

# The Role of Gerontechnology in Elderly Well-being

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Armoneam Tesfaye  
Senait Ewenetu

Lahti University of Applied Sciences  
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ABSTRACT

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Ageing population is becoming a major concern in many parts of the world. Advancements in medical science coupled with the declining rate of child birth is contributing to the growing number of elderly population in the developed world. However, ageing comes with different chronic illnesses, deteriorations of mental as well as physical abilities. These growing needs of care for the elderly put strain on the health care system which contributes to the declining quality of care for the elderly. Shortage of resources and personnel contributes to the marginalization and isolation of the elderly which leads to depression, low self-esteem and unhealthy well-being. Gerontechnology is playing a major role in helping with providing alternative ways and assistance in the field of elderly care. The purpose of this thesis project is to create awareness among nurses and healthcare professionals about the roles that technology is playing in maintaining elderly well-being as well as detailing currently available technologies in the field of Gerontechnology.

Relevant data was collected from MastoFinna, CINHALL, EBSCO, PubMed and Elsevier Science Direct. Final qualitative data analysis was performed on 13 carefully selected and studied articles. The study has shown that technology has various roles in the field of care for elderly wellbeing. These roles are telecare medicine, elderly safety, entertainment, independent living, different activities for elderly, increasing productivity and positive social wellbeing. The authors recommend future research to

include various database sources which were not accessible freely but could have contributed to find even more outcomes.

Keywords: Elderly, Well-being, Gerontechnology, Nursing, Elderly care

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Tesfaye, Armoneam; Ewenetu, Senait Vanhusten

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## TIIVISTELMÄ

Ikääntyvästä väestöstä on tulossa merkittävä huolenaihe monissa osissa maailmaa. Lääketieteen edistysaskeleet ja lapsen syntymän väheneminen edistävät kehittyneiden maiden ikääntyneen väestön kasvavaa määrää. Ikääntymiseen liittyy kuitenkin erilaisia kroonisia sairauksia, heikkenemistä henkisesti ja fyysisesti. Nämä ikääntyneiden hoidon kasvavat tarpeet asettavat terveydenhuoltojärjestelmälle räsitusta, mikä osaltaan heikentää iäkkäiden hoidon laatua. Resurssien ja henkilöstön puute edistää vanhusten syrjäytymistä ja eristäytymistä, mikä johtaa masennukseen, alhaiseen itsetuntoon ja hyvinvointiin. Geronteknology on tärkeä rooli mietittäessä vaihtoehtoisia tapoja ja avuntarvetta vanhustenhuollon alalla. Tämän opinnäytetyön tarkoituksena oli korostaa ikääntyvän väestön ja hyvinvoinnin haasteita, teknologian rooleja ikääntyvän hyvinvoinnin ylläpitämisessä sekä nykyisen teknologian alalla geronteknologian alalla.

Tärkeät tiedot kerättiin lähteistä MastoFinna, CINHALL, EBSCO, PubMed ja Elsevier Science Direct. Lopullinen laadullinen analyysi tehtiin 13 huolella valituista ja tutkituista artikkeleista. Tutkimus on osoittanut, että tekniikalla on erilaisia rooleja vanhusten hyvinvoinnin hoidossa. Nämä roolit ovat telekargialääketiede, vanhuksien turvallisuuden, viihteen, itsenäisen elämän, erilaiset aktiviteetit vanhuksille, tuottavuuden lisääminen ja myönteinen sosiaalinen hyvinvointi. Olisi suositeltavaa tutkimuksen kannalta sisällyttää mukaan erilaiset tietokannat, jotka eivät olleet vapaasti käytettävissä, mutta jotka olisivat voineet auttaa löytämään parempia tuloksia.

Asiasanat: vanhukset, Hyvinvointi, Geronteknology. Hoitotyö,  
Vanhustenhoito

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## **Abbreviations**

**ICT** - information communication technology

**RFID** - radio-frequency identification

**SAR** - Socially Assistive Robots

**IOM** - Institute of Medicine

## 1 INTRODUCTION

In our day to day life technology is playing a major role. From buying things to arranging events, technology is shaping our life differently from what it used to be twenty or thirty years ago. The nursing field is not immunized from this effect. Technology is dramatically changing the field of nursing from what it used to be forty or fifty years ago. From such inventions as tablet computers and mobile electronic charts, to radio-frequency identification (RFID)-enabled devices, the healthcare landscape is becoming more advanced and efficient, and the field of nursing has adapted along with these advances. Technology is benefiting nursing in promoting patient centered health care at a lower cost, in information storing and sharing, in educating of health care professionals as well as patients, reducing travel time and cost, providing easy access to health care professionals and many more. Nurses represent the largest health provider group of the healthcare workforce. The use of technology by nurses can have impacts on their practice and work life (Rouleau et al. 2017.).

The impact the world's ageing population will have on health and social systems globally is an increasing alarm. There is a definitive trend of growing of ageing population in the global scale because of medical advancement and increased life expectancy. (Moorin et al. 2014, 2.) With this problem comes a challenge of shortage of personnel in the nursing care field more importantly in elderly nursing care (Botis et al. 2008). Because of this challenge, technology is becoming more important in providing the necessary service in the elderly nursing care.

## 2 THEORETICAL BACKGROUND

### 2.1 Elderly well-being

Human well-being can be defined as the positive vision one can have about the life that they are leading. The importance of improvement and maintenance of the well-being of the elderly is becoming an important issue in today's western ageing society (Stephoe et al. 2015,641).

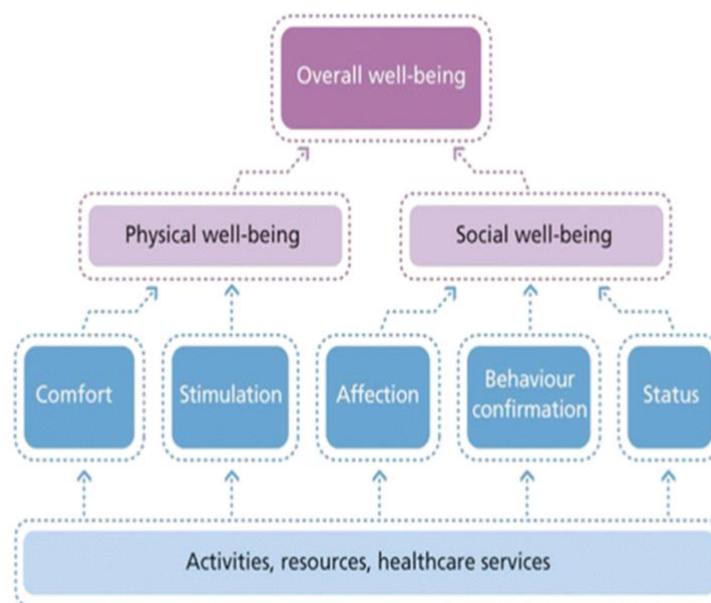


Figure 1. Hierarchy of well-being (Cramm & Nieboer 2016)

As figure 1 shows people take on diverse methodologies to get to a healthy well-being ultimately achieved through physical and social well-being. Physical well-being is accomplished through getting the necessary stimuli such as having exercise, different sensory stimuli and various mental motivations. On the other hand, social well-being is achieved by gaining satisfaction in social life criteria of society such as career goals, life goals, social support and family support. (Nieboer & Cramm 2015, 233-245.) The growing rate of elderly population is one of the most challenging aspect which plays a role in the field of elderly well-being. This rising

number affects the quality of care that elderly receive. Strong family ties affect physical and social well-being of an elderly by playing a positive role in providing emotional as well as physical support. There are some negative effects of being childless, widowed or unmarried elderly to their well-being (Williams et al. 2017,20-36.).

### 2.1.1 Ageing population

As the population of the world increases dramatically, it becomes essential to study the detail analysis of the demography change and the effects it brings (UN 2010,15-16). This information is necessary in formulating policy and programmes. Population ageing is the continuous way in which the proportion of the older generation is bigger or becoming bigger in the near future (UN 2015, 10). This process is being facilitated by demographic transition, in which the fertility of the older generation declines coupled with the decreasing rate of mortality plays a major role. Because of modern medicine and improved living condition, life expectancy has increased significantly in many parts of the world. All these factors play in to the fact that the number of people living well in to the later stages of their life to increase in many parts of the world (Harding & Gupta 2007).

Western Europe population is not immunised from this trend. By the year 2015, the proportion of the population of western Europe aged over 60 was 21%. However, this number is expected to grow to 33% by the year 2030. (Abdi et al 2018.) This alarming fact can be seen when analysing the number of people older than 60 globally in the year 2050, which will outnumber the number of the population under the age of 15 (Abdi et al. 2018). The number of over 60 age population, by 2050 will be 2.1 billion while this population was only 901 million in the year 2015 (Abdi et al 2018). This fact exacerbated by the shortage of care givers and social workers will put a big burden on health care systems and a negative effect on the well-being of the elderly (Andruszkiewicz & Fike 2015, 66). This trend is being amplified in the developed world by the accelerated rate of the ageing population compounded by low birth rate (Abdi et al. 2018).

This shift in society's demography will put more pressure on the health care system.

According to the Finnish National institute for Health and welfare (THL 2018), Finland has one of the oldest population in Europe because of high life expectancy, the age women decide to have their first baby has risen and low birth rate. Due to these factors the portion of people older than 65 years will rise from the current 20 percent to 26 percent by the year 2030 and this share will grow even bigger to 29 percent by the year 2060. This growth has prompted Finland into finding ways to support the need that will be created by the rising ageing population. Finding innovative solutions which are effective in supporting older people will significantly reduce the rising cost of social and health care costs in the future (THL 2018.)

## 2.2 Gerontechnology

The use and definition of the term technology is broad and changing from time to time. Simply technology can be defined as the application of a system and equipment which are the end results of knowledge and scientific experiments in solving real life problems. Technology is composed of two major parts. These are the physical component, which includes the tools and techniques and the information component that comprises the know-how and skill management (Wahab et al. 2012.).

Gerontechnology is a field of technology which comprises two professional fields mainly in gerontology and technology. In the past century, many scientists have dedicated resources and their time in tackling the issues of ageing and ageing society (Kwon 2016,5-10). However, most of the efforts were coming from the social and life sciences perspective. Even though there were efforts to integrate research results such as ergonomics in to the social life, the efforts were not effective enough. Earlier in the 1990s, the participation of technological sciences and designs in the field of

studies for the ageing population was meagre and not developed much. (Kwon 2016, 1-10.) In the year 1988, a small team of researchers from Holland were the pioneers in modern gerontechnology field by integrating engineering sciences with those scholars already involved in ageing sciences (Kwon 2016,5).

### 2.2.1 History of Gerontechnology

The evolution of gerontechnology started in the year 1984, by the visit of a social worker to the Eindhoven university of technology in suggesting for the fellow engineers to participate in coming up with solutions for challenges that are faced by the older generation. This led to the coining of the term “Gerontechnology” in the year 1988. (Graafmans & Brouwers 1989.) Even though there is still discussion from the linguistic and content point of view about the term gerontechnology, there are no other identifiers of the matter involved that can replace or better describe the field (Kwon 2016,5). The developments later led to the establishment of the first International Conference of gerontechnology chaired by Herman Bouma (Bouma & Graafmans 1992). The conference was regarded as successful and it gradually swayed many researchers in the field of technology, social and medical sciences fields to join in the field of gerontechnology (Kwon 2016,7). In the early 1990s, the establishment of the European network for COST A5 (Cooperation in Science and Technology: Ageing and Technology) led to vast political and scientific achievements. This success led to the founding of International Society for Gerontechnology (ISG) in 1997 under the leadership of Vappu Taipale who was also chair of COST A5, president of the Helsinki Conference, and first president of the ISG and the second international conference in Helsinki in 1996 (Graafmans et al. 1998). Gerontechnology has brought engineers, social workers, and many researchers from various fields to come and work together to solve challenges that the society faces from ageing related problems.

### 2.2.2 Gerontechnology today

Gerontechnology today brings together engineers and designers to come together and tackle challenges that require multidimensional aspects and needs of elderly to come up and produce solutions. According to Vichitvanichphong et al. (2018, 405-427) there are two ways Gerontechnology is playing a role in assisting the elderly, direct supportive and indirect empowering technological inventions.

The main purpose of direct supportive solutions is to help the elderly person to lead a normal life as much as possible. Achieving this helps the person to lead independent lifestyle which helps in maintaining a healthy well-being socially and physically. These technologies are aimed at helping the elderly in the day to day life. Currently these technological inventions include multipurpose robots, smart homes, remote cares and other supportive devices. (Vichitvanichphong et al. 2018, 405-427.) While in the other hand indirect supportive assistive solutions tend to focus on creating or controlling approach in assisting the elderly to manage their independent life style. These technologies focus on the fact that giving the direct assistance is not enough but also, it is important to teach and train elderly persons to improve their skills by using technologies such as social media and targeted games (Vichitvanichphong et al. 2018, 405-427).

### 3 THE AIM AND PURPOSE OF THE THESIS

#### 3.1 Aim and Purpose

Technology is being implemented in the field of elderly care for assisting family members and professional care givers but the full implementation is hindered because of many reasons, mainly because of lack of awareness (Kernisan 2016,92-93). The aim of this thesis is to create more awareness of how technology is contributing in different roles in the maintenance of elderly well-being and the current status of available technology in assisting the elderly well-being. The ultimate outcome of our thesis will be a descriptive literature review which will help in creating awareness to nursing students, health care professionals and future researchers on this subject.

The authors focused on elderly nursing care because we are living in an ageing community where the number of senior citizens is increasing and the demand and pressure on health care professionals is very high. To fulfil the demand of the health care service, technology implementation in elderly health care services is vital. It will help in minimizing the cost and inefficiency which will increase the quality of the service the elderly will receive.

#### 3.2 Research Questions

The research questions for this study are as follows:

- What is the role of gerontechnology in elderly well-being?
- What kind of gerontechnologies are available currently in assisting the elderly well-being?

## 4 METHODOLOGY

### 4.1 Descriptive Literature Review

In general, thesis work can be done based on practical experimentations and literatures reviews. Our thesis work is based on qualitative data analysis by evaluating up to date trust worthy articles and research results.

Descriptive literature review provides current information related to the research topic by evaluating currently available trusted and scientific based research. The main goal of this type of review is to gather up-to-date information about a specific topic and give the reader a comprehensive analysis of the available sources and data. Therefore, this type of review is suitable to examine state-of-art knowledge on the topic and present objective analysis. In addition, it can be used to critically summarize literature and draw conclusions out of it (Cronin et al. 2008, 39-40.).

For our thesis work, we have used descriptive literature review. Because of the implementation of this technique, we were enabled to come up with a summary and a conclusion which will answer the research question and accomplish the aim of the study.

### 4.2 Data Search and Collection

In this thesis, we have used academic search engines and database. The search engines Masto-Finna and Helka are used to get peer reviewed and full text articles related to our topic. These searching tools are reliable and provide us with international articles which are related to our topic. EBSCO and CINHALL research databases are also used as our source to get e-journals, e-books and discovery articles.

We have used several keywords to retrieve related research articles that are related to our thesis topic. These include words like \*elderly care\*, \*technology\*, \*elderly nursing care\*, \*smart home\*, \*gerontechnology\* to

search for the articles. We have used Boolean operators \* AND\* and \*OR\*. We have used \*AND\* operator to combine the key words such as \*elderly care\* AND \*technology\*, \*elderly nursing care\* AND \*home appliances\*, \*elderly\* AND \*technology\*. In addition, \*OR\* operator is also used to include either of the identified key. Using the key words and the Boolean operators, we have got several articles. We have chosen 13 articles that are closely related to our thesis topic. The chosen articles were published in the last ten years to find up to date and latest technologies applied in the elderly nursing care. Table 1 shows the key words and databases used in the data search process.

Table 1: Data search key words and results

Keywords	Database	Publication year	Results
Elderly care, technology, gerontechnology,	Masto-Finna	2008-2018	321
Elderly care, technology, gerontechnology,	CINHAL	2008-2018	20
Elderly care, technology, gerontechnology,	PubMed	2008-2018	15
Elderly care, technology, gerontechnology,	Elsevier Science Direct	2008-2018	4

#### 4.2.1 Criterias for Inclusion and Exclusion for Search Results

The search result came up with various articles which then must be selected up based on criteria to narrow down to the relevant articles.

Articles which fulfilled the inclusion criteria were selected for the study while others were excluded. Table 2 shows the criteria used to include and exclude the retrieved articles.

Table 2: Data inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Articles published between 2013-2018	Published before 2013
Free access of full text	Full text unavailable or paid access
Articles related to subject matter	Not relevant content to the study
English language publication	Language of publication not English
Peer reviewed articles	
Scientific and evidence-based research	

## 4.2.2 Flow Chart of Article Selection Procedure

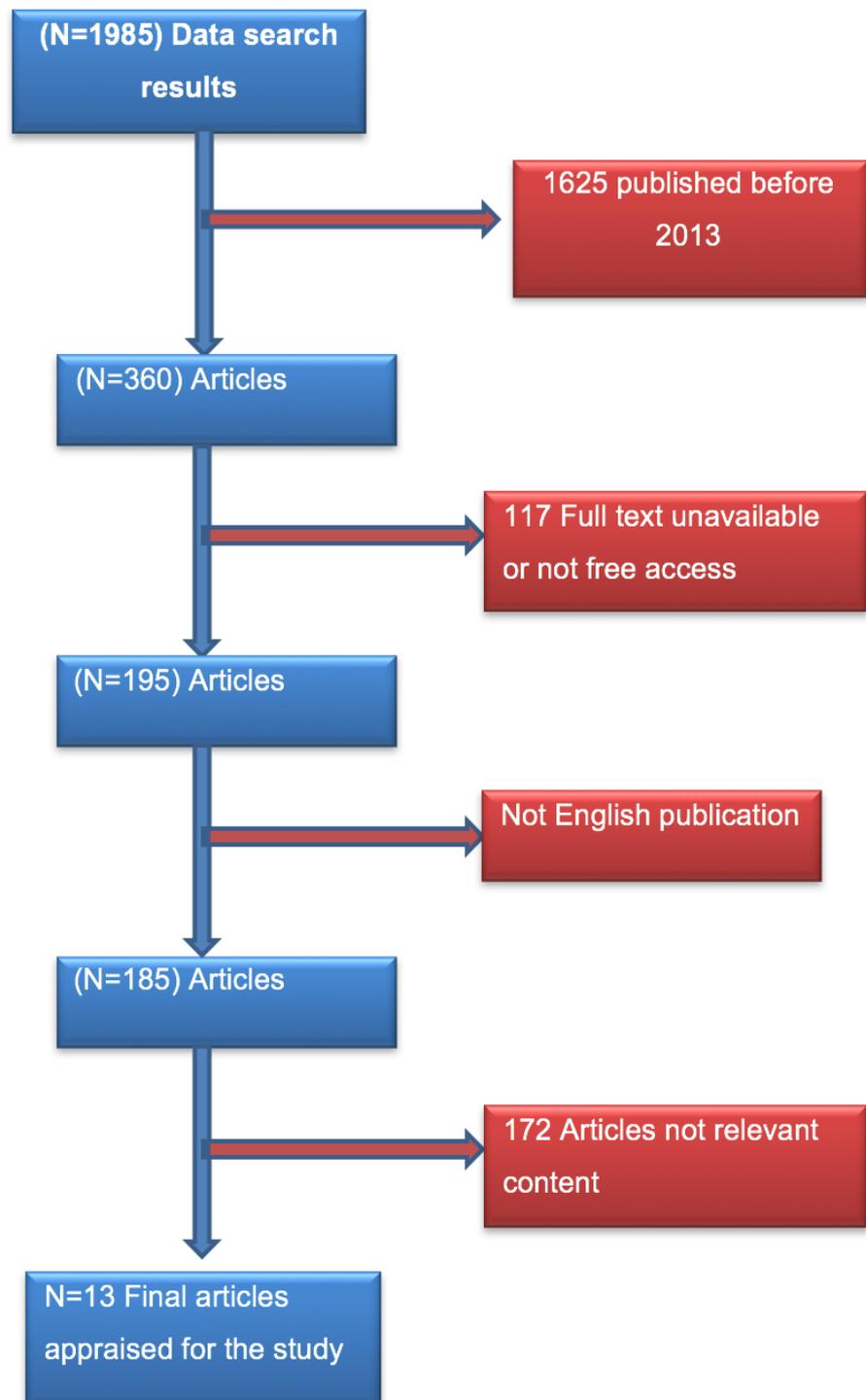


Figure 2: Flow chart representation of data selection process

## Articles used in the findings of the literature review

Table 3: Appraised articles

Authors, Journal, Year	Article	Aim of the research	Result
Helen Hasana and Henry Lingerb 2016 Educational Gerontology, VOL. 42	Enhancing the wellbeing of the elderly: Social use of digital technologies in aged care	To determine the role of ICT to improve the wellbeing of elderly and how it helps them to overcome isolation and loneliness by connecting them to family, friends and community.	Elderlies can enhance their wellbeing using ICT and keep themselves productive and connected to the rest of the society. Senior participants were able to extend their capability of using ICT to do interesting activities.
Toshiyo Tamura and Takumi Yosimura 2014 Advances in Science and Technology Vol. 96	Tools for the care of elderly people Applying information and communications technology to fall risk assessment	Application of technology in assessing and lowering fall injuries	Using an assistive device helps to improve the wellbeing of the elderlies. An airbag with motion detection belt monitor and record fall and reduces injuries of the subject from falling of the subjects.
Gyanendra Prasad Joshi,	Smart Solutions in Elderly Care	The use of RFID systems	RFID systems play a vital role in

<p>Srijana Acharya, Chang-Su Kim, Byung-Seo Kim, and Sung Won Kim.</p> <p>2014</p> <p>International Journal of Distributed Sensor Networks, Vol. 10 Issue 8.</p>	<p>Facilities with RFID System and Its Integration with Wireless Sensor Networks</p>	<p>integrated with wireless sensor networks in elderly care facilities and the opportunities, challenges and future of smart solutions</p>	<p>recording and tracking personal belongings, accessing relevant information, and managing daily lives of elderlies for example reminding their medicines on time. However, the study suggests RFID systems should be integrated with sensor networks to lower the limitations.</p>
<p>Abdi, J. Jordan Abdi, Ahmed Al-Hindawi, Tiffany Ng, Marcela P Vizcaychipi.</p> <p>2018</p> <p>BMJ Open, 8(2),</p>	<p>Scoping review on the use of socially assistive robot technology in elderly care.</p>	<p>The role of Socially assistive robot (SAR) technology for the elderly population care in future.</p>	<p>Socially assistive robots (SAR) show a potential use in the care of the elderlies in the future. The number of ageing population will double by 2050 and assistive robots plays a great role in in the following main aspects: affective therapy, cognitive training, social facilitator, companionship and physiological therapy</p>
<p>Maria Magdalena, Bujnowska-</p>	<p>Use of telemedicine-based care for</p>	<p>The implementation of telemedicine</p>	<p>Use of telemedicine is a developing</p>

<p>Fedak and Grata-Borkowska.</p> <p>2015.</p> <p>Smart Homecare Technology and Telehealth, 3, p. 91.</p>	<p>the ageing and elderly: Promises and pitfalls.</p>	<p>in elderly care and its obstacles</p>	<p>solution for the elderly care. With the developing technology telecare is a good way to deliver health care for old people who live in rural area and in places where finance is scarce giving equal chance for seniors. It also enables elderlies to live in their home instead of institutions and exercise their autonomy and privacy. The fact that elderlies are resistant to using new technology and learning the necessary skills are limitations for telemedicine.</p>
<p>Arif, M. J.</p> <p>2014.</p> <p>Technology and health care: official journal of the European Society for Engineering and Medicine, 22(5), p. 677.</p>	<p>A review on the technologies and services used in the self-management of health and independent living of elderly.</p>	<p>Re-evaluate existing solutions related to elderly assistance come up with alternative technology based solutions</p>	<p>Technology is advancing the quality of life and care measurements for elderly people. Independent living, home safety, telemedicine and many other advancements are accomplished by implementing these technologies.</p>

<p>Sandra A. Zwijsen, Alistair R. Niemeijer and Cees M.P.M. Hertogh</p> <p>2011.</p> <p>Ageing and Mental Health, 15(4), pp. 419-427.</p>	<p>Ethics of using assistive technology in the care for community-dwelling elderly people: An overview of the literature.</p>	<p>Ethical principles that should be considered in assistive technology (AT) in elderly with dementia who are living in the community</p>	<p>In the use of AT for the elderlies, ethical issues are not a priority. The research has divided the findings in to three main themes: personal living environment, the outside world and the design of AT devices.</p>
<p>Wang et al. Wang, Zhaochu Yang and Tao Dong</p> <p>2017.</p> <p>Sensors, 17(2), p. 341.</p>	<p>A Review of Wearable Technologies for Elderly Care that Can Accurately Track Indoor Position, Recognize Physical Activities and Monitor Vital Signs in Real Time.</p>	<p>Explore the current wearable technologies for elderlies</p>	<p>The usage of different technological innovations improves elderly care services. Wearables like RFID tag, smart clothes, human activity recognition(HAR), sensors and vital sign monitors have been put into use.</p>
<p>Vadillo, L.</p> <p>2017.</p> <p>Journal of Sensors.</p>	<p>A Smart Telecare System at Digital Home: Perceived Usefulness, Satisfaction, and Expectations for Healthcare Professionals.</p>	<p>Evaluation of current satisfaction and future anticipations of Telecare professionals on advanced Telecare solutions.</p>	<p>Professional's satisfaction is important factor in the implementation of current and future Telecare solutions.</p>

<p>Kernisan, L. 2016. Generations, 40(1), pp. 92-98.</p>	<p>Promises and Pitfalls: Technology and the Future of Delivering Eldercare.</p>	<p>Prospective use of technology in elderly population and the related obstacles.</p>	<p>Technology experts need to put their effort for the successful use of technology for the wellbeing of elderlies and the caregivers as well.</p>
<p>Andruszkiewicz G, Fike K. 2015, Generations, vol. 39, no. 4, pp. 64-68.</p>	<p>Emerging Technology Trends and Products: How Tech Innovations Are Easing the Burden of Family Caregiving</p>	<p>To inform families and care professionals about new technology solutions for care givers and seniors.</p>	<p>Gives information and guidance on tech innovations for family care givers and health care professionals. It deals with from trending technological inventions and products to how these technologies can be used in a positive manner to lessen the effects of the growing amount of problems that comes with the growing number of the older age population.</p>

<p>Marchibroda JM. 2015, Generations, 39, 1, pp. 52-55.</p>	<p>New Technologies Hold Great Promise for Allowing Older Adults to Age in Place</p>	<p>Exploring how current technologies are working and go through the barriers that limit the full application of technology in the wellbeing and care of elderlies.</p>	<p>The duration of staying in hospital is highly minimized by cardiac telemedicine. The cost of new technologies and refund inconvenience are obstacles that hinder development of the service.</p>
<p>Lea H et al. 2017  ROSE consortium</p>	<p>Robotics in Care Services: A Finnish Roadmap</p>	<p>Technology supporting ageing in place in Finland and abroad.</p>	<p>Application of technologies and robots support the daily activity of elderlies to improve their wellbeing. Robots play an important role in improving the health care service in Finland.</p>

### 4.3 Data analysis

After the relevant articles and research studies are selected the next process is data analysis. The authors have discussed two approaches namely deductive approach and inductive approach. Deductive approach of analyzing qualitative data results focuses on analyzing data based on a structure that is devised by the researcher. This is done by using research questions as a guide to categorize the available data. This is a quick and simple methodology to qualitative data analysis and very helpful when the researcher knows beforehand the expected data and outcome. However, Inductive data analysis is not based on a designed or determined framework. The inductive approach tends to be suitable for data analysis when the researcher does not have enough information about the fact of the data or the outcome from it. (Elo S. et al. 2014,1-10.) We have chosen to use a deductive data analysis method.

The data analysis is mainly focused on the 13 chosen articles which reflect data from different background and parts of the world. All articles were carefully studied and the needed data was extracted to get the best possible outcome. The data extraction was helped by our research questions to guide and get the right information.

## 5 THEORETICAL FRAMEWORK

The theoretical framework section of a research or a study is one of the main important features of a research which gives it the structure and reasoning behind the study, the use, the worth it gives and the problem statement (Grant & Osanloo 2014,14). It provides the anchoring foundation for the data analysis method implemented as well as the literature appraisal section.

The shortage of resources being accelerated by the rise of the population of the elderly is forcing society to consider effective and efficient ways to care for the elderly well-being. One of the main solutions to tackle this challenge is to explore the ways technology can play in this care giving roles. The 2008 IOM report about Retooling for An Ageing America, the institute has clearly declared and recognized the need to organize and develop the existing and future systems for the care of the already growing elderly citizens (IOM, 2008). It shows that the notion for the need is not a new phenomenon and technology has achieved many advancements since that time to help in the elderly care well-being (Kernisan 2016,93). One of the challenges in implementation of these technologies is to know what kind of effects they will have on the care system. Whether the implications it will have on the health care system and other contributing services that play role in maintaining healthy well-being in the elderly care system are positive and constructive. Human resource shortage is one of the main scarcities that affect the elderly care and to know how technology will help is very important information.

Earlier researchers have found out that it is very vital and immense task that we are facing in balancing the compassionate, time efficient and cost-efficient care for the elderly that can be sustainable. It is impossible to achieve without the help of technology and it is definite technology will change the future of elderly care, but how it will affect is going to totally depend on users, health care professionals and society at general. (Kernisan 2016,92-96.)

Andruszkiewicz & Fike (2015,67-68) have found out that many challenges are faced in the adoption of new technology such as awareness, acceptance and financial constraints. They have shown that integration of new and efficient technologies is affected to significant amount by the lack of the awareness about the available technologies and the roles technology plays in the care that they are providing.

Elderly citizens in many parts of the world from different background have the same preference to spend the later stage of their life in a familiar environment which plays major role in having a healthy well-being. The role of families in maintaining this differs from culture to culture. While the western culture promotes loose dependence of the elderly on their family while cultures such as from Africa and Asia show high interdependence of family and elderly family members. In these various environments, technology can play roles in assisting the elderly to maintain ageing at place. (Charness et al. 2016,233-242.)

Peek et al. (2016) states that while all stakeholders in the elderly care sector concur that the direction of technological developments and advancements, they have different point of view when it comes to implementations and type of technologies which can be deployed in this sector. All the perspectives however focus on customizing technologies according to the need of the elderly among the community while at the same time providing the assistance that is needed by the stakeholders to support the type of service which can be deployed on a large scale. This thesis focuses on finding out which roles of care can be served and assisted by technology and investigating currently available technology in the field of gerontechnology.

## 6 FINDINGS

As the population of the elderly increases, it creates more pressure on resources and the health care system while more and more elderly are ending up isolated (Hasan & Lingerb 2016,749). This shortage of resources and personnel forces elderly people to live for too long at home or moving to elderly caring facility in a community that they are not accustomed to (Wells & Herd 2013). Isolation or being marginalised because of shortage of resources leads to the decline of the healthy well-being of the elderly and ending up with depression and other severe problems (Hasan & Lingerb 2016,749-755). However, research has shown that a healthy well-being is positively supported when the individual is lively, functional, socially well connected and mentally satisfied (Taylor et al. 2014). The challenge becomes to take care of the elderly citizens in cost effective and efficient manner. Technology is playing a major role in meeting this demand. As it is difficult for the elderly to go out like they used to, participate in different activities and being functional, technology is providing an alternative way for the elderly to fulfil these activities and transform their life and well-being in a positive direction (Marchibroda 2015,52-55).

### 6.1 Role of Gerontechnology in Elderly Well-being

The role of gerontechnology in the elderly care field is being increased because of different factors such as increasing number of elderly are either familiar with technology or easily grasping its handling, shortage of personnel such as nurses and care givers, regulatory guide lines, the health care system changing direction towards the adoption of purchasing care packages instead of the traditional system and the easy access of technological equipment compared to earlier times (Marchibroda 2015,54).

The authors, after the careful study of the appraised articles, have come up with 7 different themes about the role that technology is playing in the care of the elderly. They have been outlined in this section.

### 6.1.1 Social Wellbeing

Elderly citizens face quite a lot of isolation and feeling of loneliness from staying at home alone or joining an elderly home care for a long time in a different community. This steals their sense of belonging to the community and has a negative impact on happy old age. As it is not easy for elderlies to go out and take part in community activities using information communication technology (ICT) helps them to maintain their social wellbeing and avoid isolation too. ICT can reconnect elderlies with their family, friends and the community enabling them to remain active part of the society and remain productive. Different online activities play a different role in the life of an elderly. For example, learning how to use computers gives feeling of success and makes them be able to use computers for different purposes. Elderlies can create and use email to reach friends and families or they can use browsers to surf the web which makes them get different information and enjoy their leisure time. ICT plays a great role for elderlies to be part of the modern world by using social medias and enrolling for online courses to get knowledge and new proficiencies developing themselves. (Hasan & Lingerb 2016,749-757.)

### 6.1.2 Productivity

The impact of technology on the productivity level of the elderly is dramatic (Hasan & Lingerb 2016, 750). There are many aspects of social life that can be participated by the elderly which will contribute in a good way to the society as well as the community that they live in. From the many ways that elderlies can benefit from the use of technology, examples include writing and publishing stories or sharing their experience online from the comfort of their home, participating in simple online projects that do not require high expertise, share their knowledge and experience without the hassle of traveling long distances. (Hasan & Lingerb 2016,756.) A healthy wellbeing is achieved when one feels important and satisfied by the role they have in the society and technology is playing a major role by

providing the platform where the elderly can contribute to the society that they live in and in turn helping to achieve a healthy well-being to the elderly.

### 6.1.3 Activities

According to the research performed by Hasan & Lingerb (2016) finding purposeful and meaningful activity leads to a healthy mental and social well-being. According to the research, activities such as researching family history online and creating family tree were among the most popular ones. The research shows us that when the person chooses what they want to do and are interested to do, this leads to a successful implementation of the technology involved. Technology in this instance is providing the purposeful thing to be performed and in doing so it is helping the healthy well-being of the elderly.

### 6.1.4 Independent Living

It does not matter what stage of life one is to want to be independent. Independence is one of the most important aspects of life that we develop through our entire life that is dear to us. When it comes to elderly people, independence becomes a major trait because many aspects of life are changing caused by old age. (Hasan & Lingerb 2016,749-757.) Technology is being used to help elderlies to maintain their independence as long as possible by increasing their self-reliance to do some activities like ordering groceries online, booking traveling tickets by themselves or by buying or selling things on the internet (Hasan et al. 2016). Currently there are many innovations that promote independent living of elderlies by assisting them in their daily routines like transportation, shopping and housekeeping.

Elderlies can do their grocery shopping online using an application on their smart phone and get home delivery. This gives independence for older adults who need assistance for mobility and saves the time they spend going to the shop and avoiding stressful shopping trips with few clicks. Regarding transportation, current innovations are making safe, cost-effective and modern transportations to be available. (Andruszkiewicz & Fike 2015,64-68.) Customers can request on their phone for an Uber ride or a wheelchair accessible car. Companies such as Google and Tesla are developing high-tech self-driving cars that maximize independence and mobility for older adults. Older people can order services online such as home cleaning, laundry, hire transportation, buy grocery, hire a home help, get home maintenance services such as plumbing. These technologies are not only giving self-sufficiency for elderlies but also easing the burden on the care giver and the health care system. (Andruszkiewicz & Fike 2015,64-68.)

#### 6.1.5 Entertainment

Technologies like SAR (Socially Assistive Robots) can play a great role for the wellbeing of elderlies by improving mood, lowering agitation and generating good emotions and feelings. A study made on 78 participants evaluated the use of SAR on the utilization of socially assistive robots in giving companionship and avoiding loneliness. (Abdi et al. 2018.) Doing small activities like playing games, watching television and being able to choose their favourite program by themselves gives them joy and a reason to look forward to the following days. After getting training how to take pictures and videos with their phones and computers, many older people enjoy taking pictures as their hobby. (Hasan & Lingerb 2016.)

#### 6.1.6 Safety

Limited movement during old age and loss of a good sense of smell can result in a higher risk of accidents associated with fire. In addition, falling is

also a major safety risk which needs to be addressed.

Recent technological advancements play an important role in managing falls. Among these technologies fall detection sensors work with integrated PtZ camera. When the sensor detects fall, the PtZ camera gets activated. In areas where the fall detection system is not working and the person is not able to trigger the emergency alarm, smart wearables equipped with different sensors can be utilized to detect fall.

Additionally, an emergency recognition system can be implemented to improve the safety of an elderly. This system with its installed sensors learns the routines of the person and gives a signal if it detects any unusual activity. (Arif et al. 2014,677-687.)

#### 6.1.7 Telecare

The benefit of telecare is immense when it comes to helping elderly patients in reducing the amount of unnecessary travel to the hospital and the time they spend in the hospital (Marchibroda 2015,52-55). It is an important need of the elderly to age in an environment that they are familiar with. It helps them to maintain a healthy and satisfying social well-being compared to when they are away at a hospital or nursing home (Hasan & Lingerb 2016). Technology has advanced in many ways that it is now possible to have technologies that provide information in self-diagnosis, technologies that can monitor vital signs and chronic conditions at home without the need to go to a hospital and technologies that provide access to the healthcare system and health care professionals remotely (Magdalena et al. 2015). However, all this freedom and convenience comes with its own risks and drawbacks involved such as privacy, ease of usability and cost issues remain main obstacles in adoption of telemedicine (Andruszkiewicz & Fike 2015,64-68).

## 6.2 Current Technology in Elderly Well-being Care

### 6.2.1 RFID and Sensor Technology

In ideal world, the elderly population would be healthy, active and able to participate in numerous daily activities without any danger or risk involved. However, the reality is that with old age comes vulnerability to declining physical and mental capacity (Tamura & Yosimura 2014,73-77.) One of the big risks associated with older age is the risk of falling. Latest RFID and sensor technologies are playing major roles in preventing and reducing the risk associated with falling (Joshi et al. 2014). Falls are one of the most common causes of injury that sends elderly patients to a hospital but the risk is not limited only to residential or public areas but also inside hospitals. For example, out of the 2829 patients who were reported to have injuries related to falling in Japan in the year 2011, 1911 accidents happened inside a hospital environment (Tamura & Yosimura 2014,73-77).

Current RFID and Sensor technologies deployed in the prevention and minimizing the risk of falling include bed sensors, pressure mat sensor, sensor pad connected to a monitoring system, air bag jacket, automatic beds that can lower to aid getting out of bed and nonslip shoes or stickers to reduce slip risks.



Figure 3 Air bag jacket before and after deployment (Tamura & Yosimura 2014).

With old age comes the declining ability to memorize things and the elderly are the main sufferers from it. RFID has been successful in implementation of a smart reminder system to help and ease their daily life (Joshi et al. 2014). For example, RFID system is implemented in a way that when an elderly is about to leave their home it will scan their tag and remind them if they forget what they need before they go out. A smart scheduling RFID system is used to remind the elderly to perform scheduled tasks or activities such as medication usage, turning off lights, locking doors and windows. When it is programmed it can also remind tasks such as writing a letter, sending an email, paying of bills or simply visiting the theatre or event place not to miss favourite activities. RFID has been also deployed in the telemedicine field by automatically delivering emergency actions in cases of chronic patients (Joshi et al. 2014.).

All this does not mean there are no challenges in the deployment of RFID and sensor technology equipment. Some of the challenges include electrical interference from spectrum congestion, lack of standard protocols, problems arising from range issue, cost of RFID infrastructure, security issues, privacy and legal issues (Joshi et al. 2014). Although these challenges are real, RFID and sensor technology provides simple solutions to help the elderly live independent and comfortable life.

### 6.2.2 Socially Assistive Robots (SAR)

The number of older population in the world is growing fast and it is estimated it will be doubled by the year 2050. This brings considerable load on the health care service system and shortage of staff. Implementing socially assistive robot technology (SAR) plays a great role in supporting the health and social care in meeting the required need. The robot industry is discovering socially assistive robots which can perform complex series of physical duties. In addition, these robots have features that can make the user take the robots as a companion for social interaction. Based on their function, SARs are divided in to two main categories, which

is service robots and companion robots. Service robots assist in the daily activities whereas, companion robots work to enhance the psychological and the overall wellbeing of its user. Scientific studies show that SAR assume different roles. Five of the roles of SARs were studied which are affective therapy, cognitive training, social facilitator, companionship and physiological therapy. (Abdi et al. 2018.).

SARs gives affective therapy by improving the behaviour, mood and overall wellbeing of an older person. A study done on elderlies with dementia showed the use of assistive robot helped them to bring a positive result by lowering agitation, depression and increasing quality of life. Robots can develop cognitive aspect of an older person by improving working memory and executive function. Utility of robots improves sociability of participants between each other in elderly home care or with the care givers or other people. It also has companionship role which lowers loneliness and social isolation of the elderly. (Abdi et al. 2018.).

In many European countries, it is older people's choice to age in their own place rather than join elderly home care. Similarly, in Finland seniors prefer to stay at their home as much as possible. Application and acceptance of assistive robots is moderate in Finland. Few Zora robots are introduced recently in elderly nursing homes. (Lea et al. 2017.).

Although the utility of SAR plays an important role in improving the life of the elderly, it also has its own drawbacks (Zwijssen 2011,419-427). Using assistive robots results in less contact of an older person with family and friends resulting in isolation and loneliness. The cost related to SAR technology is substantial to maintain and train the care giver and the user. In addition to the cost older people are not always welcoming towards technology. There is a need to work on improving the acceptance of robots and the positive impact on the life of an older person. (Kernisan 2016,92-97.)

### 6.2.3 Telemedicine

Telemedicine care is a technological system to provide remote health and social care to patients, specially to elderly patients so that they can be afforded with independence and autonomy in leading their life. With old age comes the increased demand for health care. The elderly are the ideal target group that telemedicine is designed for (Magdalena 2015,92).

Telemedicine combined with smart home technology helps older age people to lead their life in their own home or in a familiar environment. This helps and plays a major role in the healthy well-being of the elderly individual. Telemedicine provides a modern alternative to get diagnosis, treatment, guidance and information regarding to the patient's need not only for older age patients but also for patients who live in rural or remote parts of the world (Vadillo et al. 2017).

According to Valdillo et al. (2017) the main three sectors of telemedicine are

- Providing safety and security monitoring for example sensor technologies, fire and flooding detection.
- Monitoring of patient's vital signs and other aspects of health such as blood sugar, blood pressure, heart rate and body temperature.
- Guidance and support through internet and telephone to provide teleconsultations, reminders for doctor appointments, medication reminders and health information.

Telemedicine has various benefits targeted at the elderly, however there are also pitfalls to this technology such as older peoples' resistance to new technology, privacy and security, not enough training for old age people and health care professionals and the cost of infrastructure (Kernisan 2016,93).

## 6.2.4 Wearable Technologies

The cost for taking care of an older person in the daily activity is very expensive. Either the older person must join a nursing home or a personal nurse must be hired which is costly and it gives pressure for the family. Application of wearable technologies and sensors improved the care services and reduced the associated care cost encountered. It is highly predictable for elderlies to face health problems, falling accidents, and emergency situations. (Wang et al. 2017.) Falling is a common problem among elderlies during their daily activity and fall risk assessment needs to be done by applying information technology. Wearables and sensors record when and how an older person falls. Wearable airbag system is also used to prevent injuries from falling. (Tamura & Yosimura 2014,73-77.)

With the application of wearable technologies and a good monitoring alarm system can lower the adverse effect resulting from sudden illness and falling. (Wang et al. 2017).

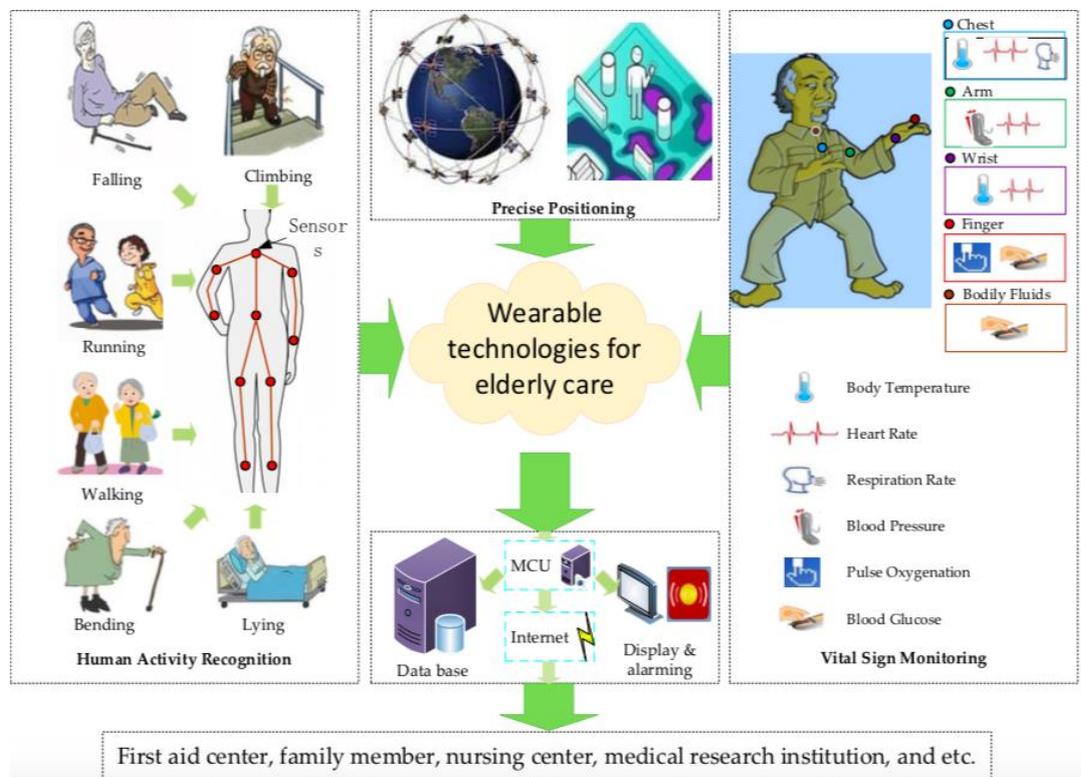


Figure 4: function of wearable technology (Wang et al. et al. 2017).

According to figure 4 (Wang et al. 2017) wearable technologies are generally divided in to three major groups:

- Indoor positioning system that functions by constantly spotting the location of an older person. It detects and tracks objects assisting an older or a disabled person in the normal routines.
- Activity recognition: Sensors are located on wearable devices that can monitor the normal activities like walking, sleeping, jogging, climbing stairs, biking, doing physical exercise and in cases of abnormal situations like vomiting, falling accidentally, chest pain or fainting.
- Vital sign monitoring: non-invasive sensors are designed to function in recording the vital signs constantly and checking health in real time. Elderlies are prone to age associated problems such as diabetes, coronary heart disease, hypertension, hyperlipidaemia and measuring the vital signs continuously helps to monitor the basic health status of the person.

## 7 DISCUSSION

### 7.1 Discussion of Findings

This study has come up with significant amount of information about current technologies and the role they play in the care of elderly well-being. Old age wellbeing is affected by factors such as declining physical ability, declining mental health, side effects of chronic illnesses, social isolation or marginalisation (Magdalena et al. 2015,93). Currently available technologies and developing solutions are exploring the vast territory of the new tech-enabled care support for the elderly well-being (Andruszkiewicz & Fike 2015,65).

The study has brought up findings from the selected and appraised articles and identified 7 themes in what kind of roles technology is being implemented and 4 themes to classify the up-to-date status and available technology in the field of gerontechnology. The challenge of improving and meeting the demand of elderly citizens in a community is a major one and growing by the going years (Hasan & Lingerb 2016). The role of technology section has detailed findings regarding the various functionalities of technology regarding the field of gerontechnology in addressing this demands and gap in the social service. However, all the benefits of technology do not come without downsides. These downsides give many reasons to be cautious. Theses downsides felt especially by health care workers or care givers include the feeling of health care workers feeling that their work is tiring and slow, not having enough time to manage the technology and spend enough time with the elderly patient, not having adequate training to use new technologies, concerns regarding privacy of the client or the patient and data security. (Kernisan 2016,92-98.)

The following table and figure are used to summarize the findings of this study.

Table 4: Summary of current technology

Technology	Use of the technology	Drawbacks
RFID and Sensors	<ul style="list-style-type: none"> <li>• Fall detection</li> <li>• Sensor alarms</li> <li>• Reminders</li> <li>• Security</li> </ul>	<ul style="list-style-type: none"> <li>• Cost</li> <li>• Data security and privacy</li> <li>• Functional range</li> </ul>
Socially Assistive Robots (SAR)	<ul style="list-style-type: none"> <li>• Affective therapy</li> <li>• Companionship</li> <li>• Physiological therapy</li> </ul>	<ul style="list-style-type: none"> <li>• Decreased human contact</li> <li>• Cost</li> <li>• Resistance to acceptance</li> </ul>
Telemedicine	<ul style="list-style-type: none"> <li>• Remote medical care</li> <li>• Remote guidance and support</li> <li>• Increase self-reliance</li> </ul>	<ul style="list-style-type: none"> <li>• Cost of infrastructure</li> <li>• Risk of increased isolation</li> <li>• Data security and privacy issues</li> </ul>
Wearable Technology	<ul style="list-style-type: none"> <li>• GPS tracking</li> <li>• Activity recognition</li> <li>• Vital sign monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of knowledge</li> <li>• Resistance to use new technology</li> <li>• Malfunctions</li> </ul>

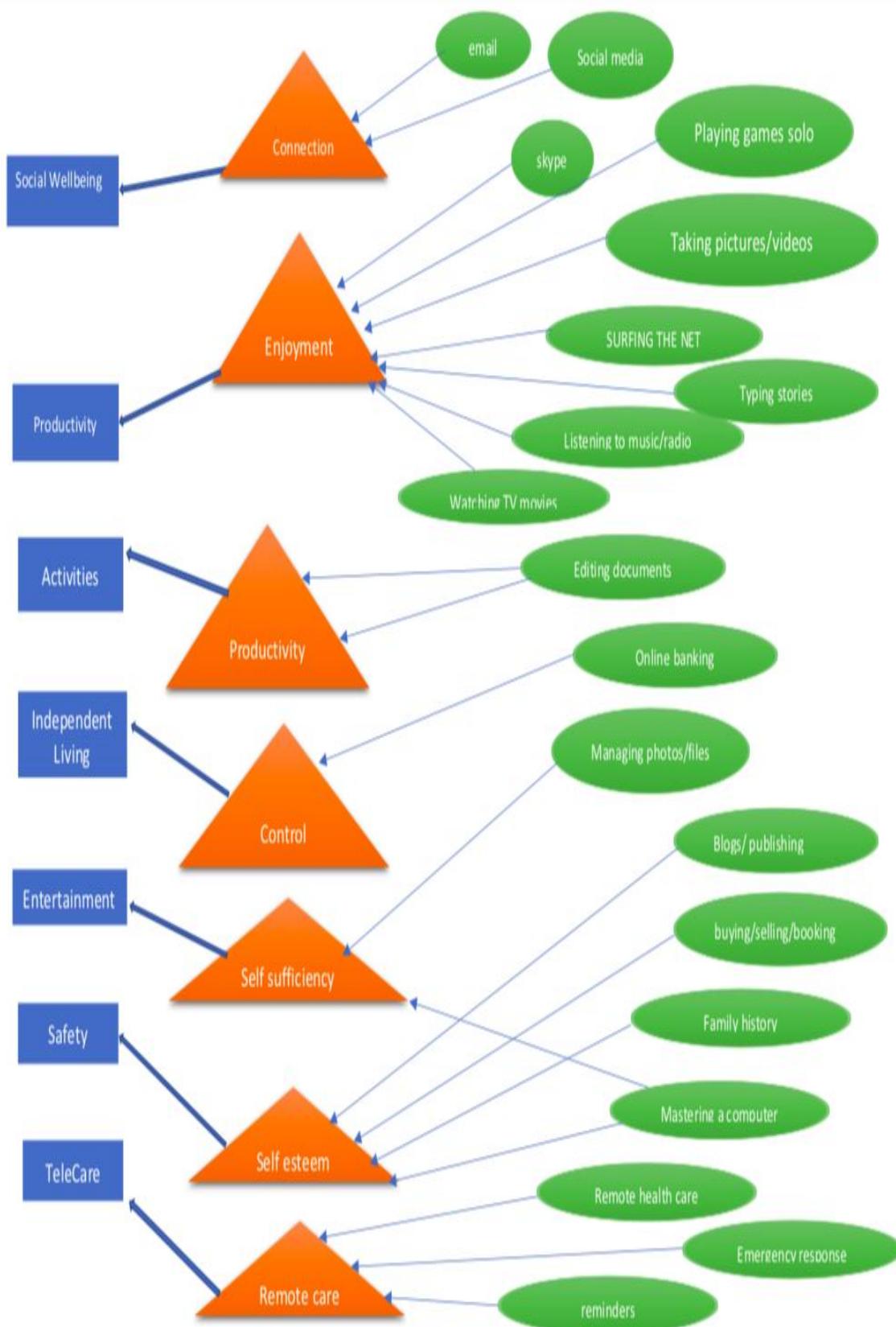


Figure 5: Summary of role of technology in elderly well-being. (Adapted from Hasan & Lingerb 2016)

## 7.2 Validity and Reliability

Reliability and validity of a research or a study is important aspect of any outcome of the study. Validity deals with the relevance of the data that was used, the tools utilised and the procedures that were followed during the research (Leung 2015). It is also important to note that the research question is appropriate and consistent with the desired outcome, the selection and the appraisal of selected articles is appropriate and importantly the results and the conclusions of the study are effective and coherent. (Leung 2015,324.)

The reliability of the study refers to the fact the processes and the outcomes of the study can be reproduced (Carcary 2009,11-24). With the challenges that come with evaluation of qualitative researches outcomes compared to quantitative research outcomes, consistence and ability to be replicability of research outcomes are important attributes of any qualitative research (Leung 2015,324-327).

During this study, the authors have used the latest and trustworthy sources from academic databases which have been peer reviewed and analysed so that they are considered as trust worthy and reliable sources. Relevant data was collected by using exclusion criteria and research questions as a guide. Because of this process the validity of this research is concrete.

The data extraction and the outcome of our study can be reproduced because of our use of reliable source databases and scientific based research. The selected articles were scrutinized to come up with the finest possible data material leading to consistent and reliable outcome.

### 7.3 Ethical Considerations

During the study and researching of this work, evidence based and scientific research books, articles and publications were used as source materials. It is the authors responsibility to reveal and tell the truth about the research and nonexistence of any dishonesty (Doody & Noonan 2016,805). All efforts have been put into finding a reliable, trustworthy and evidence backed source material, it was also important to make sure that the source materials are relevant and related to the research questions. The authors have made maximum effort in to maintaining the originality of the findings at the same time avoiding plagiarism, fabrication of wrong information and giving a balanced information to the reader.

### 7.4 Limitations and Recommendations

The study was focused on the identification of the roles that the technology plays in the field of elderly care as well as the current available technologies in the field. The study does not cover the general impact of technology in the field of nursing or medicine. The study is focused on shining the light from the technological benefit and latest status of technology in elderly caring (Gerontechnology) point of view rather than focusing on the user point of view in identifying the positive and the negative experiences.

The articles that were appraised for the study were limited to only the ones which were written in English and freely accessible. This will limit the study by not including all the paid access articles and studies. However, the study gives a detailed account information and knowledge on the subject matter and research questions.

In the future research can be performed by taking into account patient experience and point of view. Old peoples' first-hand experience and feelings can be invaluable for the future development of assistive technology. Gerontechnology has bright future in helping and easing the

burden of nurses and care givers and it should be focused on old peoples' or a patient centred approach.

## 8 CONCLUSIONS

Old age is changing the composition of our society and will continue to affect it significantly. It is creating a burden on the social health care system and care givers in general. With the growing number of old age population outpacing the ability of the care system network to handle the challenge, cracks are appearing on the healthcare system and this is affecting the wellbeing of the elderly. Scarce resources mean that the elderly population is not getting adequate care, leading to isolation and marginalization from society. Gerontechnology is playing a major role in tackling this issue and filling the gap in providing the assistance and the care needed for the elderly to continue independent life and healthy well-being.

Even though it is important to encourage health care professionals and the community in general to promote the adoption of gerontechnology, it is also important to pay attention to the barriers which will affect the adoption of gerontechnology. It is vital to have a systematic approach which will balance in finding and researching the barriers as well as working to have a solution which will eliminate or reduce the barriers. These barriers differ in variety such as security and privacy issues which come with the use of technologies to usability and easy functioning of inventions, cost of new technologies and the infrastructure needed, the stigma of using assistive devices, lack of the proper training to health care professionals or users and care givers, fear of being dependent on assistive devices and lack of awareness of the technology that exists.

Having a society which is well informed about the reality of challenges in elderly care and the affliction which it will bring on the already strained health care system, the scarcity of resources and shortage of health care workers is vital in having a progressive society.

In conclusion, gerontechnology is aiding in various aspects and improving the well-being of the elderly in aspects such as improving social wellbeing, increasing productivity, providing alternative means of various activities, providing entertainment, improving safety and remote health care assistance so that the elderly person can enjoy their independent life as far as possible. In addition, these roles of technology are helping the health care system in providing safe and effective well-being environment for the elderly, helping with issues of shortage of personnel providing efficient and quality service.

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