to actively engage in creative personal projects.

However, self-actualization is highly subjective as it is a personal concept. Hence there are difficulties realizing the sense of self through technologies.

2.6 Summary

The goal of the thesis is to understand the underlying needs of the elderly people and develop solution to address those needs. Hence, understanding the elderly people and their age-related aspects, that influence the development and utilization of the design, is necessary.

Ageing is marked by decline in physical, motor or cognitive abilities. Similarly, there are changes in roles and responsibilities and decline in social capital. All these aspects should

be considered while designing technological solution for the elderly people. Understanding user needs is necessary for a good technological solution.

Maslow's hierarchy of needs can be the basis to understand elderly people needs. According to Maslow, people try to pursue the needs starting from physical needs and progressively move towards fulfilling the needs for safety and security, the needs for love and belonging and the needs for self-esteem and finally self-actualization. For each level of Maslow's need, there are implications of technologies targeted for elderly people.

Physiological needs are fulfilled via assistance of caregiver or through various assistive technologies. Then they strive for the protection from physical and emotional danger. This is known as the needs of safety and security. There are remote monitoring system, smart home technologies, several reminiscing tools and many assistive technologies for safety and well-being of the elderly people. Communication fulfills the sense of love and belongings. There are several communication technologies supporting intergenerational communication, face-to-face or virtual presence. Ambient social networking technologies help to strengthen the existing social ties as well as increase the size of the social circle. Familiar home located displays such as digital frame or ambient lamp supports virtual presence. Similarly social TV, interactive display or social robots boost the connectivity of the elderly people with those who are meaningful in their life.

Elderly people like to be independent and are decision makers of their life. They want to be respected and valued for their decisions. This is known as the needs of self-esteem. The technologies that fulfill the purpose of the elderly people and those which help to maintain the role within society enhance their self-esteem. Most of the assistive technologies or communication technologies allow elderly people to attain the sense of independence. However, those technologies which exploits their privacy or those which are difficult to use could undermine their self-esteem. Self-actualization is the highest level of human needs and is achieved after other needs have been fulfilled. Technologies which allow elderly people to share their experiences as well as to participate in meaningful social activities could allow them to be true to themselves.

The literature review on existing technologies reveals the relevance of age-related technologies with each level of Maslow's Hierarchy of Needs. Moreover, understanding Maslow's levels of needs is essential as the level of needs are important factors in assessing behaviour of elderly people that influence the adoption of technology we design. The final work is to design a prototype addressing elderly people's need discovered from user studies described in subsequent chapters. However, the literature review has guided to consider the age-related aspects of elderly people in design.

3. USER-CENTERED DESIGN

This chapter describes User-Centered Design (UCD) process and methods involved to realize UCD in the working context. UCD process is utilized in this thesis work in order to focus early on the needs of the elderly people and involving them by utilizing various UCD methods such as data gathering, data analysis, design and evaluation methods. UCD helps to identify how the elderly people can be helped in the best way and how to design the system, realizing their needs, which is easy and simple to use. The methods which are utilized in this thesis are explained briefly in this chapter.

3.1 Defining User-Centered Design

"Development proceeds with the user as the center of focus." (Rubin J. 1984). While many of the industrial designs in the past were criticized for being ineffective and unethical as the real human needs are often not scrutinized, UCD is increasingly integrated into industrial culture as it addresses user needs at the early phase of the product development. UCD is commonly applicable in product development, more specifically in software development. UCD is a multidisciplinary design approach which involves users into design and incorporates the spectrum of approaches such as human centered design processes, participatory design, ergonomics, usability, ergonomics and user experience (Keinonen 2010). There are various ways to involve users in UCD. For instances, some UCD methods gather user needs at some specific phases such as requirement gathering phase and usability testing whereas others involve users throughout the development process.

Various ISO documents such as ISO 9241-210 and ISO TR 18529 provide definition and the best practices of UCD processes. ISO 9241-210 is a standard that provides the high level overview of the human centered design principles which emphasizes iteration and human-centered methods in the whole design process. It replaced ISO 13470: 1999 in 2010 and is mostly targeted to be used for people who manage design processes thus providing a framework for human factors and usability professionals involved in human-centered design. According to ISO 9241-210, for the design to be user-centered, there should be explicit understanding users' context of use and should involve users throughout the design and development. Moreover, ISO 9241-210 mentions the whole user experience or usability as one of its design principles (ISO 9241-210 2008). Figure 5 describes the iterative UCD process. The first step is to understand the context of use. Context of use refers to ''the users, goals, tasks, equipment (hardware, software and materials), and the physical and social environment, for the purpose of achieving particular goals'' (ISO 9241-11 1998, p. 2). Then the user requirements are specified inferred from the context of use and specific guidelines. Then the product or system is

designed to meet user requirements. The design solution varies from simple sketches to high look and feel prototype- a concrete design which demonstrates the functionalities and of the desired system. Then the design solution is evaluated either by user or expert group or both. Then the concept is refined and optimized by iterating some or all the steps mentioned above.
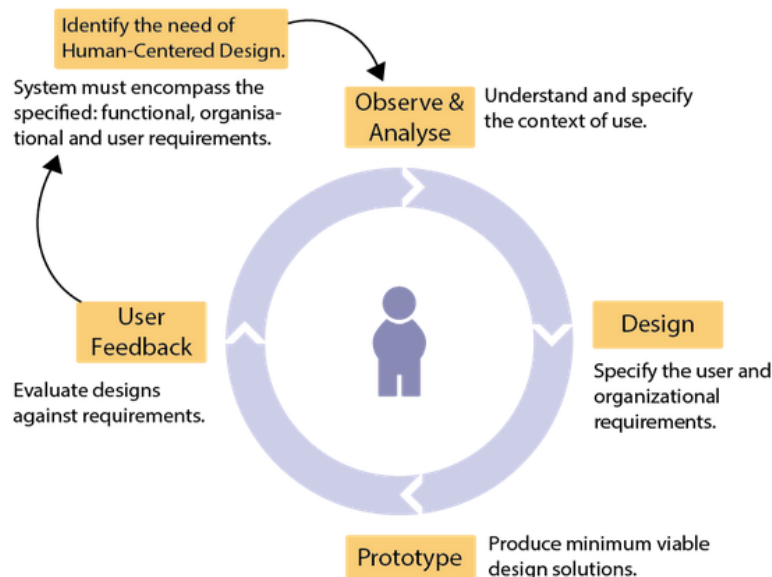
Figure 8. Adapted from: ISO 9241-210:2010 Ergonomics of human-system interaction -- Part 210: Human-centered design for interactive systems.

The greatest advantage of UCD is the active involvement of users in each step of the design process which leads to the development of efficient and usable product. Identification of needs and values of the users and prioritization of these needs, the users are interviewed and/or observed. Other data gathering methods such as diary method or focus groups, questionnaires, surveys are widely utilized to access user needs. The design is evaluated by the users to test the usability. Moreover, users can feel the sense of the ownership for the new product as their needs and suggestions are considered into design which subsequently results in higher customer satisfaction and the smooth integration of the product to the environment (Abras et al. 2004). However, involving users also impose challenges (Kujala 2003). Communication issues between users and development team and/or different goals among the stakeholders involved in the design as well as the cost associated with involving users in every phase are some of the challenges of UCD. Moreover, it could be time consuming to gather the data of users' needs as well as to understand the environment of the users.

The main objective of UCD is to enhance the usability of the designed product. Usability is defined as the ease of use and acceptability of a product for a particular class of users carrying out specific tasks in a specific environment. However, there are different

approaches of defining usability based on different views such as product-oriented view, user- oriented view, user performance view or contextually-oriented view. The concept of usability as defined by ISO 9241 is broader and is usage, user and contextually oriented and is defined as "The extent to which a product can be used by specific users to achieve specific goals with effectiveness, efficiency and satisfaction in a specific context of use." Effectiveness is defined as "The accuracy and completeness with which users achieve specified goals". Efficiency refers to "The resources expended in relation to the accuracy and completeness with which users achieve goals." The term "satisfaction" used in definition of usability is defined as "Freedom from discomfort and positive attitude to the use of the product." Similarly Context of use is defined as "Characteristics of the users, tasks and the organizational and physical environments." (ISO 9241-11 1998).

3.2 Data Gathering Methods

Specifying user needs are not always easy. Identifying user needs and establishing the requirements of the system is the initial step towards designing with great user experience. The purpose of data gathering in User Centered Design is to understand the users and discover facts and opinions of the potential users before designing and hence data gathering technique is essential for establishing requirements and evaluation. Crabtree et al. (2009) suggested that the unnecessary assumptions of the users can be discarded by data gathering techniques as it explores the cultural context for which the design is meant to be. There are different techniques of data gathering and each generates different data and requires different methods for analysis.

Three main data gathering techniques: interviews, observation and diary methods are discussed briefly as these techniques are utilized in this thesis.

3.2.1 Interviews

An interview is conversation between researcher and participants driven by researcher in order to reveal knowledge or information from the participants and are generally scripted. Interviews are widely chosen as the data collection method in HCI research and are conducted in the early phase of the UCD and tend to generate qualitative data.

They are useful for collecting the detailed opinions of the potential users of the system being designed such as their needs, user experience, their attitudes, perceptions and behaviors and the plausible reasons behind them (Lazar et al. 2010).

Interviews can be fully structured, semi-structured or unstructured. In fully structured interviews, questions are in well-defined order and data obtained from them is easy to analyze as each participant is asked the same questions in the same order. On the other hand, the semi-structured interview is more flexible approach than fully structured to gather qualitative data. In semi-structured interview, there is some list of questions or

clear theme to be covered but the interviewer can add further inquiry responding to the direction in which interviewees take the interview (Lazar et al. 2010).

Some interviews are relatively unstructured and are like conversation with a particular focus. Semi-structured interview and unstructured interview explores the topic in breadth and depth that might be unachieved in fully structured interview however, these methods impose more challenges in interpreting the obtained information (Lazar et al. 2010).

Proper planning of the interview coupled with ethical guidelines to be followed leads to effective interviewing and helps to gain the insight of the subjective understanding of the participants (Blandford 2014).

3.2.2 Observation

Observation is one of the methods of gathering qualitative data which involves understanding the users' context, tasks and goals through systematic noting and recording of events, behaviors and objects in complex social settings. Unlike interview, researchers see what the users do through the observation and nuances of users' attitude and behavior towards the design can be elicited which might not be possible only through interviews.

Human minds have difficulty restating clearly what they need when asked even if they know it. Moreover, there is the possibility to answer in an over-simplistic way when the users are interviewed or what they say might differ from what they do. Hence, observation is useful in this kind of situation. A combination of interviews with observation gives the better insight of the participants and the context of the users. Observation involves users being observed by researcher or investigator either in their natural setting or in the controlled environment. Direct observation on natural setting helps in understanding the context of user activity whereas observation in controlled environment helps in capturing the detail of what users do. Since this method is obtrusive in nature, there are chances of users not being true or natural in front of the observer (Preece et al. 2002).

3.2.3 Diary Method

The diary method is one of the data collection methods in HCI to capture user needs as they experience events. Since direct observation is obtrusive in nature, it is always not a great method for data gathering. Hence, diary methods are useful to track down information indirectly and it differs from other methods as participants are remote from researches and participants control the timing of the entries in diary (Preece et al. 2002).

Diary studies require participants to keep track of events and experiences in context at the specific time interval or whenever the event triggers. Diaries can either be pen and paper based or electronic (for instance, photographs, audio or video diaries). The main advantage of a diary study is that it allows collecting temporal and longitudinal

information in the natural setting. However, the cost and time associated with participants' recruitment, ensuring participants' commitment to diary completion and analyzing the data from diary are some challenges of the diary method. A brief training session can be provided to the participants (Preece et al. 2002).

3.2.4 Ethical Considerations in Research with Elderly People

Communication is the major challenge while collecting data from elderly people as elderly people are more vulnerable to different aspects such as functional and social issues. Hence in order to collect data, it is necessary to establish a relationship of trust between the researcher and the elderly participants. For instance, a single visit to schedule the interview is sometimes not sufficient to ensure the credibility. Language should be simple to make them aware about the purpose of the research, consequences, pros and cons of their involvement in the research and get their informed consent for participation. Similarly, while involving the participants in research, they should be provided with comfortable and distress-free situation. Moreover, the dignity of the participants should be acknowledged during interview or observation. (Jokinen *et al*. 2002)

3.2.5 Summary of Data Collection Method

Interview, observation and the diary method complement each other because the conjunction of one research method with another compensates the disadvantages of each other. Use of different data collection methods helps researcher to grasp the better understanding about the whole phenomenon such as user needs, experiences, their attitudes and behavior in context.

Interview helps to collect in-depth information about the users however the answers to the interview questions may be over simplistic or whatever they are saying might not be the same as doing. Hence, the interview information can be backed up through observation as observing users provide nuances of users' attitude and behavior as well as the actual context. Obtrusive nature of interview and observation might restrict the researcher from interviewing certain questions or observe, hence it is not possible to get all the information from users. In this case diary method help in acquiring information indirectly.

3.3 Data Analysis and Interpretation

After the data gathering session has been conducted, it is then followed by data analysis and interpretation session in order to find meaningful insights of the massive data collected from various methods and sources. Data analysis can either be qualitative or quantitative depending upon the data collected. Quantitative data is in the form of numbers or which can be translated into numbers whereas qualitative data involves descriptions, quotes from interviewees and images. Quantitative data analysis uses

numerical methods to find the size, magnitude or amount of something. The analysis of quantitative data is objective in nature and it prevents human biasness in solving proposed research questions by employing the correct statistical procedure. On the other hand, qualitative data analysis helps in structuring the findings into themes and categorizes data.

Since methods such as interview and diary studies generate qualitative data, the user data obtained from the data collection method are qualitative in nature. The results are then interpreted and the conclusion is drawn. The data should support the conclusion. The researcher's biasness should be avoided in order to prevent from wrong interpretation of the result.

Among various techniques of data analysis and interpretation, the affinity diagram is one of the common techniques used in contextual design (Preece et al. 2002). Contextual design is one of the methodologies of User Centered Design. Though contextual design is not utilized in this thesis work, affinity diagram is used to consolidate the data to get design ideas.

3.3.1 Affinity Diagram

Affinity diagramming is a simple yet powerful method for qualitative data analysis, idea-generation and organizing unstructured material into themes. It identifies and analyzes common issues, contradiction in data, user needs and preferences and design ideas.

The process of building the affinity diagram is a bottom up approach that takes the form of arranging similar ideas written in paper notes called affinity notes into a hierarchy of related categories and is generally, performed on a large walled surface. Affinity notes are generated from the transcription of interviews, observation and researchers' note, each note denoting one idea or theme. Then the notes with similar ideas are clustered on the wall. Once the ideas are grouped, heading name for each group is created. Similarly, at some point, these groups can be grouped and second level heading is created. If necessary, the third level heading emerges. During the process, the notes can be reallocated under the appropriate heading (Beyer and Holtzblatt 1998).

One of the important aspects of building affinity diagram is refining the affinity notes, interpreting it and then dividing the long statement into several sentences if any. Similarly, affinity notes that indicate the same meaning should be removed. In addition, those notes which are not self-explanatory but are meaningful could be extended and explained. Similarly the name of the heading should be appropriate. The interesting notes could be highlighted and commented while walking through the affinity diagram. This might help to trigger important design ideas.

The duration of building affinity diagram varies upon the volume of affinity notes. After affinity diagram is built then it is walked across to stimulate the design ideas appropriate

for the target user group (Beyer and Holtzblatt 1998). Affinity diagramming in general is a collaborative process of decision making for design which involves shared awareness (aware of new notes being added on the wall), cognitive offloading (annotating notes to ease cognitive load) and understanding, organizing and searching the affinity notes. Though traditional methods such as using sticky notes and walls are preferred in this method, there are several digital tools for creating affinity diagrams in order to overcome the need for pre-defined wall space (Judge et al. 2008).
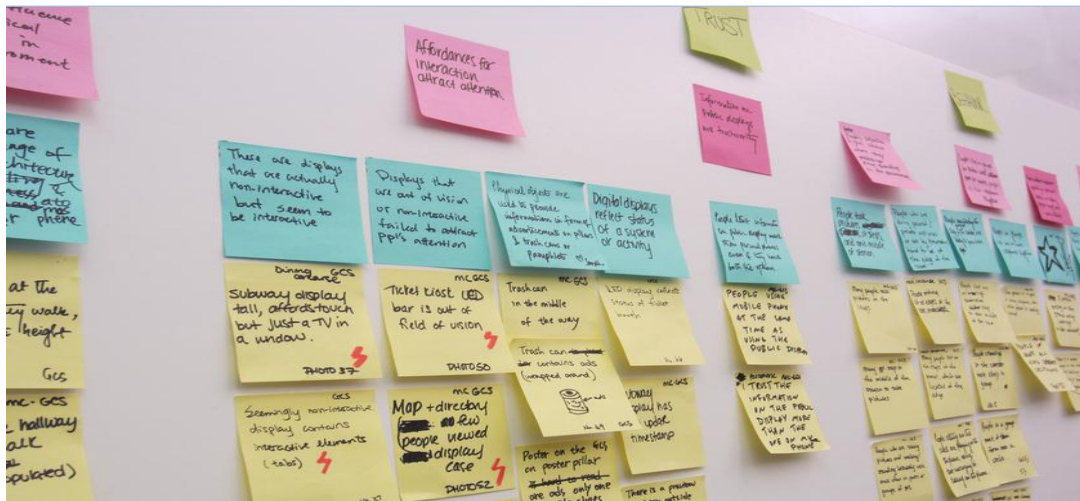
Figure 9. *Example of affinity diagram[4]*

3.4 Personas

After the user studies, the gamut of data about the user has to be communicated to the concerned stake holders.

Personas are realistic representation of user segments. Personas based on ethnographic research help in creating real users that can be used to develop products that deliver positive user experiences (Pruitt & Adlin 2006). They are useful for describing users and user requirements as they allow designers empathize with the virtual characters that subsequently lead to incorporate real users' goals and needs into interaction design. Even a target group is heterogeneous in nature and the users within the target group can have different goals and needs. However, personas allow designers to focus on higher priority goals of a particular user or a specific group of users and thus, help designers in uncovering the features and functionalities of the product. Moreover, a good communication channel can be achieved through personas to convey a huge qualitative and quantitative data to the concerned stakeholders.

Hence, personas lead to effective design to the right user group with great user experience (Putnam 2009).

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[4] http://jipinghe.com/2012/08/13/campuseye-capstone-project-with-panasonic-rd/

There are guidelines to be taken into account while creating personas. The use of non-posed photo (Pruitt and Adlin 2006), a biographical profile consisting of personal name and information (Pruitt and Adlin 2006), technology usage (Mulder and Yaar 2007) and the user goals (Cooper et al. 2007) are several guidelines for persona creation.

Persona can be primary and secondary. "The goal is to find a single persona from the set whose needs and goals can be completely and happily satisfied by a single interface without disenfranchising any of the other personas" (Cooper and Reinmann 2003). This is referred to as primary persona. Secondary persona's goals can be met by primary persona; however, there are additional needs specific to them which are not included primary persona.

Figure 10. Example of Persona[5]

3.5 Designing and Prototyping

The information of the users' needs is utilized to create an initial design and then the desired final product or service. Designing requires choosing a specified direction among many options and narrowing down those options unlike in idea creation phase. Scenarios, storyboards and UED illustrate the rough concept of the new product or service whereas prototype is considered draft of a complete design.

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[5] http://www.thelongdog.co.uk/wp-content/uploads/2009/02/corey-persona.jpg

3.5.1 Scenarios and Storyboards

Scenarios are virtual stories about user tasks and activities and illustrate user goals when the persona interacts with the specific product or service. Scenarios are effective ways to convey persona's detail such as the content and context of the interaction (Quesenbery 2006). As storytelling can convey the complex information to people, scenarios are effective in HCI.

Storyboards portray the envisioned scenario of how users interact with the system in graphical form. It consists of multiple frames with pictures accompanied by narrative description. Depiction of time, level of details, the inclusion of text description and number of picture frames and portrayal of actors and emotions are some of the important aspects of storyboarding process (Truong et al. 2006). Often considered as low fidelity prototype in HCI, it is a common tool for communicating design ideas for new products (Wahid et al. 2009).

3.5.2 User Environment Design

User Environment Design displays each part of the system relevant to the users, relation between the parts and functions available in each part thus representing the structure of the system. A UED is created from the storyboards and it acts as a specification to build a prototype. It ensures the coherence of the system by including important use cases and design goals (Beyer & Holtzblatt 1998).

3.5.3 Prototyping

Prototyping is a way of creating preliminary functional version of the products using special prototyping tools and communicates new design ideas with all the stakeholders involved. It concretizes structure of a User Environment Design into a tangible artifact- a concrete representation of part or all of an interactive system (Beyer and Holtzblatt 1998). Prototyping can be either done by sketching with pen on paper (low-fidelity prototyping) or can be computer-based tools (medium and high fidelity prototyping). Low fidelity approach is the fastest and easiest way of prototyping as this employs just pen and paper; no knowledge on tools is required. It is a cheap way of demonstrating design concepts and get desired feedback from users. Static and low visual screen layouts can be created and the users can be informed about how the system will be like .However the details such as navigation and interaction are not usually visible through paper prototyping. Based on feedback, changes can be made easily. This suggests that Low-fidelity prototypes are used in early phases of the design cycle in conceptualization and visualization phase (Preece et al. 2002).

As the fidelity increases, the prototypes become interactive and demonstrate the behavior of the system. Some of the computer based prototyping tools such as Balsamiq[6], Visio[7], Omnigraffle[8], etc. are intended to focus on making medium-fidelity prototypes. These tools enable the linking of various screens of the system and thus address navigation and flow; the focus is more on whether the user needs are met or not .The speed of medium-fidelity prototyping is achieved with templates, stencils and reusable widgets and elements. It gets faster as you become more proficient with your tools of choice. The high precision prototypes can be obtained via high-fidelity prototyping tools. The prototypes represent the core and complete functionality of the user interface (Preece et al. 2002).

The degree of fidelity should match the purpose of why we are designing the prototype. Research has shown that too high or too low fidelity of prototype can prevent the audience to focus and provide useful feedback to the designers. If the fidelity is too low, then the ideas remain unclear. On the other hand, too high fidelity results to be overdone and completely worked out (Houde & Hill 1997). It is often possible that the fidelity of prototype can be adjusted to fit the need of the users.

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[6] https://balsamiq.com/
[7] https://products.office.com/en-us/visio/flowchart-software
[8] https://www.omnigroup.com/omnigraffle

4. METHODOLOGY

The primary approach of the thesis is to involve user in the design process through UCD process. This chapter explains the user-centered design process applied in this thesis. First the user needs and requirements were gathered through interviewing and observing 9 elderly participants. The diary method was utilized to gather the perspectives of careers towards elderly people because careers are the one who work closely with elderly people. Then the needs were analysed which was followed by the creation of personas, scenarios and storyboards which described the users and how users use the system. Then finally, prototype was created.

4.1 Data Gathering Methods

As data gathering techniques, interview, observation and the diary method was used. These techniques provide answers to wide range of questions related to user needs, values and attitudes towards the current technology and the technology to be developed.

4.1.1 Participants

Altogether nine one-to-one interviews were carried out. The participants were aged between 60 to 81 years of age; all of them were living individually and alone. The first three interviews were carried at the residences of the participants. The rest of the interview was carried out in Validia[9]. Validia provides services and housing facilities for the disabled. Conducting interview in the participants' places provided an opportunity to observe and understand the context in which they live. Table 2 summarizes the background information of the participants.

One of the caretakers was assigned to us by the manager of Validia. With the help of the caretaker, selection of the participants was made on the basis of age and with no major cognitive issues that prevent them from participating in interview. Ethical considerations were taken into account while conducting elderly people. To ensure the credibility, initial one-to-one meeting with the participants were arranged before the actual meeting where the general purpose of the interview was explained and then the date for interview was scheduled.

To gain the perspectives of the caregivers who take care of the elderly people, the diary method was employed. Four caregivers were handed with the diaries but only one filled the diary.

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[9] http://www.validia.fi/

Table 2. *Background Information of the participants*

	Gender	Age	Marital Status	Family Members	Long term Illness	Description
U-1	F	69	Widow	Son, daughter, grandchildren	Multiple Sclerosis	An unpredictable, often disabling disease of the central nervous system that disrupts the flow of information within the brain, and between the brain and body.
U-2	F	64	Single	Sister, Personal assistant, caregivers at Validia	Arthritis	Joint disorder that involves inflammation of one or more joints
U-3	F	60	divorced	Brother, One personal assistant, caregivers at Validia	Heart problem, elevated blood pressure, prosthesis infection in leg	Physical
U-6	F	74	Widow	Daughter, Personal assistants, caregivers at Validia	Spinal Cord Injury(2002)	Motor
U-9	F	81	Divorced	Sons, Daughter, Grandchildren	Pain in joints	Physical
U-4	M	67	Married	Wife, children, caregivers at Validia	Long term Illness	
U-5	M	63	Unmarried	Mother (93 years old) and caregivers at Validia	No long term diseases or other disabilities except for the need for wheelchair and fingers do not work	Permanent movement disorder
U-8	M	66	Widower	Sister and caregivers at Validia	Cerebral palsy	Motor
U-7	M	69	Single	brother and a sister and caregivers at Validia	Epilepsy Seizures	Cognitive

4.1.2 Interviews

Face-to-face semi-structured interview was the main research method as it is useful for gathering in-depth information about the participants' conditions, values, needs and underlying issues as they pursue everyday activities. Moreover, existing technologies they were utilizing to fulfill their needs and their attitudes towards those technologies were also scrutinized in order to figure out what needs are still unmet and what could be possible technological solutions for this target group.

The interview involved questions related to background information, the need of help inside or outside home, connecting with people and loved ones, social activities ,how do they manage without assistance , and technologies they use to assist themselves. The outline of the interview questions is presented in APPENDIX A.

Out of Nine interviews, six were conducted in Finnish and the rest in English. The interviews in Finnish were carried out with the help of a friend as I lack proficiency to communicate in this language. I want to thank Aki Mäkinen for making the interview possible.

Written informed consents which ensure participants' right of autonomy were obtained from the first three initial participants. Informed consent mentioned the description of research purpose, methods, discussion topics as well as permission for audio taping the interviews and privacy matters. However, in Validia, informed consent was read out loud in front of each participant as most of the participants had motor dysfunction. The interview lasted on average of 45 minutes for each participant.

Observation was made during each interview, some notes were also taken. Moreover, digital photographs of the technologies the participants were using and their environment were captured with their permission to get further insights of the context in which they are socially located.

Various functional limitations and vulnerabilities were considered while interviewing this age-group. While conducting interview for this thesis, one participant had problem with parsing complex words, so interview questions were very simple.

4.1.3 Diary Method

Week-long paper and pen based diary method was utilized to gather the perspectives of caregivers regarding elderly people who provided care every day to our target group. The diary was in structured format which consists of questions regarding elderly people and their observation of elderly people in day to day situation. Appendix B depicts a diary page of the diary implemented for this thesis. Four caregivers were handed to fill the diaries; however, only one reported the diary. Written instructions on how to fill the diary

pages were mentioned on the first page of the diary. The caregiver filled the diary on any time of the day for a week from 15.9.2014 to 21.9.2014.

Due to ethical constraints, some questions were not asked directly while interviewing elderly people. Moreover, it might be difficult to state everything out of their mind due to cognitive limitation or they might oversimplify the answers. Hence, the aim of conducting diary method was to understand relational needs and barriers faced by elderly people as observed by caregivers and to get more detailed information about the social circumstances which could not be obtained from interviewing elderly people.

As mentioned earlier, this method is effective based upon how participants report the events and their motivation and effort to complete the diaries. Since the caregivers were not met face to face for explaining the background of the study and prior instruction was not given in filling the diaries due to their busy schedules.

4.2 Data Analysis and Interpretation

After conducting nine interviews and observation during the interviews, the information obtained from them was analyzed using affinity diagram. Since only one caregiver filled the diary and the information gathered from the diary was not massive, the analysis of diary method, which included the observation of the elderly people through the eyes of caregivers, was not mixed with the interviews and observation. The diary was thoroughly analyzed by reading out loud and comparing the information of one page of the diary to another and important relevant information was noted out and was utilized during presenting the result.

The analysis of interviews and observation made during the interviews started with transcribing the audio recordings and translating them into English. As mentioned before, due to lack in proficiency in Finnish, a Finnish native friend helped me to transcribe and translate the interviews in Finnish to English. However, only relevant information which was within the scope of the research was transcribed. The observation notes were also included in the interview transcripts.

The process of building affinity diagram was a bottom up approach. Each interview transcript was interpreted and affinity notes were written. These affinity notes were input to build the affinity diagram. Each interview generated 25-30 affinity notes. All the affinity notes were printed in A4 paper. Then the paper was cut out into small pieces, each representing affinity note. The notes were labeled according to participants so that it can be distinguished from different participants. Each affinity notes were read out loud and each were interpreted and reasoned to grasp participants' idea behind each note. Then the notes were grouped under common themes or headings. The headings emerged were

related to daily activities elderly people perform inside and outside of their residences, problems associated in performing these activities (social as well as physical), communication with friends, family members, neighbors and strangers, technology usage to overcome or assist to cope with social and functional limitations and technology they wish to utilize. The headings were written in colored post-it notes where different color represented different levels in hierarchy. Figure 6 represents the part of affinity diagram built during the thesis work.

Building affinity diagram consumed lots of time and space. It took approximately 30 hours to build the diagram. It was built in a study room of Tampere University of Technology.
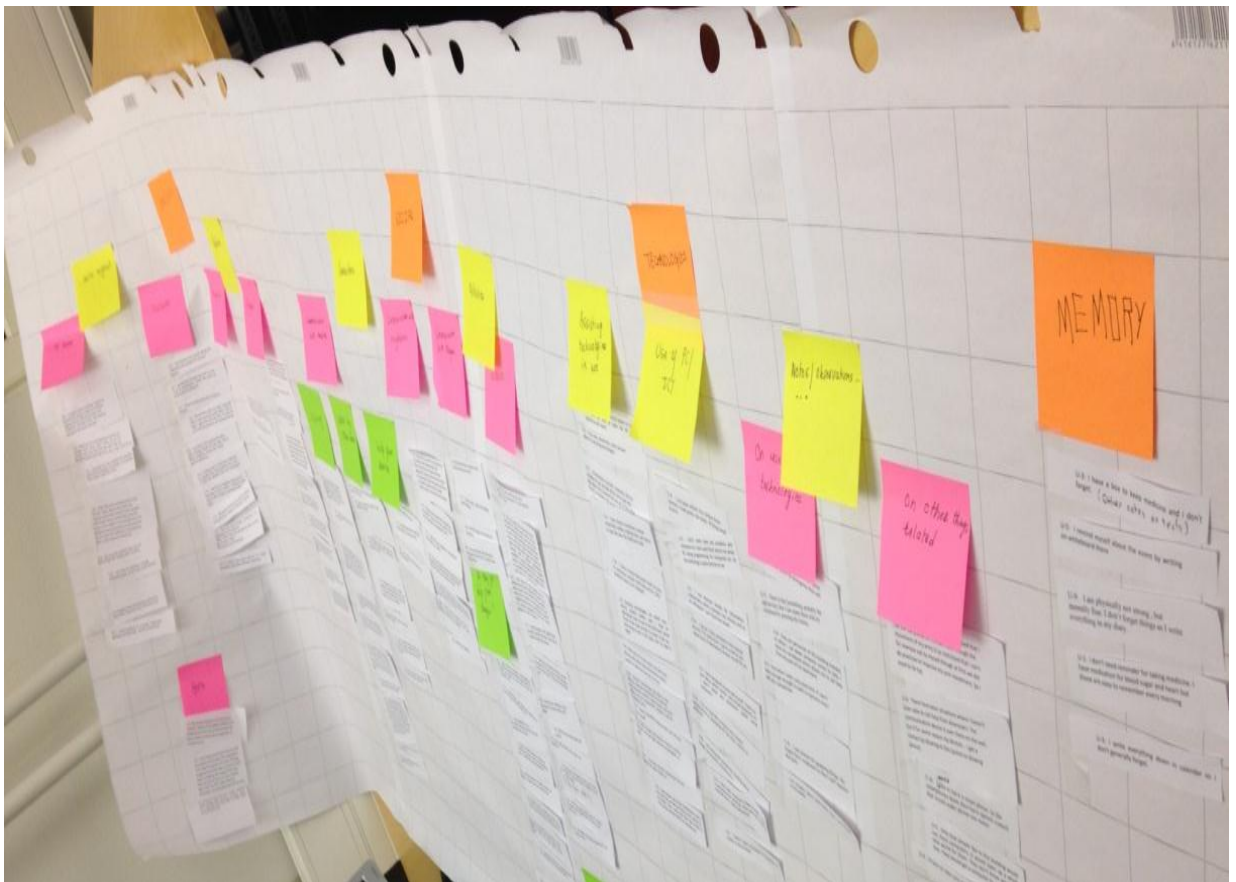
Figure 11*. Part of Affinity Diagram built during this thesis*

5. RESULTS

In this chapter, generalized and abstracted results are presented based on analysis of user data. The finding is primarily from interview, observation and diary analysis.

After analysis of the user data using affinity diagram, a strong relationship between the information from the analysis result and Maslow's hierarchy of needs was found. Hence the findings are categorized based on Maslow's hierarchy of needs. The findings suggest that need of elderly people existed on different levels. There are 5 broad categories. Moreover, the findings include the information from diary analysis. Finally, these findings were basis in deriving requirements for designing the interactive design service for elderly people.

5.1 Revealing Results

5.1.1 Physiological and Safety Needs

The background information suggests that most of the participants are physically challenged. They need support to carry out Physiological needs such as Activities of Daily Living (ADLs) or Instrumental Activities of Daily Living (IADLs). Basic activities such as bathing, dressing, undressing, cooking, transferring from bed to chair, using bathroom or eating were performed mostly through the help of personal assistant(s), relatives or even strangers. Moreover, they seek help to shop and go to pharmacy, going out for appointments, etc. These basic needs were fulfilled with the help of personal assistants or caregivers from Validia.

Most of the participants refer to needs of safety and security as physical safety. Most of the participants fulfilled their physiological needs and safety needs with the use of assistive technologies. The participants make use of assistive technologies ranging from elderly friendly kitchen-ware appliances to calling system to overcome various physical limitations. Most of the participants mentioned the use of wheelchair both manual and electric wheelchairs, walkers, canes to assist mobility within or outside their residences. One participant had her own assistive car which she could drive on her own. Similarly, a participant mentioned having robot vacuum cleaner to help her with cleaning.

Validia has environment control system like elderly friendly lifts, doors which can be opened and closed easily as well as proper lighting systems which assisted the participants. However, the participants who live independently did not have the facility of good environment control system.

The participants had call system either attached to the wheel chair or in the form of wristband so they could press in the time of emergency situations or whenever they need some help from caregivers. Untimely attendance of caregivers to these calls for help was one of the major issues of the elderly people living in Validia and expressed their discontent towards the service within Validia. Almost every participant had pill dispensers to arrange medicines for weekly doses and is checked every other week to be refilled by caregivers. Hence, they did not forget to take medicines in time.

One participant had the blowing interface as her assisting technologies. The interface helps her to call or to turn the pages of the magazine by blowing.

"Well once I'm in this chair I can use most devices with either the environment control system or with the blowing interface." (U-6, Female, 74)

But they are mentally strong and are decision maker and make choices in planning and living personal life.

5.1.2 Needs for Love and Belongings

Elderly and Social Activities

The participants seemed to engage in redefining and choosing the meanings of the activities and relationships in order to continue living in a positive emotional life. Despite mobility impairments or other personal barriers, the participants interviewed were engaged in selective and enjoyable social activities. For example, three of the participants go to water aerobics that enhance their physical activities. Moreover indulging in water aerobics give them chance to meet new people and thus helps in enhancing the social connections.

"We talk our ears off in water aerobics and make the world a better place. At least now that there are others - two women and three men. The first year I was there alone." (U-1, Female, 69)

Two of the elderly participants have mentioned about their involvement in peer support training. Moreover, they mentioned the importance of peer support they have been giving and receiving from others.

"I like to help other people, I also got helped, when we exchange experiences and life stories, it may help other people to get ideas how to manage and do things differently and peer support is very important."(U-2, Female, 64)

Some of them like to watch TV, read, going to theatre ,concerts and art museums .They have mentioned their likings to go outside and wander around the town. However they have mentioned the complications of being outside during winter.

"I drive electric scooter to look around just to look at places because this is a beautiful city. In winter it is almost impossible to drive with scooter because it's cold. My finger freezes. (U-3, Female, 60)

Barriers to social activities are mainly due to mobility impairments due to physical health declines as mentioned in background information of the participants. Apart from mobility issues and weather conditions, the concern of the participants for safety prevents them from indulging into activities. For instance, two participants feared of going outside alone. However, they are less fearful when they are with the company of somebody.

"I don't really go out without an assistant because even a small hole can change my position so that I can't control my devices."(U-6, Female, 74)

Elderly and Social Contacts

Communication was vital for the participants, to get support in their daily activities. They have social interaction mostly with personal assistants, relatives, neighbors or strangers. The interviews suggested that the participants had strong and long lasting relationship with either family or friends.

Personal assistants

Except one, all other participants had personal assistants or careers. Personal assistant work close with elderly people. Participants were assisted by their personal assistants in doing almost everything to support independent living. Some participants admitted that they could barely do anything without the assistance of personal assistance. Personal assistant provides help not only in the domestic realm but also in the public settings including fetching medicines from pharmacy as well as help elderly people participate in social activities or preferred hobbies. But the participants were the one making decisions about their own life.

"My life is limited when I don't have any personal assistants. When I have personal assistant, I get help to make different kinds of food, otherwise my food will be simple. I can plan and shop. I feel like cook and same thing occurs in other things too."(U-2, Female, 64).

Relatives

The participants pursued for meaningful and deeper relationships. At this stage of life, they seemed to be emotionally closer with either siblings or their adult children.

They have contact with family members through traditional communication devices like phone and Skype or their relatives pay visit to them. However, the frequency of contacts etween relatives and participants varied. Giving a visit by family members depended upon their jobs and how far they live.

"On vacations they spend quite a lot time in here but son and daughter live that far away from here so it is not possible to visit every week."(U-8, Male, 66).

One participant said that she depended on her children for almost all the activities and her children paid regular visits. However, it was not same for all the participants. One participant mentioned that his relatives did not visit him at all. Similarly, another participant expressed that she wished that her relatives visit her.

When I need help I call to my son or daughter depending on the type of help I need." (U-1, Female, 69)

Their relative mostly adult children communicated with the participants to be assured that they are doing well .The communication was reciprocal as the elderly people often seemed to communicate with relatives to check whether they are fine or not as well.

"Especially daughter asks me many times per day if I am ok. My daughter lives quite near and granddaughter not far either. Usually I don't have to even ask. They visit almost every day."(U-1, Female, 69)

Moreover, some participants expressed that they preferred to live near their relatives so they could give or receive help when needed or in fact they could feel the presence of their close one. The participants were aware that their children and relatives have their own life and don't want them to disturb their relatives' routine by calling or asking help from them frequently. In other words, they did not want to be burden on someone close. Even though, some of the participants felt that they wished to be visited by their relatives, it was not feasible as their relatives were old and fragile as them and they live far apart. Physical environment seemed to be barrier too. One participant who shared the time between living in his own home and XYZ expressed that it was difficult to meet her wife at home because the entrance of the house was too narrow to take wheelchair in.

Simple act of giving and receiving postcards and gifts to and from their relatives made them happy. Similarly, spending time with relatives or getting chance to travel with them made them feel good.

Neighbors

The participants who lived in their own residences expressed that they had no contact or communication with their neighbors. This is mainly because they move from other places.

"I seldom see neighbors" (U-3, Female, 60).

However the participants from Validia considered other members of Validia as neighbors and get occasional help in need.

Strangers

The participants expressed they have considerable interaction with strangers and most of them mentioned that they got help from strangers when needed. They do so because they don't have any alternative options left other than asking help from strangers when they are on their own. They admit that they are frail and are now at the receiving end of care.

"I got help from strangers. Surprisingly a lot. The world you get is the world you give away. It is almost too simple. You just have to have the courage to ask."(U-4, Male, 67)

However, two of the participants mentioned their experiences that they were unattended when they were in problem.

They exchange greetings to the passersby when they are in public spaces such as parks or alleys of their suburbs or shops. The synergy of communication with strangers was the outcome of their own experience of loneliness and they believed that they could make day of other people by simple act of greetings.

5.1.3 Needs for Self-esteem and Self-actualization

Though they seek help from personal assistant, family members, neighbors or strangers, the participants were responsible to actively plan his or her daily schedule or make important decision of their living. This provided them with the sense of independence which in turn made them feel valued and respected.

"I watch what kind of events there are with my assistant and ask tickets from Lippupalvelu. Then I have the assistant with whom I'm going, though there are times when I go alone to some events." (U-6, Female, 74)

Completing activities that they prefer provided them the sense of independence. If somebody restricted their decisions, the elderly people thought that their esteem has been undermined. Most of the elderly people knew their potential. Social activities such as participating in hobbies that they like reflect who they are (Section 4.4.2). As observed by the care personnel, elderly people who are aware of their limitations try to choose the activities according to their level of capability. They have strong desire to pass their knowledge and contribute to their society or neighborhood to make it a better place.

5.1.4 Elderly People and Technology

As mentioned in chapter 5.5, all the participants were consumer of assistive technologies. For communication with friends and families, they use phones and skype. As observed during the interviews, all the participants had TV as source of entertainment. Most of the participants were active users of computers. Six out of Ten elderly participants were the users of computers and were connected to the internet. Two of the participants who were relatively younger than others explained that they use computer for professional related activities. They explore internet mostly for seeking information related to their hobbies.

Most of them have functional disabilities which creates difficulties in using ICT technologies. However, they use it through various ergonomics devices such as alternative keyboards and mouse designed for disabled.

"I use internet mostly for information, mathematics which interests me, history and so on, whatever I can't find from books."(U-5, Male, 63)

"I use bank online, buy clothes from internet. I read news, use email. Writing email is slow. "(U-8, Male, 66)

"I work with computer 3 days a week .I have 3 computers for working. They sent me x-rays by internet then I make statement. "(U-3, Female, 60)

All participants seemed to be rather intimidated about using social networking technology like facebook and twitter however the intent of doing so was previously unclear from interviews. But the observation by the caretaker revealed that the elderly participants were concerned of security and privacy issues.

They are not afraid of learning new technologies which they perceive beneficial. For example, the two participants were keen to use new technologies and new smart phones.

"I like to have a smart phone. In the smartphones these days have speech control that would make phone use easier." (U-8, Male, 66)

One participant even wished to have the technology that would allow him to walk again and he was well aware that it is not possible through current technology.

5.2 Personas

Based on the information after analysis of collected data, primary and secondary personas were created. The guidelines for persona creation were followed. Persona includes use of photo, a personal name, a biographical profile and personal information affecting the usage patterns in relation to the design. Moreover technology usage and user goals were also included in a persona.

Interview data was utilized for biographical and personal profile as well as for technological usage pattern. Similarly user goals were inferred from the results from the data gathered.

A detailed description of persona is presented in text format. Primary Persona represented most of the participants of the interview.

Name	Saara H.
Marital Status	Single
Age	74
Disabilities	Arthritis
Personal Assistant (Yes/No)	Yes

Help from Careers/Personal Assistant

I need help in cleaning, cooking, organizing things, watering plants. Outside house, I need help in fetching the prescribed medicine, shopping, etc. Basically all kinds of activities.

Communication

Family members- I have a sister. She keeps in contact with mobile phone and Skype. We contact 3-4 times a year, my sister is retired and I hope they visit me more often.

Neighbors- I consider people of Validia as neighbors. Whenever I am in TV room or dining room downstairs, I communicate with them. There are always people to talk with.

Strangers- I got occasional help from strangers when I am outside on my own.

Social Activities

I like to be outside, drive around, like nature and beauty of it, when summer comes I am just like bird coming from south, I sit in sun as much as I can. I love to watch television I like to go to theater and concert. I like to follow sports, meet my friends; I do voluntary work in different organizations. I write interviews in sport magazines. I like to help other people, I got helped, when we exchange experiences and life stories, it helps other people to get ideas how to manage and do things differently and peer support is very important.

Technological Use

I have electric wheelchair, call system, invalid control system for closing and opening the door lifts. I have basic cell phone with alarm. I have pill dispenser to fill required dosage. I use computer mostly for reading about things (Aamulehti, articles etc.) and emailing and writing sports article. I have designed mouse myself. I have my own ideas, when I write I use virtual keyboard.

Goals

I want to remain independent and enjoy my life. I hope to keep connected with people and stay positive. I want to keep doing activities I love and help others too.

Figure 12. Primary Persona

Name	Mika k.
Marital Status	Married
Age	67
Disabilities	Long term illness
Personal Assistant (Yes/No)	Yes

Help from Careers/Personal Assistant

I need help in cleaning, cooking, organizing things, watering plants. Outside house, I need help in fetching the prescribed medicine, shopping, etc. Basically all kinds of activities.

Communication

Family members- Giving a visit by family members depends on their jobs. On vacations they spend quite a lot time with me but son and daughter live that far away from here so it is not possible to visit every week. I get it without asking (help from family members)

Neighbors- I've lived here three years but I have no contacts to my neighbors. We barely see each other.

Strangers- I can talk with strangers but the people here in Tampere do not want to communicate and they seem very busy.

Social Activities

I like listening music, watching TV (sports), using pc to interact with the world outside.

I am also involved in several rehabilitation groups. I go to water aerobics once a week which city organizes

Technological Use

I use bank online, buy clothes from internet, look for events in the internet and then I go with my assistant to that event. I read news, use email. Writing email is slow due to pain in my hand. I like to have a smart phone. In the smart phones these days have speech control that would make phone use easier.

Goals

I would like to be connected with my family members frequently. I would like to use technology to connect with the world outside.

Figure 13. *Secondary Persona*

5.3 Summary

The findings have important implications for how to design technology for elderly people. The elderly people participated in user studies were fragile and physically disabled, however, their physical, safety and security needs are addressed by various assistive technologies. User studies suggested that elderly people like to maintain strong relationship with their close ones and feel the presence even when they are distant. Hence

for the implementation of these findings, an interactive social technology can be developed to help elderly people actively participate in community and help renew or even create new social contacts and support the presence at distance. Though they use communication technologies like phone and skype, new interactive social technology has the potential to bolster need of love and belongings through communication. By allowing elderly people to be play social role of an important member of the family, a responsible neighbor or community and allowing actively to be engaged in the activities they chose, the social design can uplift the sense of self-worth.

6. DESIGNING AND PROTOTYPING

This chapter deals with how the concept of the ElderTV was emerged and mentions the design process where idea is concretized in the form of storyboards, UED and finally a prototype. Similarly, the concept is evaluated for usability and sociability utilizing sociability heuristics.

6.1 Brainstorming

The ideas for design solution emerged during the analysis and interpretation of user diagram while building affinity diagram. Presenting the data analysis results according to Maslow's Hierarchy of Needs provided the insights on real needs of the elderly people hence resulting into spectrum of possible design solutions for the elderly people. The design choices were narrowed down during brainstorming phase which took place iteratively through various meetings with supervisors Thomas Olsson and Pradthana Jarusriboonchai. The main aim was to meet the goals of the research as stated in chapter 1.2 and develop an appropriate technological prototype to meet the needs of the elderly people.

All the participants interviewed had physical or motor disabilities. There are the possibilities of devising new assistive technologies or enhancing the efficiency of existing assistive technologies for elderly people to overcome or deal with the functional disabilities.

Similarly, they were concerned for their safety and security. Hence new futuristic technology for safety could be designed. Many elderly people in Validia complained about untimely attendance of caregivers to their call when in need. Hence, there is possibility to address this problem by designing some efficient time management system which could be used by caregivers of the elderly people. However, most of their physiological and safety needs were addressed by existing assistive technologies in considerable amount.

Participants interviewed in the data gathering phase wanted to be involved in the lives of friends and families without imposing burden. Moreover, they wanted to participate in hobbies they choose for recreation and share their thoughts to their peers. The technologies they used for communication were traditional phone, mobile phones and Skype. Hence, while brainstorming, we see the potential of social technology to address the higher needs such as needs of love and belongings, self- esteem and self- actualization.

Several social technological solutions were taken into considerations based on results from user needs studies and literature reviews. Interactive table display, social TV and

social robots were possible solutions for enhancing communication among friends and families either in collocated or distributed environment supporting face-to-face communication or the presence. As several research suggests, interactive table display could be developed to support collective activities in common meeting places such as sharing pictures to enhance storytelling and communication as well as help reminisce memories of the elderly people (Apted *et al.* 2006). Moreover, elderly people could be empowered through tabletop games which are fun as developed by Mahmud *et al.* (2008). Similarly, socially assistive robots could be design solution for the elderly people to provide care and companionship as well as assist them to communicate with each other or with the loved ones.

However, among these possible design solutions, social TV was considered attractive for elderly people as TV is one of the most familiar technology which causes less reluctance in adoption of the design. Kensaku (2010) mentions that time spent watching TV increases with age. Most of the participants mentioned possessing TV and watching TV was one of the social activities or the source of entertainment. Social TV therefore has the potential to impact the social lives of the elderly people. Here, the concept of social TV known as ElderTV is put forward as a design concept.

6.1.1 Concept of Social TV

TV is one of the mostly utilized entertainment devices and is inseparable part of most of the living rooms. It provides opportunities to interpersonal communication. Social TV extends TV viewing experience by integrating social features which will allow people to socialize while watching TV. The desire to communicate on what they view is natural to human beings. According to Harboe et al. (2008), the design of social TV prototypes is to allow people to communicate with a circle of friends and families to share feeling of togetherness. The key elements of designing social TV are Television Presence, co-viewing experience, freeform communication and awareness of viewing experience and preferences. Television presence is supported through displaying buddy list. Co-viewing experience is achieved by ability to suggest programs to others what user is currently viewing or view the program someone is watching. Freeform communication is supported through various modalities such as text, chat and voice calls. (Harboe *et al*. 2008)

Different researches have put different dimensions for design of social TV over the course of time. Coppens *et al.* (2004) state personal content, rich communication and community support as the basic components of social TV experience. On the other hand, Ducheneaut et al. (2008) identify two dimensions of sociability: direct and indirect. Direct sociability refers to discussing TV program content during, just before or after watching the television program whereas indirect sociability refers to discussing about the television program apart from actual television viewing experience. Similarly, Chorinanopoulos (2007) divide sociability into two dimensions: synchronous-asynchronous communication and collaborated-distant presence.

TV viewing activity can be coupled with second screen devices such as smartphones, tablet or laptops or ambient displays for social sharing and awareness of other users watching TV remotely. Harboe et al. (2008) utilizes an ambient display in Social TV2 to provide awareness of friends and families in distance. An ambient display in the form of color changing lamp was used to display the number of friends watching television hence changing the color of the display to blue, purple or yellow. Other previous research in second screen based social TV experiences includes Cruickshank (2007) and Obrist (2010) and both utilize mobile devices as second screen to support TV viewing experiences.

However, existing social TV design concepts lack to consider age-related changes and socio-cultural barriers of elderly people. 'Simple Teleda' (Miyazaki *et al.* 2013) and 'PresenceRemote' (Sokoler and Svensson 2008) explained in chapter 2.5.2 are some of the examples of social TV concept for elderly people.

6.1.2 Social TV- ElderTV

The following chapters present the concept of Social TV- ElderTV. ElderTV is the social TV prototype for elderly people which allow elderly people to communicate with their small group of friends and families. It provides opportunities of shared viewing experience by employing second screen. The size of second screen is considered to be 10 inches believing that it would be helpful for elderly people with visual and motor disabilities. The second screen displays simple interface where users can view the buddy list watching TV programs thus supporting the presence. Users can recommend the programs they are currently watching to their friends, thus supporting the co-viewing or shared experience of watching TV. Hence the second screen acts as a control device to the channel. This system incorporates both direct and indirect sociability. Direct sociability is facilitated as users can voice call their friends in the list and discuss about the TV programs they are currently viewing.

Similarly, the TV program content can be discussed after the TV show thus enabling indirect sociability. Since the users have subtle information of activities of others, the information can be utilized to 'break the ice' while meeting outside the context of watching television. It provides awareness of everyday life of the elderly people without active intervention hence, social TV provides peace of mind to their relatives at distant.

6.1.3 Context of Use of ElderTV

Defining context of use helps to understand the actual situation under which the system can be used and helps to identify user requirements for a product. Product or services should be designed for specific context. The usability of the product depends on context of use. Similarly, the context of use for ElderTV contributes in design as it provides information on different conditions that influence the interaction of users with the system.

Over a period of years, many researchers have framed the definition of context of use and have mentioned different components of context. The context components presented in most of the researches include physical, temporal, task, social and technical context. Physical context describes the features such as spatial location, sensed environmental attributes (for instance hot, cold, quiet, calm), movements and mobility and artefacts present when users interact with the system. Temporal context describes when users interact with the system such as time of the day, season, year, etc. Task context describes the surrounding tasks with respect to users' task while users interact with the system. Social context describes surrounding people, interpersonal role and interactions and culture which influence the use of the system. Technical context describes other relevant systems, devices, networks or services and their interoperability (Jumisko-Pyykkö and Vainio 2010).

Table 3 tries to summarize all the possible circumstances, that is, the context of use where ElderTV would be utilized. The context of use in case of ElderTV was defined from the observation of the participants in their residence during the interview.

The environment where ElderTV will be utilized is home of the elderly people where they watch TV alone and ElderTV would facilitate distant communication between friends and families. Similarly, the context can be public places such as common room of rehabilitation centre thus providing the space for interaction. Watching TV in public space resembles to traditional TV watching scenario where elderly people gather together at common room of rehabilitation center and watch TV program. This enables face-to-face collocated communication about the TV content.

Table 3. *Context of Use (Physical, Temporal, Task, Technical, Social) for ElderTV (Jumisko-Pyykkö and Vainio 2010)*

Users- Elderly people, their friends and families

User Goals- Entertainment, communication, to feel the presence and connectedness

Equipment- TV screen, set up box, second screen display

Components of Context	Subcomponents	Home	Public space (e.g., rehabilitation centre)
Physical	Spatial location, functional place and space	living room	Common room or place for meeting in rehabilitation centre

	Sensed environmental attributes	Audio: quiet Visual: calm, indoor	Audio: quiet/ noisy Visual: indoor
	Movements and mobility	No motion/ motion	No motion, travel
	Artifacts	Wall, TV , tablet	Wall, Table, TV, tablet, etc.
Temporal	Duration	Vary	Vary
	Time of day / weeks	Vary	Vary
Task	Multitasking 1	Check tablet	Check tablet
	Multitasking 2	other tasks	Talk with friends
	Interruptions	Physical, Social interruptions	Physical, Social interruptions
Social context	Persons present	Self, family members, friends	self, other rehabilitation centre
	Interpersonal actions	One-to-one One-to-many Co-sharing	One-to-one One-to-many Co-sharing
	Culture	Traditional TV viewing culture for entertainment, information	TV viewing culture for communication
Technical context	Other systems and services	SNS, tablet, phone	SNS, tablet, phone
	Interoperability	Static, phone	Static, phone

6.1.4 Scenarios and storyboards

After brainstorming and defining the context of use of the social TV, the idea of the ElderTV was illustrated using scenarios and storyboards thus helping to concretize the concept. Each scenario highlights the details of the vision of the ElderTV. Then the vision of the product is further depicted through storyboard by drawing frame sketches.

The sketches helped to illustrate the vision of the system and aid to understand how target group- elderly people will use the system as well as give information of context and timing. It also helped to communicate these aspects with supervisors involved in this thesis work. However, this could be utilized in future for user evaluation and communicate the design ideas among real users to get comments and feedback of the concept implementing the concept. The following preliminary developed scenarios and storyboard illustrate the concept of connectedness, presence and communication, shared experience of watching TV. It depicts how persona –Saara uses ElderTV.

1) Scenario 1 depicts the use of second screen which features user interface of ElderTV. It illustrates how Saara, an elderly persona could view the list of frieds who are watching TV at the same time she is viewing and how she could recommend the TV program to one of the buddy in the friend list and feel the presence.

2) The second scenario involves watching program recommended by others and depicts how Saara is engaged in conversation with others through voice call while watching TV.

Scenario 1

Its 19 o' clock. As usual, Saara is now infront of television to watch her favorite TV talk show on current affairs. Today, the guest on the TV talk show is an environmentalist talking over the issues on global warming. She checks her second screen (tablet) to find more detail about the show and the guest. She finds the show interesting. Curious, who are watching the talk show; she checked the second screen again. She finds that 2 of her friends are watching the same show she is watching. But her daughter Anna is watching KUMMELI. She then send recommendation to watch the same show as she is currently watching thinking Anna might be interested. It seems that her daughter accepted the recommendation and is now watching the channel as Saara is watching and is following the discussion. It makes Saara can feel the presence of her daughter and they are watching the show in the same virtual environment.
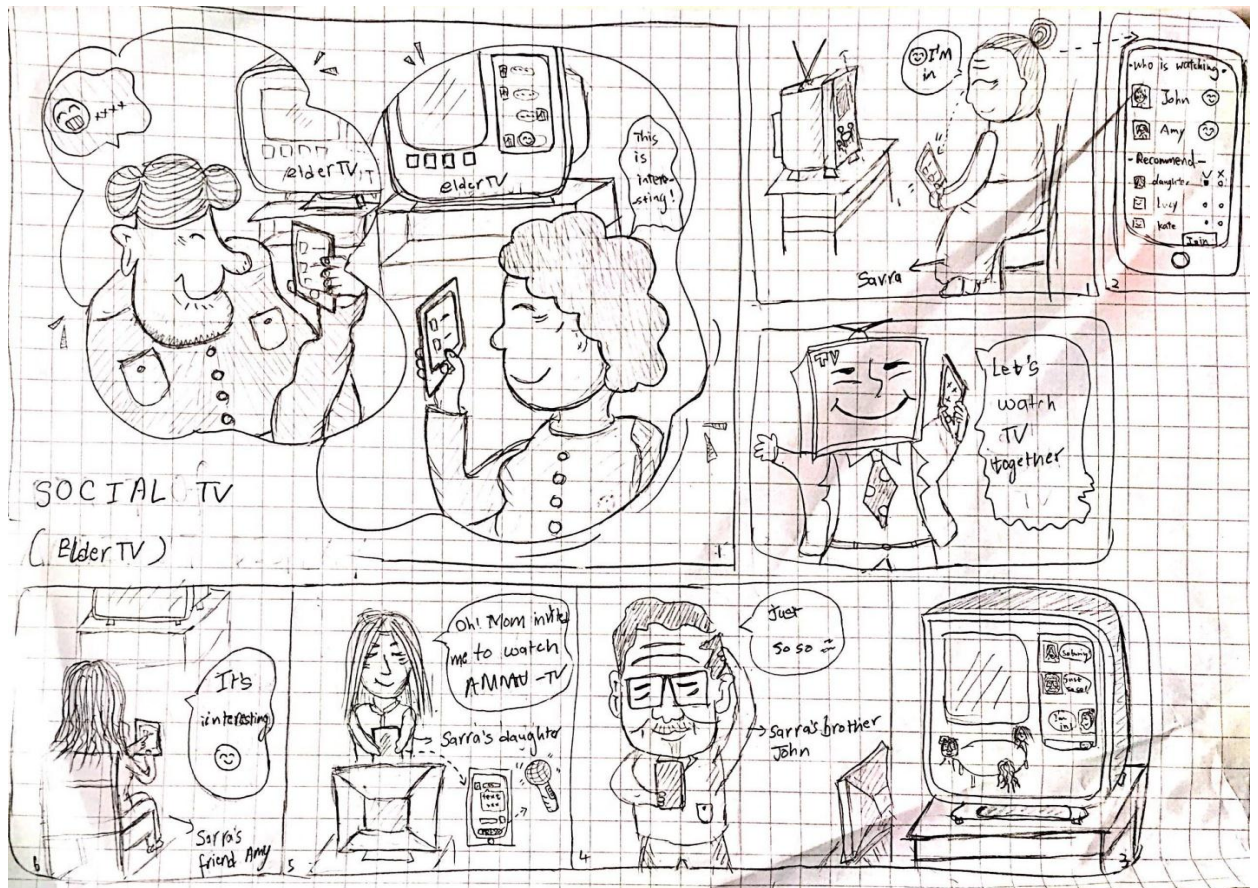
Figure 14. *Storyboard depicting scenario 1*

Scenario 2

Saara is watching Bold and Beautiful but she did not find today's episode interesting. She then checks what her friends are watching. She finds out her good friend Mika is watching JOPET SHOW. She then switched the channel to watch comedy circus. Meanwhile she got recommendation from Piva to watch national geography channel. While she get recommendation, the whole screen is turned yellow. She then changes to that channel and found out that it is featuring exquisite places of South Africa. She calls Piva during the show to thank for recommendation and discuss about the show.

Figure 15. *Storyboard depicting scenario 2*

6.1.5 User Environment Design

User Environment Design served as plan to the design of the prototype- ElderTV. It helps to visualize the skeleton of the ElderTV showing each part of the system, how it support the work of the user, functionalities available in each part of the system and how users could navigate from one part of the system to another. It thus help to concretize the vision or storyboard of the system.

With UED, it was assured that the structure is right for the target group and it was easy planning to add or remove features from the system.

Appendix C represents initial version of UED of ElderTV with many features. However, the UED was iterated after the discussion with supervisors to make the concept simplistic and easy to use by the elderly people. Since elderly people have reduced ability to multi-task, many initial features illustrated in the Appendix C are not included in the second version as shown in Figure 16. The figure below depicts the iterated version of UED of ElderTV with four different parts. Each part has name, its purpose list of functionalities and objects which user could modify. The first part of the system is Friend List where each user can view the list of friends and TV programs they are watching. Through Friend

List, they could navigate to other parts of the system such as Recommend TV Show, View Recommendation and Call.

Friend list

-see what programs friends are currently watching

Functions

-view friend lists

Links

-recommend TV show

- view recommendation

-Voice call

Objects

TV program names

Friend's name

Recommend TV show

- Invite friends to watch the show you are watching

Functions

-View List of friends

- Select Friend to recommend the TV program you are watching

Link

- Friend list

Objects

- Friend's name

Call

- call your friend who are watching TV to discuss the TV content

Functions

-voice call

Link

- Friend list

Objects

-Notification message

View Recommendation

- Invitation from friend to watch the show they are watching

Functions

-confirm to switch the channel

-cancel

Link

- Friend list

Objects

-Notification message

Figure 16. UED of ElderTV

6.1.6 Prototyping

Mid-Fidelity prototype was developed implementing the User Environment Design and demonstrating the user interface of the system, further concretizing the vision. Prototyping tool FluidUI[10] was utilized. The prototype depicts the user interfaces of ElderTV (Figure 17). The prototype was iterated twice to achieve simplicity and yet maintain the sociability features of the Social TV.

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[10] https://www.fluidui.com/

1) The main user interface of the second screen displays a list of friends who are watching TV programs. The list of the friends are displayed from the contact list of the user's phone. Then the user can recommend program he/she is watching or call their friends while watching the TV program and discuss about the TV content. Similarly, user can click on 'WATCH' to view the TV program others are watching. Hence the second screen acts as control device to change the channel.

2) The second interface depicts the interface after user clicks 'RECOMMEND' button. It shows a list of friends to whom user can recommend the current show he/she is watching

If the user gets recommendation to watch program from others, the screen color changes to notify to the user.

The user interface of ElderTV is simple and easy to use by elderly people. The fonts are sufficiently large to accommodate the visual acuity loss. The buttons are big enough. The information in the screen is not overwhelming. Since, elderly people have reduced ability to multi-task, the initial user interface (Appendix D) was considered overwhelming for elderly people. Following features which were present in initial version of prototyping (Appendix D) are omitted from the second version of prototyping (Figure 17) to make the layout simplified:

- Detail description of the TV program- It displays more information of the TV show to the viewers.
- Rating- Users could rate the TV show. Ratings can be utilized to recommend the TV shows to friends on the friend list.
- Capture- User could capture picture or video from the TV show they are watching and share to their friends on the list. This facilitates asynchronous communication
- Join conversation- Users could communicate with other viewers through text chat or emoticons.

However, removing these features do not affect the sociability and usability aspects of ElderTV, that is, the iterated version of prototype supports social presence by allowing users to see the list of friends watching TV. Similarly, co-viewing experience can be achieved by users through sending or accepting recommendation of the TV show they are watching. Communication is supported through voice call before, during or after the show. TV content provides subject matter to talk and hence stimulate communication.
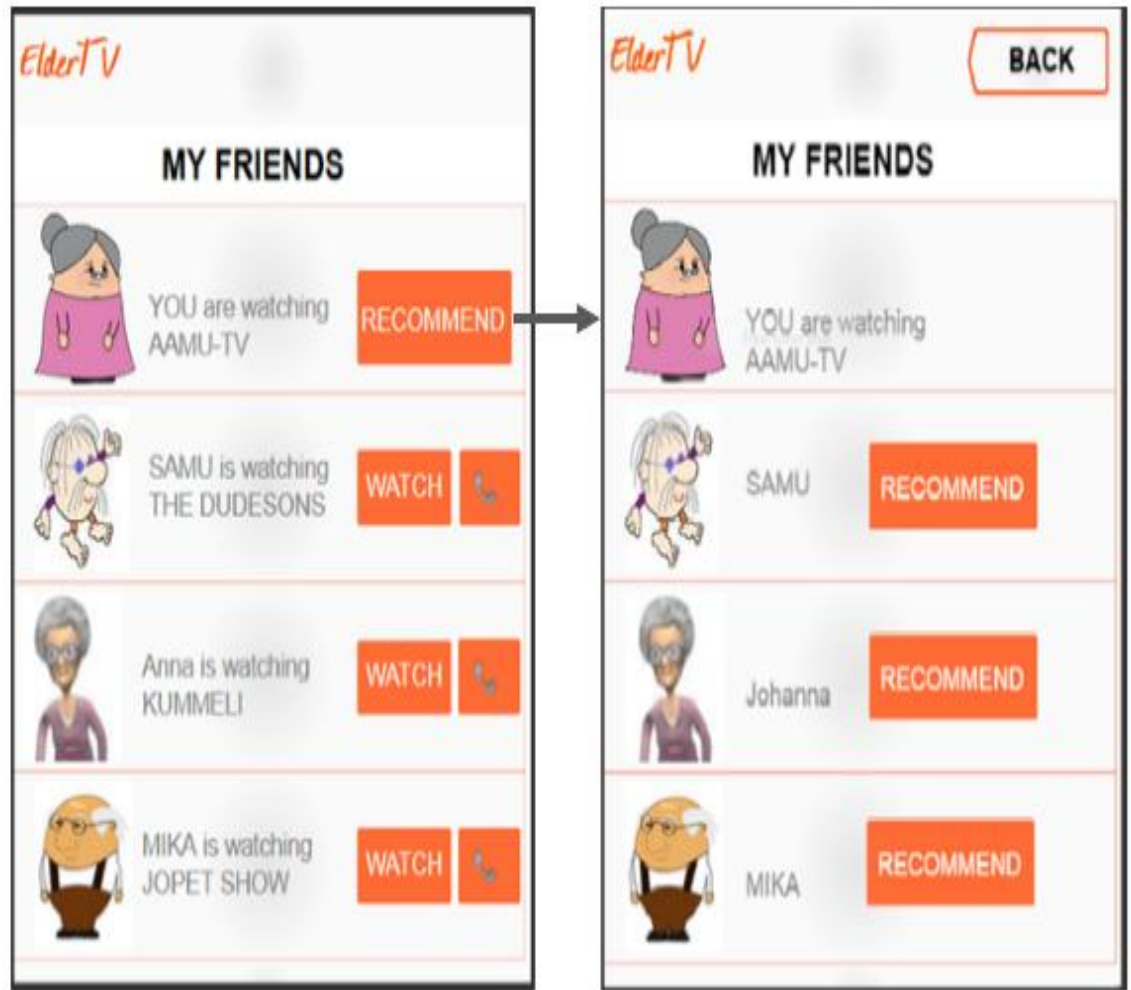
Figure 17. User interfaces of ElderTV

6.2 Sociability Heuristics for Social TV

After the prototype to manifest the concept of social TV, it has to be evaluated to check whether the design is usable or not and is engaging and pleasant to use. Evaluation is critical phase of the UCD and is best done in the early phases of the design process to uncover design issues and is done in iterative manner. Heuristic evaluation is one of the effective evaluation methods to find out problems in early phase of development at low cost and is easy to perform. It is performed by one or more experts that utilizes a list of rules called heuristics or usability principles to determine the user-friendliness of the system (Nielsen 1994).

Since social TV explores the sociability aspects of the design, it is important that the system should incorporate all the social interactions that are central in the context of watching television. The definition of sociability differs from one domain to another. According to Greets and De Groof (2009), Sociability for interactive television "is the extent to which an iTV application supports synchronous as well as asynchronous social interaction between co-located viewers and/or remote viewers, creating a sense of

connectedness while watching audiovisual content intended to entertain, inform, enrich or involve viewers." There are several usability heuristics that help designers in creating usable interfaces of the system; similarly, sociability heuristics help to create sociable interfaces and support sociability and enhance social interactions. It helps to support the social uses of television.

The prototype was evaluated using Sociability heuristics for social TV proposed by Greets and De Groof (2009) where thorough inspection of ElderTV was carried out by cross checking each features and functionalities of the system with each heuristics list. The prototype was developed based on the findings of needs from user studies. However, utilizing heuristics acted as design guidelines for ElderTV. Initially all the heuristics rules were implemented in the prototype however, considering the functional limitations of the elderly people, some of the heuristic rules were later not utilized. The design is meant to be simple and easy to use by the elderly people as implementing all the rules makes the system less elderly friendly.

The sociability heuristics rules against which ElderTV was evaluated are presented below:

1. Offer different channels and levels for communicating freely

The system should provide chat as well as text chat if possible. The voice chat facility could be provided for those people who have difficulty in text chat. It should support different responses such as emoticons, gestures as well as free-form communication. (Greets and De Groof 2009)

2. Use awareness tools for communicating availability

The system should provide information on presence or awareness of other users. The information can be in the form of list of buddy list who are watching television with the name of the program and the channel they are watching. (Greets and De Groof 2009)

3. Allow both synchronous and asynchronous use

The system could provide different functionalities for interacting synchronously as well as asynchronously in order to facilitate communication at the same time or at different times. (Greets and De Groof 2009)

4. Support remote as well as collocated interaction

The system should have the possibilities to support multiple users in collocated environment as well as distant locations. (Greets and De Groof 2009)

5. Exploit viewing behavior for informing and engaging other viewers

The system should utilize the information from users viewing history for creating extra functionalities. For example, recommendations can be provided by the system based on other friends' watching behavior. (Greets and De Groof 2009)

6. Give the user appropriate control over actions and system settings

The system should allow users to have control over their actions and system settings. This rule is close to one of Neilsen's usability heuristic rules "User Control and Freedom". (Greets and De Groof 2009)

7. Guarantee both personal privacy and group privacy

Not everybody is willing to share the information of the programs they are watching with friends and families. Hence the system should make sure to enable both personal as well as group privacy. (Greets and De Groof 2009).

8. Minimize distraction from the television program

The features of social TV that allows communication and interaction might interfere the traditional TV watching scenario. Though the main objective of the system is to facilitate communication, the distraction must be less so that the viewers can focus on watching television. (Greets and De Groof 2009)

9. Notify the user of incoming events and situation changes

When viewers are requested to respond to an action of another user such as accept recommendation to watch program or voice call, there should be clear means to notify them about these changing situations. (Greets and De Groof 2009)

10. Adapt to appropriate television program genres

The system should offer features or system settings that are appropriate for the TV genres. (Greets and De Groof 2009)

11. Let users share content flexibly

If the users want to share the content, it should be possible to and from different devices. Similarly there should be possibilities to edit and write comments to the content. (Greets and De Groof 2009)

12. Encourage shared activities

The system should allow the users to start and maintain shared activities around the television content, such as communicating, watching together, choosing programs or controlling the content. (Greets and De Groof 2009)

Table 4 summarizes how the prototype- ElderTV compares to the individual heuristics of Greets and De Groof (2009).

Table 4. *Sociability heuristics for social TV (Greets and De Groof 2009)*

	Heuristic	This solution
1	Offer different channels and levels for communicating freely	The system only supports voice call. User can either do voice call before or after the program.
2	Use awareness tools for communicating availability	User can see the list of friends watching TV (feel the presence), User can even see what program others are watching.
3	Allow both synchronous and asynchronous use	send recommendation of currently watching programs and accept recommendation to watch the program and talk through voice call at same time
4	Support remote as well as collocated interaction	Support communication with friends at distance or communication in rehabilitation centre
5	Exploit viewing behavior for informing and engaging other viewers	Not implemented
6	Give the user appropriate control over actions and system settings	User has the ability to accept or reject the recommendation sent by others
7	Guarantee both personal privacy and group privacy	The scope is not yet determined
8	Minimize distraction from the television program	The affect is not known.
9	Notify the user of incoming events and situation changes	Friend either watching or not watching the TV shows was clearly visible
10	Adapt to appropriate television program genres	Users can watch whatever show they want.
11	Let users share content flexibly	Not implemented

12	Encourage shared activities	Recommend to watch TV shows and be in the same space

Communication among distant viewers could be supported by text, chat or emoticons. Initially, all these communication options were utilized in ElderTV, however, the system now is limited to voice call because text and emoticons are too tedious and are obtrusive for elderly people with physical disabilities. Generally in interactive TV or social TV, wide range of communication options is given. Emoticons and generic messages are useful for invoking the interest in TV programs. In the case of ElderTV, users are devoid of these communication choices because elderly people are less adept to multitasking.

Awareness is the key feature of the social TV which is utilized in ElderTV as suggested by heuristic 2. Awareness is not just about the presence but more information about who is currently watching what channel and program. This provide elderly people with the option and the subject matter to talk with family members or friends. Despite the privacy issues which users could be concerned of, users could share the information for the purpose of interaction.

ElderTV supports synchronous communication where users can recommend TV programs they are currently watching to their friends and they can respond to the recommendation and use voice call to talk about the TV program at the same time. However, different time zone could affect the communication. Allowing recommendation to be saved and sending the recommendation could allow asynchronous communication. However, saving recommendation for future use is not included in ElderTV. But asynchronous communication is possible by talking about the TV content before or after watching the TV program.

Both distant as well as collocated interaction is supported by ElderTV as suggested by heuristic 4. For places like rehabilitation center, elderly people could engage to watch TV programs at the common places. Hence, watching the TV program could stimulate conversation.

As discussed in heuristic 2, the system supports presence and information on what others are watching, which could be further enhanced where past and current viewing behavior can be combined to provide new functionality to implement heuristic 5. For example, recommendation of TV program can be based on past viewing behavior or other's viewing behavior. Friends' viewing behavior could provide information about their interest and provide them with favorable subject and time to interact. This feature is not exploited for the sake of simplicity which might devoid users from extra information about the viewing history of other's friend and getting recommendation based on viewing history, however, not having this feature might not affect the interaction between viewers.

There are privacy concerns while sharing information but this is not yet not addressed in ElderTV. Users do not want to share every information to their family members or friends on what they are watching. Users should be allowed to select only certain friends to watch certain channels. This feature is tedious for elderly people to perform, but their younger friends such as children and friends from the buddy list could utilize this functionality. However, the conversation is private through voice call.

Elderly people could be easily distracted from watching TV if there are different functionalities asides watching the TV content. For example, text chat or voice chat can affect the audio-visual content in distant and collocated communication. Hence, ElderTV is designed to minimize distraction by providing simple interface on second screen. However, the feature could be exploited only after user testing.

Watching different program genres depend on interest of users. Some genres require lots of attention to get information and hence communication or other functionalities could distract the TV watching experience. On the other hand, some program such as comedy shows elicit conversation and interaction among viewers. Elderly people could watch any program which is available, however, the genre or the TV content which stimulates social interaction is yet to be studied.

Social TV is also about the shared content. For example, videos or pictures relevant to the context can be shared among the friends in the list. For example, snap picture of TV program or videos could be send by elderly people to their friends who missed to watch the program, thus supporting asynchronous communication. This would allow elderly people to express their opinions and enhance the interaction. Initially, ElderTV utilized heuristic 11 for sharing the snap picture of TV program, however, considering the difficulty in multitasking for elderly people, this feature was not utilized.

Finally, ElderTV promotes shared activities among elderly people while watching TV thus enhancing the social experience. As ElderTV meets sociability dimensions, there are substantial perceived benefits of communication and presence and strengthening the existing relationships. As discussed in Chapter 2.4, the perceived benefits of using ElderTV as well as the familiarity of technology might lead to its successful adoption by elderly people. Moreover, the design is simple considering the functional limitations of elderly people such as the font size is large enough due to ageing, buttons are large enough, the functions and features of ElderTV are designed to minimize the cognitive load. These factors leads to the usability of the ElderTV.

7. DISCUSSION AND CONCLUSIONS

This chapter consists of the brief summary of the thesis, self-reflection, limitation and ideas for future research topic. The contribution of the thesis is mostly empirical adding knowledge to the existing researches about the needs of the elderly people. This resulted in a design of a prototype which could address the social needs of the elderly people.

7.1 Summary of the Thesis

The goal of the thesis is to find the underlying needs of the elderly people and to come up with concept design addressing the needs. UCD process was employed involving 9 elderly people and one caregiver. The data collection method of UCD process such as interviews, observation and diary method helped to discover the important and interesting aspects of the elderly people and utilize those aspects in design. Semi-structured thematic interview helped in collecting the related background information of the elderly people, the need of help required inside or outside home, connecting with people and loved ones, social activities, how they manage without assistance, and technologies they use to assist themselves. Chapter 4 presents the methods utilized in user studies as a part of UCD process.

Analysis and interpretation of collected data from user studies was done by affinity diagramming. Maslow's Hierarchy of needs was utilized as a framework to present the results revealing the needs of the elderly people. The result of the user studies are presented in Chapter 5.

From the user studies result, it was visible that most of the participants were subjected to physical, motor or cognitive changes and these issues were addressed by the use of assistive technologies as well as built environment of the rehabilitation center. Besides functional changes, there were changes in social roles. Once a caregiver in their early phases of life, they are now at the receiving end of care. Despite the disabilities, the results revealed that they highly value communication, independence and autonomy. Similarly, the participants were involved in social activities indicating that they are part of larger community as well as they like to maintain high self-esteem and self-actualization.

The result indicated the potential aspects of social technology which could influence positively on the social aspects and well-being of elderly people. Hence, the design was steered towards social technology. And the concept of social TV emerged and the prototype of ElderTV was developed. The prototype is intended to meet different dimensions of sociability such as direct sociability where TV content could be discussed just before, during or just after watching the TV program and indirect sociability where the TV content is discussed beyond the context of watching TV. The design of ElderTV

supports presence and awareness, free form communication through voice call and shared experience of viewing television, thus allowing elderly people to communicate with a circle of friends and families. Chapter 6 elaborates the design process in depth.

Sociability heuristics for social TV (Greets and De Groof (2009) served as design guidelines and evaluation tool for developing prototype. User interface of ElderTV is simple and it incorporates sociability dimensions. Hence, the ElderTV concept could be useful for elderly people for enhancing the existing relationships between close friends and family and extend the TV viewing experience in shared social experience.

7.2 Methodological Reflection and Limitation

Lack of clear vision during the initial phase of this thesis might subsequently affect the structure and themes of the interview questions. Hence, there might be failure in capturing possible or potential needs of the elderly people. Another issue during data collection phase was language. As mentioned before, majority of the interviews were needed to be done in Finnish, they were possible only through the help of a friend. So, considerable amount of time was consumed in translating the interview questions from English to Finnish. Moreover, the audio recordings in Finnish language were transcribed and then translated back to English. Hence, there might be possibility of information loss in this process.

Analysis and interpretation of collected data resulted into strong correlation with different level of Maslow's needs. However, the levels of the needs of the participants were interrelated to each other and hence there were no distinct hierarchies visible as Maslow's stated. However, the Maslow's Hierarchy of needs served as a framework and helped to prioritize the needs of elderly people and the technologies they use.

The results from the analysis of data can be biased because of my work as a personal assistant. And there are chances to enforce my own understandings and perceptions while gathering and analyzing data. This may lead to reliability issues of the work carried out.

Considering the elderly people's inevitable functional issues, there were some implications in design. Simplicity and familiarity were focused while proposing design concept. Since TV is familiar to all the participants, the concept of social TV was put forward as a design concept. A simple mid-fidelity prototype was developed to demonstrate the functionalities and features of Social TV known as ElderTV. Social TV is not widely introduced till date in industrial markets; moreover, social TV focused particularly for the elderly people is very sparse. Therefore, the scope of the social TV for elderly people is difficult to be determined. Many existing social TV prototypes support social presence through displaying buddy list, free form communication through different modes of communication such as text, voice or group chat and gestures. Chat and viewing chat history is regarded as necessary feature. Similarly, co-viewing is another

main sociability feature which is achieved through program suggestions and watching the TV program others suggested.

Hence, it can be seen that social presence is not totally new concept in Social TV; however this study focused on social aspect of the elderly people rather than social TV for general people. ElderTV supported social presence by displaying buddy list from mobile phone contact list in second screen. Users of ElderTV can recommend TV program and watch recommended programs thus supporting co-viewing.

Since simplicity was taken as one of the main design guidelines, many features available in existing social TV were dropped out in the second iteration of the design of prototype in order to accommodate elderly people's use. For example, text chatting and watching TV program at the same time could distract the viewers. Assuming text chatting could be tedious for elderly people due to motor disability; the feature was discarded in ElderTV. However, elderly people could utilize the direct voice call using second screen.

Despite aspiring to contribute in interpersonal communication, viewing more descriptive information of the TV content on the second screen was removed from ElderTV to minimize distraction. Similarly, ratings and emoticons were removed as it might confuse elderly people. Sharing the TV content such as link of the episodes the viewer is watching or snap picture from the TV content which could enrich the communication are not included in ElderTV.

Social TV is a form of social networking service which maintains and develops existing social ties as TV is a frequently talking point. Similarly, it can develop new relationship with the strangers. However, this aspect is not exploited as the buddy list displayed in second screen is only limited to the contact list on their mobile phones. This however, strengthen the ties among close friends and family members and there are less privacy issues when the information is not shared among strangers.

User evaluation, one of the important phase of UCD, was left out during this project due to language barrier and resource limitation. User evaluation if performed would have validated the prototype.

Iteration is fundamental in UCD as it helps to achieve concrete design and increases the usability of the design. Iteration was not performed throughout the UCD process; however, storyboarding, UED and designing prototypes were iterated.

7.3 Conclusion and Future Work

It could be concluded that this thesis work met the goal of understanding elderly people's needs in day to day activities considering both functional limitations and social settings

in which they reside. The user studies suggested, among various needs ranging from physical to self-actualization needs, the social needs of elderly people for connectivity with close friends and family were least addressed by the current technology they were utilizing. Finally, an interactive service concept of social TV is designed to address the social needs of connectivity by allowing them to communicate with a circle of friends and families while maintaining their independence. However, the research opens up some research questions for the future regarding implementation, user testing and validity of the prototype.

The design now is limited to strengthen the bonds between close friends and families. Another aspect the research should consider in future is enhancing communication among strangers. This might generate privacy issues as elderly people might not want to share information with strangers. But this enhances the communication beyond friends and families and helps elderly people to create new social contacts. This could reduce loneliness and could stimulate further social activities with like-minded people.

Social TV evokes TV content based communication. There is the possibility to explore what kind of TV program or genre stimulates more communication in future research work. There are different genres such as news, sports, soap opera, drama movies, reality TV shows, live shows, etc. Each genre generates different user experiences. Genres like news, sports, comedies, live shows like debates and elections could stimulate more reaction than other programs and induce fun while conversation. Moreover, they could support synchronous communication through utilization of different communication tools suggesting more research could be carried out.

On the other hand, some genres might need high degree of concentration and interacting while watching TV can interrupt the viewing experience. However, the users could be provided with options to interact about the TV programs through asynchronous communication. For example, links of the TV program could be saved, the snap picture or videos of the programs could be shared asynchronously and users could annotate to those recordings or pictures. Hence, future research could be carried out to support these features for asynchronous communication but yet maintaining the simplicity of the design.

In addition, further research should consider high fidelity prototype and actual implementation as proof of the concept. The social TV provides user experience which is the convergence of one or more users, audio-video content, broadcasting, networked devices and internet with attention to enriching the interpersonal communication through communication modalities. Hence, the actual implementation would explore the relationships with different disciplines of sociability, usability, telecommunication and software engineering.

The concept of the design could be successful from the iteration of different methods in UCD process. For example, interview questions about the needs of the elderly people were general and wide. However, after figuring one of the significant needs of elderly people as social needs, more detailed interview questions could be specified to explore the social dynamics of the elderly people. Hence iterating data collection method such as interview or observation or diary method could result in more valuable information of the target group.

Furthermore, usability testing should be carried out in order to validate the concept of Social TV. It involves the real users while testing the prototype where usability issues are identified. Usability test would have resulted into different findings such as easiness of use of application by elderly people, effectiveness of the use of the second screen display, viewers' attention to watching television content while communicating with friends and family, what genre stimulates communication the most and so on. Moreover, the iteration of the design could be carried out to resolve the usability issues figured out from the usability testing and hence, making the design more concrete.

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APPENDIX A: INTERVIEW QUESTIONS

Background information

Name

Gender

Age group

Marital status

Health Status (long-term illness/disability or Long-term illness/disability) (yes/no)

Personal assistance (yes/no)

Supporting daily life

At home

What kind of help do you get from your personal assistant? (If not then neighbors or family members)

a) Cleaning

b) Repairing

c) Walking inside from one room to another

d) Cooking

e) Sending postal mails

f) Reminding about medicines

g) Reminding important events

h) Contacting (or calling) other people

i) Scheduling events (arranging events)

j) Help with clothes

Outside home

a) Shopping

b) Walking

c) Gardening

How?

Connecting with people and loved ones

Have you got any help from?

   a) neighbors
   b) Unknown stranger?

Do you communicate with?

   a) neighbors
   b) Unknown stranger?

How often do you hear from your family?

How often do they visit you?

Do you need help to contact your family members?

Social activities

What are your hobbies/social activities? Where?

What kind of help do you need when you practice your hobbies?

Do you share your stories/experiences with other people involved you with the same social activities?

Without assistance

How do you manage with your daily tasks? (At home, outdoors)

What difficulties do you face in your daily tasks?

When you are in the need of help, how do you seek it?

Technology

What kind of assisting technology do you use (wheelchair, walking stick, medical reminders) in your daily activities?

Why, when, how, where?

Do you use mobile phone?

Do you need a special phone?

Do you use computer?

Are you engaged in online community? Do you get support from others with same condition (yes / no?)

If yes what kind of communities are you involved in?

How is it beneficial for you?

Did you participate in any online social activity related to health in past year? (If yes)

What kind of online communities do you belong to? How is it beneficial for you?

APPENDIX B: WEEKLONG DIARY

This diary will be utilized for my Master's Thesis related to the need of low-level help/support for elderly people living alone. This is a weeklong diary. Each page represents a day in a week where general help and difficulties faced by elderly people in this Validia house is addressed.

Date:

General help given (apart from medical help)

Reasons for calling help (in emergency situations)

Does the call for help ever remain unnoticed?

How often do their relatives visit them?

Do elderly people talk with each other?

Do you see them talking with strangers?

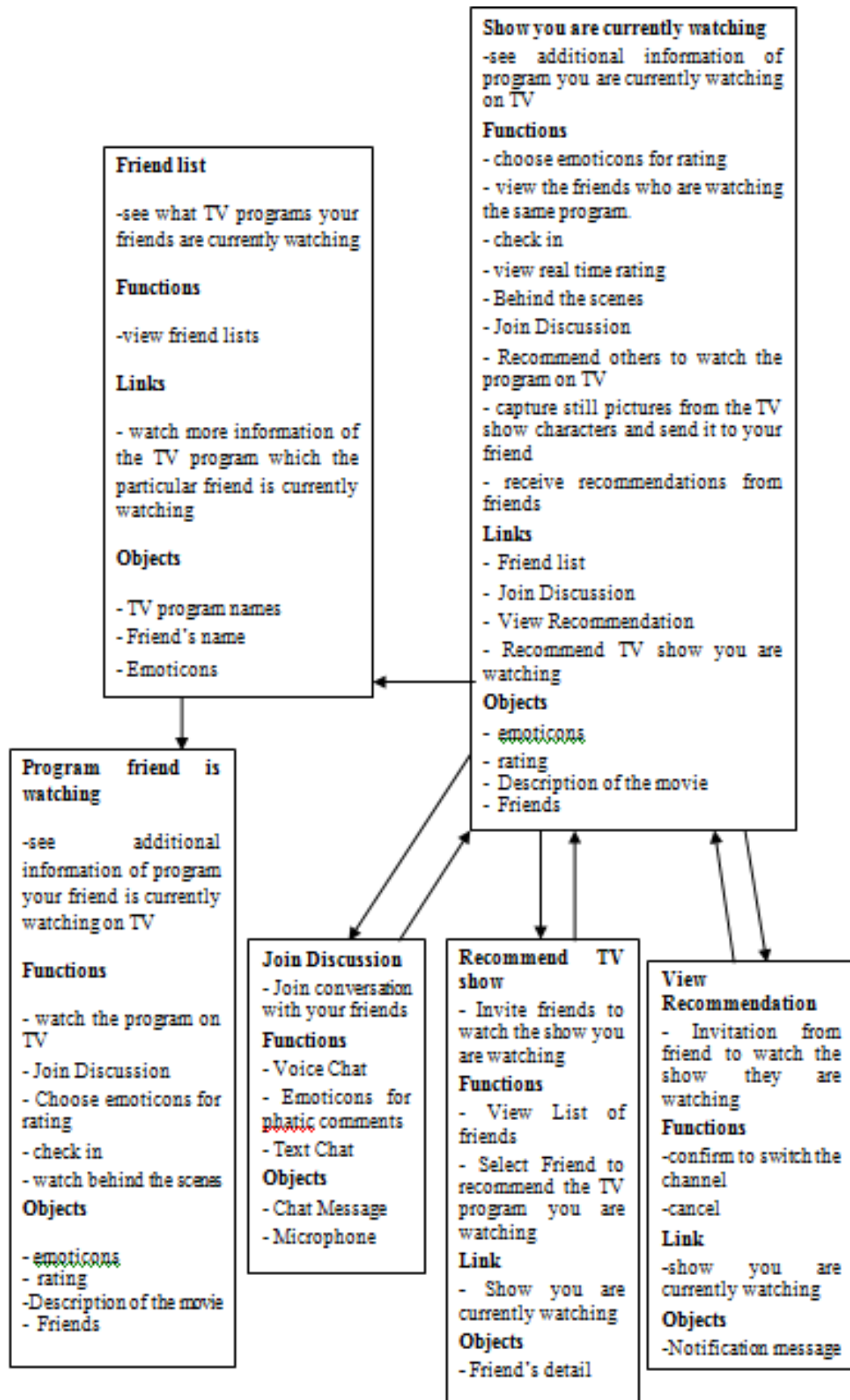Do residents feel isolated? How do you notice it?

What kind of free time activities are they involved in?

Are there any activities in group? If so what kind of activities?

Difficulties of using assistive technology? (On daily basis)

What significant thing do you notice elderly people sharing with you about the social circumstances?

APPENDIX C: FIRST VERSION OF UED

Show you are currently watching

-see additional information of program you are currently watching on TV

Functions

- choose emoticons for rating
- view the friends who are watching the same program.
- check in
- view real time rating
- Behind the scenes
- Join Discussion
- Recommend others to watch the program on TV
- capture still pictures from the TV show characters and send it to your friend
- receive recommendations from friends

Links

- Friend list
- Join Discussion
- View Recommendation
- Recommend TV show you are watching

Objects

- emoticons
- rating
- Description of the movie
- Friends

Friend list

-see what TV programs your friends are currently watching

Functions

-view friend lists

Links

- watch more information of the TV program which the particular friend is currently watching

Objects

- TV program names
- Friend's name
- Emoticons

Program friend is watching

-see additional information of program your friend is currently watching on TV

Functions

- watch the program on TV
- Join Discussion
- Choose emoticons for rating
- check in
- watch behind the scenes

Objects

- emoticons
- rating
- Description of the movie
- Friends

Join Discussion
- Join conversation with your friends

Functions
- Voice Chat
- Emoticons for phatic comments
- Text Chat

Objects
- Chat Message
- Microphone

Recommend TV show
- Invite friends to watch the show you are watching

Functions
- View List of friends
- Select Friend to recommend the TV program you are watching

Link
- Show you are currently watching

Objects
- Friend's detail

View Recommendation
- Invitation from friend to watch the show they are watching

Functions
-confirm to switch the channel
-cancel

Link
-show you are currently watching

Objects
-Notification message

APPENDIX D: FIRST VERSION OF USER INTERFACE OF ELDERTV