Exploring How Technology Supports Health in Old Age

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The purpose of this literature review is to identify the ways technology is being used in the health maintenance and health promotion of elderly people. The research questions used to guide this investigation were; (i) What are the available modern technologies currently used in elder care? And (ii) How are these technologies incorporated into elder care? Dorothea Orem's Self- Care Nursing model was used as a theoretical framework. The methodological approach was a literature review with 30 articles. We used Graneheim & lundman structure when finding meaning and this was qualitative. Findings show that technologies can be used as a powerful tool in promoting the quality of life of the elderly. It also shows that technological innovation reduces health care cost and reduces the burden of health care providers. Nevertheless, for these technologies to realize its full potential, the benefits of technological innovation should be marketed more in order to increase awareness about its effect not only to the elderly but to the health care system as well. There are three authors for this study which allowed better understanding and more insights of the articles being analyzed and studied. This effort was connected with the TyöPeda research and development project sponsored through the Ministry of Education and Culture, in the country of Finland.

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1 INTRODUCTION

As the world's population increases and continues to age so are technological advancements rapidly developing as experts keep pace to find solutions to the gaps for better quality of life. According to the United Nations, by 2050 it is anticipated that globally the number of elderly people will more than double what they are today, increasing to 2 billion people (United Nations, 2013). The population 75 years of age and over is projected to increase four times faster than the population of persons under age 65, leading to upward pressure on expenditure growth. In Finland, there were over 1.1 million people in 2015 older than 65 years, which was the sixth biggest share among the EU countries (SVT, 2015 a). There will be 1.5 million people or every fourth of the Finns, over 65 years old by the year 2030 (Ajankohtaista ikäänty-nei-den, 2016). About 400, 000 of Finns however are living alone (Statistics Finland, 2016). In Japan, elderly people aged 65 or older constituted 25% of the total population in 2013. Moreover, 18.5% of the Finnish population was over the age of 65 in 2012 (Miwa, et.al. 2017).

The purpose of the study is to identify the ways technology is being used in the health maintenance and health promotion for better quality of life for the elderly people. The authors searched for evidence that technology indeed promotes elderly health holistically from physical, psychological, cognitive to sociological aspect. In the background chapter, we did this by introducing the concepts of health and aging as inevitable processes in human life, where the changes accompanied with it need to be managed. We accomplish this by diving into the concept of health, specifically elderly health, and list ways on how to promote it holistically. Another major subtopic we focused on is the idea of technology, its continuous advancements and how is it being incorporated in elder care as well as its impact on the tasks and roles of health care professionals. Under this topic we offer types of assistive devices categorized according to their main function. Lastly, we merged the concepts of health, aging and technology and their correlation as tools and processes for the promotion of quality of life of the elderly population. In chapter three

we bring in the theoretical framework chosen for this thesis, which is the self-care deficit theory or Orem's model of nursing developed by Dorothea Orem. In chapter four the choice of methodology along with the data collection and depiction of analysis are brought forward followed by the results chapter. The discussion and conclusions sections comprise the final effort.

2 BACKGROUND

In this section of our thesis, we first discuss the overarching theme of health. Then we bring forward the process of aging and combine these themes in a section on healthy aging. We explain the concept of health and enumerated ways on how to effectuate, taking into consideration, the special needs of the elderly holistically. The next main topic we bring forward is the idea of technology and list some of the innovations used by elderly persons to enhance their quality of life. Finally, the themes of health, aging and technology are discussed in combination. Statistics are threaded throughout this chapter to provide a holistic picture of our thesis topic.

2.1 The Fundamentals of Health and Wellbeing

The word “health” comes from the old English word for heal (hael) which means “whole”, concerning the whole person and the integrity, soundness of that person. (Naidoo & Wills, 2003) In 1946 the World Health Organization originally regarded health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Wellbeing consists, not only the physical aspect but also psychological and social ones (Earle et al. 2007). The Merriam Webster dictionary concluded that health is the level of functional and metabolic efficiency of living being. In addition, it explains that in humans, it is the general condition of a person's mind and body, usually means to be free from illness, injury or pains. (Merriam Webster dictionary)

In 1986 the World Health Organization stressed health as a resource for everyday living by stating that “to reach a state of complete physical, mental and social wellbeing, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. However, Walker and John (2012) refer back to the ancient Greeks, who defined health (Hygeia) and well-being (eudaimonia/happiness) differently. Health is linked to well-being but tends to have a disease focus, while well-being includes the special determinants of health. Well-being can be measured, both subjectively and objectively, thus, could be used to evaluate the impact

of policies and health promotion programs (Walker and John, 2012). Aging is a gradual, continuous process of natural change that begins in early adulthood. During early middle age, many bodily functions begin to gradually decline. The body changes with aging because changes occur in individual cells and in whole organs. These changes result in changes in function and in appearance. (Richard W. Besdine, MD, Merck Manual Consumer version)

2.2 The Aging Process

Most people can expect to live into their sixties and beyond. Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%. By 2020, the number of people aged 60 years and older will outnumber children younger than five years (WHO, 2018). The remarkable improvements in life expectancy over the past century ranks as one of society's greatest achievements. Even elderly people who were once considered to have a very high mortality risk now seem to be surviving longer (Crimmins & Saito, 2000; Rosén & Haglund, 2005). Although, most babies born in 1900 did not live past age 50, life expectancy at birth now exceeds 83 years. Finland with its life expectancy of 77 years for male and 83 years for females ranked 21st and is one of the highest life age expectancy among other European Union's countries (WHO, 2018).

Aging is having freedom, wisdom, and enjoyment (Carlsen, 1991; Rowe & Kahn, 1998; Coleman, Ivani-Chalian, & Robinson, 1998). The WHO constitution affirms that the enjoyment of the highest attainable standard of health is a fundamental human right (preamble). Every human being of every age, including the aged people should have access to proper physical and social health care (WHO 2012). The rising proportion of older people is placing upward pressure on overall health care spending in the developed world, although other factors such as income growth and advances in the technological capabilities of medicine generally play a much larger role. (NIH, NIA and WHO October 2011).

2.2.1 Gerontology and mapping out the needs of the elderly

Gerontology is the study of old age and ageing (Stuart-Hamilton, 2011) and is defined as the study of the social, psychological, biological, and cognitive aspects of individuals as they grow from middle age through old age (AGHE 2016). According to the World Health Organization, most developed countries have accepted the chronological age of 65 years as a definition of 'elderly' or older person. However, in many parts of the developing world, chronological time has little or no importance in the meaning of old age (Gorman, 2000). UN stated cutoff is 60+ years to refer to the older or elderly persons. Within the elderly population, further classification like the oldest old (normally those 80+), and centenarian (100+) and even super-centenarian (110+) are also made (WHO, 2019)

Although, everyone has an intuitive sense of what old age and ageing are, providing an objective definition is surprisingly difficult. Ageing is more sensibly described as a change within old age or change that affects older people. (An Introduction to Gerontology by Ian Stuart-Hamilton, 2011). It is often associated with the age at which one can begin to receive pension benefits (WH0, 2019). As aging accompanies physical, emotional and cognitive changes so as their needs on these aspects become extensive. There are numerous approaches in promoting and maintaining or even enhancing the health of older people. We listed some common and feasible ways of executing it.

With regards to their physical aspect, healthy diet comes first. Nutritional needs can become more difficult to meet because of physiological, psychological and social changes associated with ageing that affect food and nutritional intake and body weight. This means older people are at an increased risk of malnutrition. (Nicola Davies, 2011). Encouraging older adults to prepare meals can increase their appetite and food intake, and providing opportunities for older adults to eat a wide variety of foods, in company, is a simple strategy to increase food intake (Miriam Clegg and Elizabeth Williams, 2018) Vitamins D and B12 are particularly vital for the older person and should ideally be promoted by nurses carrying out nutritional assessments (Nicola Davies, 2011).

Leisure-time physical activity (LTPA) and commuting physical activity are important aspects for cardiovascular disease prevention and reduced mortality risk (Philipe de Souto Barreto, et. Al, 2018). Physical Activity targets for older adults include balance and strength. Many older adults do not meet PA guidelines, therefore, emphasis on alternative behaviors, such as reducing sedentary behavior, may be more feasible. As years increase the older person experiences many physical changes that hinder to fully participate his/her surroundings. The changes are often more physical than psychological in nature. Such changes include hearing loss, visual impairment, speech disorder and muscle weakness. In addition, the elderly may also experience some psycho-social changes, confusion, isolation and loneliness, bereavement and memory loss, this being one of the biggest mental problems affecting the older people (Rowland 2009; McMahon & Isaacs 1997).

Mental and Cognitive aspect of the elderly is also included when considering holistic wellbeing. Elderly people are – for example – more likely to suffer from loneliness and social isolation. Health promotion strategies for the elderly generally have three basic aims: maintaining and increasing functional capacity, maintaining or improving self-care, and stimulating one's social network (Stanislawa Golinowska et.al, 2016). Cognitive training is based on the idea that the brain, even in old age, can change for the better. It uses guided practice of a set of tasks related to memory, attention, or other brain functions. It can be conducted on the computer or delivered in person, either individually or in small groups; however, it typically involves using repetitive exercises designed to improve single (e.g., memory) or multiple (e.g., memory and reasoning) cognitive abilities (Alexandra Kueider, et. Al, 2014)

2.2.2 Supporting the Health of Elderly People

One WHO expert unanimously stated that the importance of a healthy lifestyle at every stage of life using health promotion measures is essential. Evidence has shown that exercising, quitting smoking and limiting alcohol consumption, participating in learning activities and integrating in the community can help to inhibit the development of many diseases and prevent the loss of functional capacity, thus improving quality of life and lengthening life expectancy (Stanislawa Golinowska et.al, 2016).

In order to promote health and well-being for a better quality of life for the elderly people throughout the world, WHO launched a new health and ageing program aiming at the importance of lifestyle factors, healthy ageing through a combination of training, advocacy and research. WHO (2002) Active ageing allows the ageing elderly to realize their potential for physical, social, and mental well-being throughout the life course in order to participate in society, while providing them with adequate protection, security and care in time of need (WHO 2002). As individuals live longer, health promotion behaviors become even more important, particularly with regards to maintaining functional independence and improving quality of life (Tai Wha Lee, et. Al, 2006). Health promotion aims to reduce differences in health status and ensure equal opportunities to enable people to achieve their full health potential. Health promoters should work to increase knowledge and understanding, and individual coping strategies. Enablement requires health promoters to act as a catalyst and then stand aside, giving control to the community. (Naidoo & Wills, 2003)

2.3 Technology and Caring for the Elderly

Technology, in its most general sense, refers to some sort of practical application of basic knowledge. It usually serves to extend our capacities or capabilities over space or time and increases our efficiency in carrying out various tasks (Furphy, 2016). Continuous technological developments in health care have saved countless lives and improved the quality of life for even more. Not only has technology changed experiences for patients and their families, but it had a huge impact on medical processes and the practices of healthcare professionals (Bianca Banova 2018). In Japan, a series of policies promoting information communication technology development for welfare have been issued and practiced since the 90's (Obi et al. 2013). According to Obi et al. (2013), there have been five major technology categories which industries and researchers work for in Japan: health, safety, independence (in living), mobility and (social) participation. A Japanese-Finnish collaborative project "Meaningful Technology for Seniors: Safety, Comfort and Joy (METESE) -Models of Digital and Human Networks" was launched in 2015. This project aims at developing an integrative approach to develop, implement and evaluate

meaningful technologies for the elderly, based on the understanding of care service systems in both countries (Kentaro Watanabe et.al, 2016).

Older people should be supported in managing basic routines in their daily life independently (Ahanathapillai et al., 2015). The variety and availability of technologies in supportive living environments show encouraging developments for people with disabilities to live independently and participate in daily activities (Agree & Freedman, 2011). The type of care demanded vary from support for basic activities to medical services such as wound dressing, pain management, medication, health monitoring, prevention, rehabilitation or services of palliative care (Fujisawa & Colombo, 2009). Given the fact that 89% of the older adults prefer to stay in the comfort of their own homes, and given the costs of nursing home care (CDC, 2007), it is imperative to develop technologies that help older adults to age in place and to allow them to participate more fully in all aspects of life. (Sinclair D. Et al, 2008) This can be done by supporting each individual in managing basic routines in their daily life (Ahanathapillai et al., 2015).

A term called Gerontechnology uses a combination of gerontology and technology in designing different technologies (example, smart home) and environment for the elderly people. These promote independent living and social participation to maintain quality of health, comfort and safety (Graafmans, et. al. 1998 p. 27). It refers to the study of the complex relationship of the biopsychosocial aspects of human aging and multiple forms of technology, primarily information/communication technology (computers and mobile devices), assistive devices, medical devices, and home modifications. Moreover, it refers to the application of study in the development and deployment of technological tools that assist with meeting the needs and fulfilling the wishes of older adults, and providing enhanced life satisfaction, through support for aging. (Furphy, 2016)

About 20% of people over seventy years of age and 50% of the people over 85 years, usually report difficulties in doing their activities of daily living. About 20.3 % in the age group of 65-74 years old in Finland, in 2018, reported severe limitation in activities of daily living (Johansson, 2010). This means, there is a mobility reduction; muscles weaken which affects standing and balance affecting their cognitive performance (Oshiro

et.al, 2008) For that reason, adoption of information and telecommunication technologies in the elderly sector to enhance service delivery has been considered. These systems and communications have ensured easier connections offering enhanced services to the elderly in the nursing home and hospitals (Central Intelligence Agency, 2012).

2.3.1 Types of assistive devices for the elderly

According to Reisinger & Ripat (2014), assistive technology refers to equipment and services that support and maintain the declined physical and cognitive functions due to age and disability. Assistive technology has been found to be one of the most important factors in supporting activities and participation of individuals with disabilities (Borg, Lindström, & Larsson, 2009). Some studies indicate that assistive technologies may deliver valuable remote services to people with special needs that will support the management of their everyday life. This technology opens the possibility for implementation of specialized services such as assistance for daily activities, health monitoring and emergency systems (Kleinberger et. Al, 2007).

Technology also has the potential to assist in monitoring and maintaining health as well as managing health conditions and diseases. Older adults may particularly benefit from using health technologies given that the likelihood of having a disability or health condition increases with age. Furthermore, technology has the potential to reduce medication and illness mismanagement, which could significantly impact society as a whole. Costs due to medication mismanagement alone for people 65 and older in the U.S. were estimated to be $887 million in 2005 (Field, Gilman, Subramanian, Fuller, Bates, & Gurwitz, 2005). Technological interventions that defray these costs could dramatically lessen the burden on the healthcare system (Mitzner et.al 2011).

The use of technology has been adopted with regards to treating the ageing population because the number of nurses has not risen to meet the demand of an increasing elderly population. Therefore, technology integration is important and useful tool in providing care to the elderly patients. (Kelley et al. 2011) There has been some studies done with

regard to the use of assistive technology for older people; however, awareness is limited about the diversity and effectiveness of assistive technology. (Khosravi & Ghapanchi, 2015). Some of the ways through which technology has influenced health is social inclusion and improved professional participation that supports independent living (Sinclair D. Et al, 2008, pp. 3). Finnish and international studies states that elder people often need help with washing and bathing, doing household chores, banking and shopping, carrying a load. About 40-50% of Finnish clients need company in walking outdoors and stairs (Hammar, 2018), some elder Finns requires help with dealing with paperwork like keeping track of financial matters and social benefits (Boerner et.al, 2016).

With this improvement, comes a challenge of shortage of personnel in the nursing care field more importantly in elderly nursing care (Botis et al. 2008). The shortage of caregivers and social workers puts a big burden on health care systems and impose a negative effect on the well-being of the elderly (Andruszkiewicz & Fike 2015, 66) this being the case, repeated studies have indicated about the contribution of technology to elderly care in institutions and at home as most of the developed world want to promote elderly people living independently at home as long as possible. Therefore, assistive technology is believed to contribute a lot in enhancing the self-care ability of elderly and eases the workload of nurses. The use of safety alarms, smart sensors and remotely monitored devices to increase the safety and security of elderly people living at home have been already implemented in European countries (Molin et al 2007 & Kachouie et al 2014).

Listed below are some assistive technology devices that are currently in use. First, there is the smart homes and telehealth services. The term smart home refers to a home equipped with technology that enables the elderly people to promote independence, enhance functional health, security, safety and increase quality of life of older adults (Graafmans, et. al. 1998 p. 27). Smart homes are equipped with automated systems for different tasks such as lighting, fall detection, kitchen safety, door switches, movement sensors, individual tracking badges, reminder system and personal household assistant (Morris et al. 2013). The next is telemedicine and telehealth services. Through these, there are exchanges of health information between a client and a health care provider using technology. It aids the health care service providers' ability to monitor the health of the elderly

living at home and helps healthcare practitioners in managing their time more effectively by reducing the need for actual home visits. Moreover, it can minimize inconvenience from frequent trips to the health care centers, which is particularly useful in rural areas, (Paul & McDaniel, 2016).

Assistive robotics are the newest of the technologies that can be used to assist older adults with control over items in their environment and with completion of activities of daily living. (ADLs). (Edwards K. & McCluskey A, 2010). In addition, it has become an important research and development target to provide an effective solution for sustainable elder care (The Headquarters for Japan's Economic Revitalization 2015). The development of 8 key areas has been developed that support older people. There are, wearable transfer aids, non-wearable transfer aids, outdoor mobility aids, indoor mobility aids, toileting aids, bathing aids, monitoring systems for nursing care homes and monitoring systems for private homes (Marketta Niemellä et.al 2016). Using therapeutic robots in health care for elderly people, according to conducted studies has indicated the effectiveness of this method to improve moods and depression, encourage communication, decrease stress level and physiological improvement. (Shibada & Wada, 2011). In Finland, the Ministry of Social Affairs and Health published quality recommendations for ensuring good ageing and services in 2017-2019, in which using technology is raised as one recommendation in parallel to e.g. developing housing services. In particular, the document mentions robotics and automation as an enabler for new services for elderly people, in order to support autonomy and independency for older persons, improve services and develop care work (Niemelä and Watanabe, 2018).

Specific robotics have been used with specific categorization based on their functionality as seen in rehabilitation, or social robots. The rehabilitation robotics are usually used in physical activities and assistance which are not featured with communicative capabilities. The utilization of the robots can enhance the quality of life of the elderly. In different situations, the social robots are used for communication purposes with the elderly and can either be categorized as serviced based robots or companion-robots. The social robots are primarily used for both assistive roles for the elders in addition to providing them with social interactions in the health care provision (Blazun et al., 201

Activity monitoring technology is another technological innovation that can monitor health status remotely and continuously for a long duration without the need for institutionalization. It not only provides the opportunity for better management of a person's condition and may help in reducing the consequent health care costs. Wearable activity monitors measure movement by estimating the number of steps taken each day, distance travelled, energy expenditure, sleep parameters, and heart rate, among other activity metrics. There are different types of wearable devices that can be used for monitoring and tracking fitness-related metrics for daily activities. Commonly used are: (1) Pedometers: that "estimate the number of steps taken through mechanical or digital measurements in only the vertical plane"; (2) Accelerometers: that "Detect acceleration in one, two or three directions to determine the frequency, quantity and intensity of movements"; (3) Integrated Multisensor systems: that "Combine accelerometer with other sensors that capture body responses to exercise (e.g. Heart rate) to optimize physical activity assessments. (Dobkin, 2013, Van Remoortel et. Al, 2012 & Plasqui, 2007)

The next grouping of assistive technology is mobility aids. These are assistive devices commonly used by older adults and, to the exclusion of wheelchairs, that can obtain without a medical consultation or fitting (Edwards K. & McCluskey A, 2010). Beneficial effects of mobility aids include reducing fall risk (Nandapalan et. Al, 1995), enhancing confidence (Quine et. Al, 2002), and increasing autonomy (Allen et. Al, 2001; Verbrugge & Jette 1994), for persons with difficulty in walking. The mobility devices' helps in the rehabilitation of the elder person who have gait disabilities. Their objective is to help people regain their strength, balance, range of motion, independence and to recover from some injuries, and other debilitating conditions. Individuals using these are usually required to repeat concise movements that include joint and muscle movements. Another example of a mobility aid is the wheelchair, which is the most common type. The use of wheelchairs has been found to improve mobility, socialization, independence, a sense of freedom, and the ability to contribute to society among the appropriate users (Edwards K. & McCluskey A, 2010). Electric powered wheelchairs and scooters are often used when individuals are unable to walk on their own as well as unable to use their upper extremities

to physically propel themselves in a wheelchair. Scooters are a popular choice for many older adults, with about 90% reportedly obtained without medical consultation (Ibid)

The elderly people population is very vulnerable to physical and mental diseases (Donaldson & Watson 1995, Hawkley & Cacioppo, 2007) The relationship between the greater need of care and increased number of diseases and functional impairments is widely known (Karlsson et al.). Because of this, there is a need for technological innovations that could help ensure healthy aging and quality elderly care. (Ramachandran, 2011) For example, there may be physiologic benefits related to assistive device use, including improved cardiorespiratory function, enhanced circulation, and prevention of osteoporosis. Patients using assistive devices have reported improved confidence and feelings of safety, resulting in increased activity levels and independence (Bateni, 2005) because the goal of these devices are to improve independent mobility, reduce disability, delay functional decline, and decrease the burden of care (Bateni, 2005 & Faruqui SR, 2010) In addition, assistive technologies could promote independence and, consecutively create positive mood and behaviors, and increase quality of life (Kerssens et al. 2015)through nurturing independence. Assistive technologies can also minimize the cost of long-term care (Harrefors et al. 2010) by participation in their own health care (Siegel & Dorner, 2017). It also facilitates communication with care professionals and providing wide access to health and well-being information (Siegel & Dorner, 2017)

2.4 Bridging Health, Aging and Technology

According to World Health Organization (WHO), the pace of population ageing around the world is increasing dramatically. Population aging is likely to influence patterns of health care spending in both developed and developing countries in the decades to come. (NIH, NIA and WHO October 2011) In developed countries, where acute care and institutional long-term care services are widely available, the use of medical care services by adults rises with age, and per capita expenditures on health care are relatively high among older age groups. (NIH, NIA and WHO October 2011). As the elderly are more likely to be suffering from chronic conditions and multi-morbidities, and their functional capacity is frequently limited. This implies that supporting the health of the elderly need

to account for these limitations in health and daily activities and require more involvement of professional health promoters and more individualized approaches.

All countries face a major challenge to ensure that their health and social systems are ready to make the most of this demographic shift (WHO, 2018) For example, governments are striving to find innovative solutions to support the complex demands of the increasing 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). Thus, in order to meet the demands of rapidly aging world, health care personnel shortage and modern society, technology can, to some extent, provide the necessary service in the elderly nursing care (Pressler and Ferraro 2010) as seen in the technological advancement of social robots that support the process of caregiving. For example, personal robots are designed to interact with human are being developed to become part of day to day life (Kachouie et al. 2014) Care robots aids, for instance, simplify tasks of the daily life for aged and/or handicapped people, increase the quality of life of their users by giving them more autonomy (Herstatt et al., 2011), protect them or perform certain tasks with a certain quality standard (for example, serving medication, drinks or food). (Goeldner et al. 2015) and has embodied character, which may provide emotional attachment (Parviainen et al. Forthcoming; Komatsu and Takahashi 2013)

Although the increasing elderly population may present a host of challenges, one of the intimidating concerns focuses on health care. The WHO reports that by the year 2030, shortages can mount up to 9.9 million physicians, nurses and midwives globally (WHO, 2019). Because of the crucial roles of health care providers, especially the nurses, they can be important partners in the development, implementation, and evaluation of health-related technology. In this changing landscape, nurses must expand their roles as health partners, educators, and care managers to facilitate wise and effective use of health information in order to support technology-enabled consumers. One way of accomplishing this is by their active participation in the expansion of HIT-enabled care (Effken and Abbott 2009). Also, health care worker under the field of elderly care could focus on enhancing elder individuals' quality of life by supporting them to maximize their abilities through technology despite their hesitations in adopting and using these advancements.

In one survey, 34% percent of adults aged 65 and over report having a health condition or disability, and 37% of adults over 75 report having three or more chronic conditions (CDC, 2006). The data suggest that older adults are aware that health technologies can support their preference for remaining independent and living in their own homes (AARP, 2008). Three-fourths of the survey respondents reported a willingness to use telemedicine as a means for healthcare professionals to diagnose or monitor health conditions remotely (Mitzner et.al 2011).

In closing, host of technological innovations have been developed, invented, studied and tested for use in long-term facilities, hospitals, communities and even in-home settings. Several of these innovations are designed to deliver care in a faster and more efficient way, thus saving healthcare costs, saving time in long queues for appointments and prescriptions and even saving energy to drive long hours for minor procedures. Most devices and systems invented nowadays facilitates elderly care. A recent study about Japan from where enormous kinds of invention and technology originates, states that persons over 65 years of age comprises a quarter of the country's population, which is 127 million justifying Japan's quick adoption of robots and smart sensors in elderly home care. In some cases, through these kinds of technological advancements in health care that enhance patient care improved quality of life can be impacted. The increasing number of people living longer paved a way to international interests in the enhancement of quality of life in older age (Bowling 2005, 1)

3 THEORETICAL FRAMEWORK

The theoretical framework is the blueprint or guide for research which consists of theoretical principles, constructs, concepts, and tenants of the theory. It provides the structure in showing how a researcher defines his study philosophically, methodology and analytically (Grant & Osanloo, 2014). Experts say that using nursing theoretical models of nurses in the analysis of their decision-making processes and actions, serves as a foundation (Sinclair, 2007) and can enhance the type of documentation a person is doing (Rautasalo et al. 2004). Ravich and Carl (2016) concur that the theoretical framework assists researchers in contextualizing formal theories into their studies in scholarly and academic

fashion. Theoretical frameworks thus, aid the researcher in finding appropriate research, research approach, analytical tools and procedures for research inquiry (Akintoye, 2015).

3.1 The Self-care Deficit Theory

The framework guiding this study is the self-care deficit theory, (SCDT). This theory is also referred to as an Orem's model of nursing. This model was developed by Dorothea Orem between 1859 and 2001. Orem's SCDT of nursing is based on the premise that all individuals are capable of self-care. According to Orem, “self-care” consists of actions that individuals freely and deliberately initiate and perform on their behalf in maintaining life, health and well-being (Orem, 1985).

According to Minkler (1999) every individual can perform self-care, and their responsibility for their health should be stressed. Orem's initial definition of nursing's concern included man’s need for self-care action and the provision and management of it on a continuous basis in order to sustain life and health, recover from disease or injury, and cope with their effects (Orem 1959). More simply stated, her definition of nursing's goal was “to overcome human limitation” (Orem, 1959).

Orem’s theory is made up of three related theories, they are: theory of self-care, theory of self-care deficit and theory of nursing systems. According to Orem “the three-part theory focuses not on individuals but on persons in relations. Each of the three theories focuses on a specific dimension of the person: The theory of self-care focuses on the self, the theory of self-care deficit focuses on you and me: and the theory of nursing system focuses on we, persons in community” (1990, p9)

3.1.1 The theory of self-care

Orem defined self-care as autonomous and self-directed continuous actions performed by adults that cater the regulatory needs of their functioning and development. Self-care req-

uisites are the execution of self-care activities at a given time. The requisite is not synonymous with health or wellbeing but how a self-care action brings a desirable impact on the person (Orem, 1987). In case of elderly patients, self-care is usually achieved when individuals are transformed from passive, dependent patients to active partners (Schwerter Kyle & Pitzer, 1990) The figure below depicts these themes.

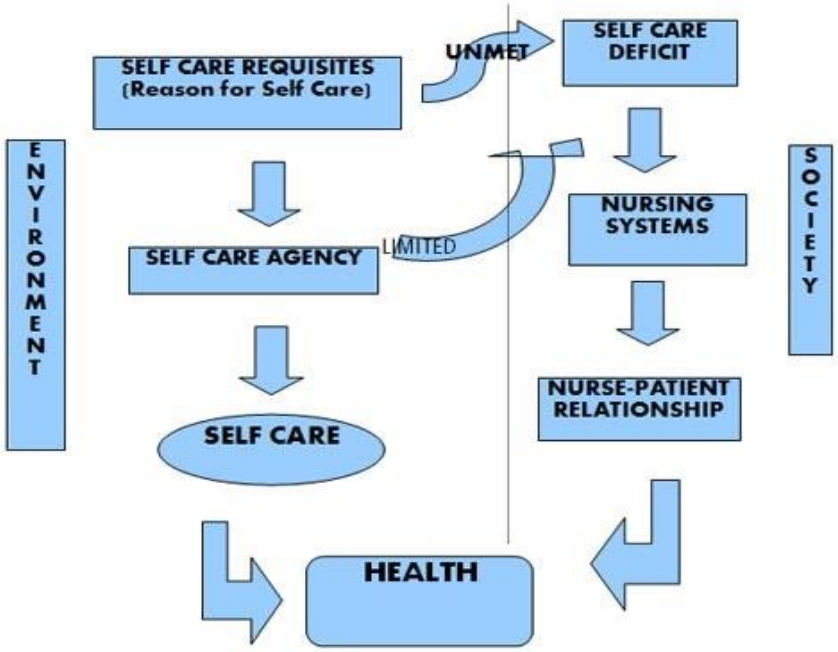

Figure 1. Orems theory of care

Notice in the figure above that the self-care deficit is described by Orem includes aspects relating to the environment, health status and caring team. According to this theory, the inability of the person to perform self-care activities because of restrictions that may include the provision of assistance and care given by the self-care agencies to the individuals who are complete, partial, or incapable of performing self-care. Offering assistive devices as a viable option to all elderly offers a pathway to maintaining independence and self-worth. Notice the focus of this is the person as the recipient of therapeutic self-care of the self-care agency.

3.2 Rational for Choice

This model was chosen first because Orem's theory provides a useful framework in understanding the patients in their pursuit of continued independence and self-care. This concept is associated with a desire to enable and allow people to be initiative in being responsible for their own health care when it is possible (Pearson & Vaughan, 1993). Self-care and its maintenance among older adults is often demanding and challenging (Dunning, 2009, 367). But when it is performed effectively, it helps in maintaining structural integrity and human functioning, as well as contributing to human development (Orem, 1991). Orem’s approach has advocated that the maintenance of optimal health and wellness is achieved through self-care or the ability of the person to take care of themselves.

4 AIMS AND RESEARCH QUESTIONS

Currently, there seem to be rapid advancements in technological innovation specifically targeting elder care as nations around the world try to cope with the aging crisis. Therefore, the purpose of this literature review is to identify the ways technology is being used in the health maintenance of elderly people. To begin the research process, a topic is selected, and a research question formulated. It is known that research questions should be clear, focused, significant to the field of study of the writers, and aim to gain new information. Additionally, a good research question aids in the refining of the thesis statement as it will then be answered at the conclusion of the study. (Cochran & Patton 2002). The research questions used to guide this investigation were; (i) What are the available modern technologies currently used in elder care? And (ii) How are these technologies incorporated into elder care?

5 METHODOLOGY

This thesis incorporates a literature review, in which inductive approach is used wherein data is collected from different sources and then later analyzed based on the fundamental questions. Next part consists of the sources and methods used to extract data and followed by analyzing of data using the Graneheim & Lundman (2004) method.

5.1 Data collection

In the data retrieval process, we first selected and limited our research by querying Science Direct, Sage Journals, EBSCO and google scholar data bases.. In the data retrieval process a variety of keywords and phrases related to the core questions were used. The process began with Science Direct, using the advanced search options and the words, technology innovation AND elder care AND health resulting in 1762 hits. Included publications were from the last ten years, hence, “2009-2019” which yielded 1030 hits. We further narrowed the search by selecting, “reviewed articles” and “full-text” articles resulting, in 110 hits. The final stage of the selection process was accomplished by reviewing the titles and abstracts of the 110 articles resulting in 10 articles.

For SAGE Journal, in the advance search, type-in the keywords “technology innovation AND elder care AND health “garnered 1752 hits. Included publications were from the last ten years (2009-2019) yielding 801 results. Peer reviewed and full text articles were then selected narrowing the results to 21 hits. The final stage of the selection process was accomplished by reviewing the titles and abstracts of the 21articles resulting in 2 articles.

The next data base that was used was EBSCO (academic search elite) which yielded 786 results using the keywords technology innovation AND elder care AND health in the advance research. Narrowing it down to articles within ten years, (2009-2019) gave us 501 hits. We further narrow down the research by selecting “reviewed articles and full text articles” garnering 206 hits. And by reviewing the titles and abstracts, we got 3 articles.

As the number of articles reviewed were not sufficient to conduct a reliable literature review, the search was broadened to get more results. Using the same keywords technology innovation AND elder acre AND health in the advance research, we got 103,00 hits. Further narrowing it down to articles within the last ten years (2009-2019) resulted 18100 articles. The final stage was accomplished by choosing full text and peer reviewed articles along with reviewing the titles and abstracts resulted in 15 articles being selected. This literature search resulted in a total of 30 articles to be used in this thesis.

5.1.1 Implying inclusion and exclusion criteria

We began the process by performing a title and abstract screen. This was accomplished by reading the publications and evaluating them for their relevance and quality, in relation to our topic and research questions. The articles which did not meet the inclusion criteria were eliminated. In the end, there were a total of 30 articles chosen. The inclusion criteria were: (I) Articles had to focus on the elderly, (ii) articles had to describe technological usage in the elderly population, (iii) articles had to relate to the enhancement of elderly well-being using technological innovation. In addition, they should be related to at least one of the research questions, be peer reviewed and published within the last ten years. Articles which were not in the English language, articles that did addresses the elderly, but were not relevant to the literature review were also excluded. Below is the illustration that was created through the literature review process.

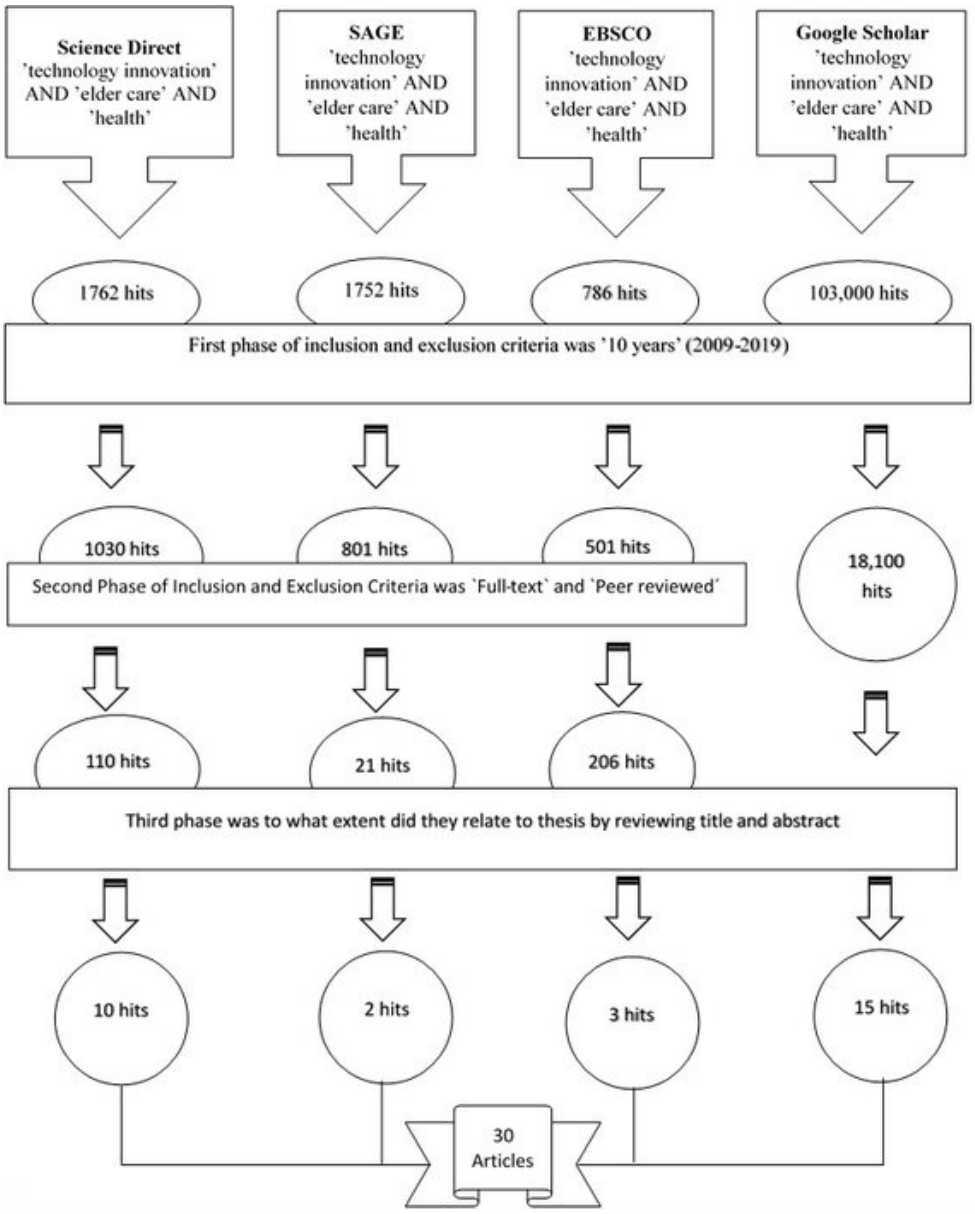

Figure 2. Illustrates the process of data collection

5.2 List of Articles

The following articles were chosen based on inclusion and exclusion criteria which were implied in two phases as mentioned earlier:

1. Acceptance and use of health information technology by community-dwelling elders. Fischer S. Et. Al., 2014. International Journal of Medical Informatics. Volume 83, Issue 9, pp. 624-635.

2. Gait and balance in the aging population: Fall prevention using innovation and technology. Khanuja K. Et. Al., 2018. Gait and balance in the aging population: Fall prevention using innovation and technology. Maturitas. Volume 110, pp. 51-56.

3. The potential for technology to enhance independence for those aging with a disability. Agree E., 2014. Disability and Health Journal. Volume 7, Issue 1, Supplement, pp. S33-S39.

4. Digital technology to enable aging in place. Gollamudi S., Kwang-il K. Steinhubl S., 2017. Experimental Gerontology. Volume 88, pp 25-31.

5. Smart homes and home health monitoring technologies for older adults: A systematic review. Liu L. Et. Al., 2016. International Journal of Medical Informatics. Volume 91, pp 44-59.

6. Information technologies for active and assisted living—Influences to the quality of life of an ageing society. Dorner T. E. & Siegel C., 2017. International Journal of Medical Informatics. Volume 100, pp 32-45.

7. Assistive Technologies in the Home. Brummel- Smith K. & Dangiolo M., 2009. Clinics in Geriatric Medicine. Volume 25, Issue 1, pp. 61-67.

8. Telehealth in older adults with cancer in the United States; The emerging use of wearable sensors. Naeim A. & Shen J., 2017. Journal of Geriatric Oncology, Volume 8, Issue 6, pp 437-442.

9. The Promise of wearable activity sensors to define patient recovery. Appelboom G. Et. Al., 2014. Journal of Clinical Neuroscience. Volume 21, Issue 7, pp 1089-1093.

10. Cognitive assisted living ambient system: a survey. Li R., Lu B., and McDonald-Maier K. 2015. Digital Communications and Networks, Volume 1, pp. 229–252.

11. Assistive technology for independent living with dementia: Stylized facts and research gaps. Bächle M. et.al., 2018. Health Policy and Technology. Volume 7, pp. 98-111.

12. Recognition of falls using dense sensing in an ambient assisted living environment. Ranasinghe D., Torres R. L. And Wickramasinghe A. 2017. Pervasive and Mobile Computing. Volume 34, pp 14-24.

13. Factors affecting home care patients' acceptance of a web-based interactive self-management technology. Brennan P. Et. Al., 2011. Journal of the American Medical Informatics Association, Volume 18, Issue 1, pp. 51-59.

14. A sociological approach to ageing technology and Health. Sociology of Health & Illness. Kelly J. & Meika L., 2010. Vol. 32, pp. 171-180.
15. The impact of technology on older adults' social isolation. Khosravi P., Rezvani A. And Wiewiora A. 2016. Computers in Human Behavior. Volume 63, pp. 594-603.

16. Telehealth program promotes older-adult health and well-being. Larkin M. 2018. The Journal on Active Aging. Pp 76-80.

17. Older adults and mobile phone for health: A review. Demiris G., and Joe J. 2013. Journal of Biomedical Informatics. Volume 46, pp. 947–954.

18. Remote Patient Management: Technology-Enabled Innovation Evolving Business Models for Chronic Disease Care. Coye M. J., DeMello S., and Haselkorn A. 2009. Health Affairs. Volume 28.

19. Robots in Health and social care: A complimentary Technology to Home care and Telehealth care? Boulos K., Dahl T., and Maged N. 2013. Robotics. Volume 3, pp. 1-21.

20. The sustainability of European Health Care Systems: beyond income and aging. Pammolli, F., Riccaboni, M., Magazzini, L., 2011, pp. 623-634.

21. Technology Growth and Expenditure Growth in Health Care. NBER Working Paper Series. Amitabh, C., Skinner, J., 2011. Working Paper 16953. Pp 1-54

22. Older adults: Are they ready to adopt health-related ICT? Heart, T., Kalderon, E., International Journal of Medical Informatics 82. 2013. Pp 209-231

23. Older Adult Perceptions of Smart Home Technologies: Implications for Research, Policy & Market Innovations in Health Care. Original Research Paper. Coughlin, J., D'Ambrosio, L., Reimer, B., pp 1-6

24. Medical innovation and age-specific trends in health care utilization; findings and implications. Social Science and Medicine. Wong, A., Wouterse, B., Slobbe, L.C., Boshuizen, H., Polder, J., 2012. Volume 74. pp 263-272

25. Investigating the Effectiveness of Technologies Applied to Assist Seniors: A Systematic Literature Review. International Journal of Medicine Informatics. Khosravi, P., Ghapanchi, A.H., 2016. Volume 85. pp 17-26

26. Factors influencing the adoption of home Telecare by elderly or chronically ill people: a national survey. Journal of Clinical Nursing. Peeters, J., de Veer, A.J., van der Hock, L., Francke, A. 2012. Volume 21. pp 3183-3193

27. But obviously not for me': robots, laboratories and the defiant identity of elder test users. Sociology of Health and Illness. Neven, L., 2010. Volume 32. pp 335-347

28. Towards a comprehensive public health response to population ageing. Author Manuscript. Beard, J. and Bloom, D., 2015. pp 1-11.

29. Nurse Care Coordination and Technology Effects on Health Status of Frail Elderly via Enhanced Self-management of Medication: Randomized Clinical Trial to Test Efficacy. Author Manuscript. Marek, K.D., Stetzer, F., Ryan, P., Bub, L.D., Adams, S., Schlidt, A., Lancaster, R., O\Brien, A.. 2013. Volume 62. pp 269-278.

30. Market adoption barriers of multi-stakeholder technology: Smart homes for the aging population. Technological Forecasting and Social Change. Ehrenhard, M., Kijl, B., Nieuwenhuis, L., 2014. Volume 89. pp 306-315.

5.3 Data analysis

Content analysis is a method to analyze communication messages (Cole, 1988) and to increase understanding and knowledge about the topic of interest (Cavanagh 1997). Data analysis of the research is conducted by using inductive approach. An approach based on inductive data focuses from the specific to the general, unit of analysis are observed and combined into a larger whole statement (Chin and Kramer 1999). There are several different approaches in performing qualitative content analysis. According to Hsiu-Fang & Shannon (2005) there are three approaches to an analysis. Conventional content analysis-refers to an open coding of the empirical materials emphasizing on the grounded theory so that there are no defined categories for coding. Directed content analysis is more organized than an open coding approach and is a deductive approach. Analysis starts from a theory or initial researches as guidance for initial codes. This approach compares and discusses the results of various researches or theories. The summative content analysis

involves counting and comparisons of keywords or phrases in the text and then followed by interpretation of the contexts (Hsiu-Fang & Shannon 2005). The aim is to become immersed in the data, thus written material is read through several times (Burnard 1991).

Another approach to qualitative content analysis is introduced by Graneheim & Lundman (2004). This approach pointed out qualitative content analysis in Nursing researches which uses an inductive way by reading through the whole texts several times to obtain a wider picture of the context. Meaning units undergo concepts of reduction (Findahl and Höijer, 1981) and condensation (Coffey and Atkinson, 1996) and then broken down into smaller meaning units while preserving its core (Graneheim & Lundman, 2004).

5.3.1 Step 1: reading and coding

After reading through the articles and filtering those through the inclusion and exclusion criteria 30 were chosen which were relevant to the thesis subject. Later on, the articles (the unit of analysis) were read more carefully making notes separately when relevant data is found especially relating to the research aims and questions. In the notes, the main keywords of the meaning units were used as labeling codes, to facilitate easy access in restudying the articles. In this stage keywords were underlined and highlighted, and big dots were used beside the codes which helped the authors show the statement's degree of relevance to the thesis' subject.

5.3.2 Step 2: Listing and categorizing the codes

At this stage written notes were reviewed and gathered phrases were listed. Upon reading through the lists, the pieces of information were then categorized according to the importance of the codes.

Tables in the appendix section show an example of the process by which we started from several meaning units and came up with categories. It started with meaning units, then the text was condensed, abstracted, and labelled with codes. The context of the meaning unit was kept in mind, while condensing and labeling. Patterns drawn from the codes,

their similarities as well as differences were sorted into categories which were discussed by the researchers and edited as necessary (Graneheim and Lundham, 2004).

5.3.3 Step 3: Emerging themes from the categories

The table below shows the major and minor common categories among the 30 articles and how these categories were gathered to make a theme. The latent content of the categories was drawn to come up with sub-themes and a main theme. Note that only the categories related to the questions of this research paper are included in the table.

Table 3. Illustration of the most common categories and their distribution inside the 30 units of Analysis and coming up with a theme

Theme	**The Relationship Between Technology and Quality of Life in Elder Care**													
Sub Theme	**Supporting the elderly**							**Factors Influencing Perceived Quality of Life**						
Major Category	**Technical Strategy**					**Non-technical strategy**		**Physical Effect**				**Psychological Effect**		
Minor Category	**Robots**	**Telecare**	**Web-based technology**	**Medication technology**	**Mobility device**	**Family support**	**Health care provider**	**comfort**	**Safety/ security**	**Long life**	**empowerment**	**Autonomy /independence**	**Self-esteem/ self-confidence**	**Companionship/ belongingness/ isolation**
Units of Analysis	2,6,10,14, 15,19, 23,25, 27	1,2,3, 4,5,6, 7,8,9, 10,11, 12,13, 14,15, 16,21, 22,23, 25,26, 29,30	1,2,4,6,8,10,11,13,15,17, 18,29	7,14,24, 25	9,14,24,25	10,29, 30	3,5,7,9,10, 11,23,25,26,29,30	5,6,7, 8,9,10,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,30	2,3,4,8,10,11,12, 14,17,25	2,3,4, 5,6,7, 8,9,10,11,12,13,14,16,17,18,19,20,22,23,24,25,26,27,28,29,30	6,9,15, 17,19, 25,26, 27,28, 29,30	1,2,4, 7,8,10,11,13,14,15,16,17,18,19,23,25,26,27,29	11,14	4,6,14,15,19,22, 27,28,29,30

5.4 Ethical considerations

Ethics can be defined as a method, procedure, or perspective in deciding how to act in the analysis of complex problems and issues (Resnik 2011). To avoid errors in the findings, fabrications and misinterpretations of results, ethical decision-making process is used. The authors ensured a high standard of ethical consideration in the review by following the Arcada's guidelines and standards for ethical writing. The authors of this paper tried to maintain Arcada University of Applied Sciences' own standards and instructions in

writing scientific research which are outlined in Thesis Guide 2009 version 1.2, as much as possible. The guidelines for literature review (Carpenter & Speziale 2007, Comerasamy & Sui, 2013, Maguire, 2005) were discussed and followed strictly at every stage of the writing process. The authors chose the topic after discussing with the research adviser at Arcada University, Helsinki.

The authors used their official right as registered students of Arcada University of Applied Sciences in obtaining the articles from different official academic databases thus no sorts of piracy and unofficial electronic sources thus copyright violation is avoided. The authors ensured that during extraction and appraisal of articles, process was done objectively, no conflict of interest and without any bias. The data collection through primary sources has been used and when content was not available, secondary sources were used. To ensure the avoidance of any aspect of plagiarism in all stages of the writing process, the Arcada's guidelines for referencing and citation was strictly followed. The authors also consulted the adviser and the librarians to ensure the reliability and relevance of the material used. The authors only used articles from the Arcadas' database as a trusted academic source.

The Responsible Conduct of Research Guidelines were applied to ensure ethical reliability and trustworthiness of the literature review. Ethically proven and accepted data collection and research methods were used. The work of other authors was respected and acknowledged through citation, referencing were shown to maintain the value of their work. No financial aid received nor asked to conduct this thesis (TENK, 2012: 30-31.) Integrity and avoidance of all kinds of research misconduct were adhered to strive for high standards (Polit & Beck 2013). And to ensure the absence of plagiarism, the work was checked with Urkund software.

6 FINDINGS

This chapter discusses the findings, according to the information gathered from the 30 articles. The major categories, which emerged during the data analysis process, are arranged in alphabetic order. (The numbers in the brackets represent the chosen analyzed articles). The table in the appendices section illustrates how a qualitative inductive analysis of the thirty articles resulted in major and minor categories.

To review, the aim of this research is to identify the ways technology is being used in managing the elderly people. Based on the goal, research questions were generated. Although the effects of technology for the elderly are the main topic, related topics are also being studied. The research used qualitative methods to examine thirty scholarly articles in order to find information related to the topic. To gather an extensive amount of information, articles were used primarily. The topic was narrowed down by focusing on the factors influencing quality of life and strategies supporting it. The narrowing of the topic gave room to focus on the research aims from beginning to the end of the research process. The articles chosen for this research include relevant information that assist us in finding information that relates to our research aim.

Studies that formed the *non-technical strategies* category show that physical and psychological support of family members is beneficial because family members remind their older family members, for example, to take medicine and assist them with tasks related to medication management. Studies that tested technology and nurse coordination in assisting elderly with their health care management showed that health care provider coordination has a beneficial effect on cognitive functioning, depressive symptoms, functional status, and quality of life in both mental and physical functioning of the elderly. Therefore, non-technical strategies affect psychological and intellectual aspects as well as quality of life of the elderly. [3,5,7,9,10,11,23,25,26,29,30]

The second major category was p*hysical effect***.** These studies repeatedly indicated that the use of technology could significantly improve the quality of life of the elderly for several reasons. Firstly, because the aim of technology use is not only ‘optimal health’

with its implied anti-ageing, but rather support for the body and mind as these change across the lifespan. In addition to showing improved health-related quality of life, there is also a decrease in health care utilization in terms of emergency room visits and hospitalization. Technology includes lots of devices as a means of not only monitoring, health and wellness in older adults, but also serving as a feedback tool and detecting, at an early stage, functional impairment. There are also applications being used which support and empowers elderly by allowing them to be actively involved in their health care. Using mobility devices on the other hand, have been found to improve ambulation thus increasing feelings of security. Several sensors and micro-controllers were embedded to monitor movements and capture floor vibration. Studies show that there is a significant decrease in fall incident among elderly who utilizes these devices as these technologies can sense balance and motion interactions with the environment, thus making adjustments and corrective stepping to prevent falls. With the assistance of robots and assistive devices, it provides comfort to the elderly by assisting them with their daily activities, thus reducing the task difficulty while making their life easier. These readily available technological resources can facilitate the care delivery process, which can lead to better patient outcomes. Technological innovations, thus slows the progression of changes associated with aging, and helps older individuals maximize their overall function, which results in supporting the aging process.
[2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,22,23,24,25,26,27,28,29,30]

Third major category *psychological effect*. These studies repeatedly indicated that technological devices improve wellbeing by promoting independence. The use of assistive technology enhances the ability of adults to make choices about when and how they carry out activities and improves participation. Furthermore, these technologies assist the elderly with activities of daily living from dressing, cleaning the home, and even reminding them to take the medications. It offers home telehealth services that enable frail older adults to maintain independent lifestyles. In addition, the use of sensors in the transmission and analysis of data promotes people for self-monitoring and self-management of their own health, which diminishes health care utilization.

In addition to independence, it enhances their autonomy about their own health. It provides relevant health information and management to negotiate health and illness in their daily life thus, they have a better understanding about their condition and have more confidence in self-management. In addition, different technologies can be used to boost elders' self-esteem and self-confidence. Some pursue cosmetic surgery and anti-ageing therapies to feel better, cultivate better treatment by others, and (ideally) achieve happiness. Anti-ageing medicine or longevity medicine is created with its emphasis on elderly's 'optimal health' or the prevention of any aspect of ageing (mental, physical, or emotional.

Technologies, through social interaction, can also alleviate loneliness and social isolation among the elderly by providing companionship. For example, by the mere presence of robots, it can increase their social interaction by acting as companions and providing support for daily activities. It improves the level of physical activity, thus reducing social isolation. Another type of technology is the digital technology, which allows people to have a better interaction with their social environment. It enables the elderly to feel less lonely by having regular video-based talks to connect with family members and friends. This kind of talk therapy decreases their level of social isolation and depression. By connecting to the outside world, they can gain social support, engage in activities of interest and adapts to socialization activities, therefore they stay connected to the community.
[1,2,4,6,7,8,10,11,13,14,15,16,17,18,19,22,23,25,26,27,28,29,30]

The next category identified through the literature review was *technical strategies.* To name a few, technical strategies include robots, web-based applications, sensors, tracking and monitoring devices. Telehealth applications, medication devices and those technologies that aid elderly in their day to day living also belong to the above-mentioned category. These multitude number of technological advances integrated in the health care system have influenced elderly care substantially. Developments of these innovations come from studying their efficiency, effectivity as well as their negative sides when utilized and therefore unceasingly improving the quality of the delivery of health care services to elder individuals.

[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,21,22,23,25,26,27,29,30].

The major themes above along with their subthemes when combined, formulated two sub themes, which were, *supporting the elderly* and *factors influencing perceived quality of life*. Together, these resulted in formulating the main theme, *the relationship between technology and quality of life in elder care*.

7 DISCUSSION

The subject being studied covers a wide range of subtopics considering the propositions of each negative and positive side of the matter. In this review of related literature, we focused on different kinds of technological advancements and their role in elderly health care. Based on our investigation by reviewing articles consisting or relating to the focus of our study, technology has been for decades one of the means in developing the health care system, thus, enhancing services and practices in caring for older individuals. Like any other innovation for modernization, there are advantages and disadvantages for both the beneficiary and the benefactor. In this context, we can consider the health care professionals and the elder individuals as beneficiaries.

7.1 Impacts of Technology on Elder Care

Taken as a whole, there seems to be evidence that suggest, advances in technology have a great impact on every aspect of human life, specifically physical, psychological and emotional aspects. One type of technology supports physical aspects of older individuals' life by assisting them in mobility for their daily functioning. This benefit allows the elder people to be more independent and have a feeling of security and comfort by participating in the management of their own health care. Hence, technology facilitates in the self-assessment activity of the elder people relating to their health status, which identifies the seniors´ capacity and limitations towards health. Furthermore, these advances also add up to seniors´ confidence since they are the ones who determine their level of functioning and to what extent they will be able to improve better. Through technological innovations, therefore, motivate the elder people to work independently on their activities of daily living, which leads to a gradual progression of changes related to the aging process and promotes long life among the senior citizens.

Through this literature review, it was found that technology could reinforce psychological, mental and cognitive functioning of the elderly. With this type of technology, elder people will be able to maintain or even develop their brain functioning by taking part in activities of self-care and interacting with the social environment through group activities

or simply chatting with other people, hence limiting the risk of social isolation and depression. The three aspects—psychological, mental and cognitive are very closely interrelated with each other that if one aspect is being enhanced, it affects the functioning of the other two. In addition, technology empowers not only the physical functioning and psychological aspect of elder peoples' lives, but also the emotional state. These uplifts the capacity level of elder people considering them as the powerless cluster of the society. Various kinds of robots may support elder individuals emotionally, as being their companion. In fact, as robots function as enabling devices, it can support elder individuals' overall needs from physical to emotional aspects through assistance and mobilization. With these issues in mind, questions remain that focus on ways technology will influence elder people in the future.

7.2 Relevance of the Related Theories in Nursing Practice

There are 17 articles used as resources, which focuses on elder individuals' independence and 18 articles on health maintenance. These could be the grounds supporting the theory of self-care, theory of self-care deficit and theory of nursing systems under the umbrella of Orem's model. The theory targets an individual's self-reliance and understanding of the requisites in sustaining a person's needs and self-dependent care to obtain optimal quality of life one could possibly have.

These technological innovations promote a better quality of life for older individuals and also, alleviates the workload for health care professionals. One of the major problems today in the field of health care is the lack of sufficient health care workers sustaining the needs of elderly individuals. With these innovations, the workload of health care professionals, especially nurses are being alleviated. At the same time, elder individuals are being empowered to function and perform activities independently according to their capabilities. As individuals live longer, health promotion behaviors become even more important, particularly with regards to maintaining functional independence and improving quality of life (Tai Wha Lee, et. al, 2006). Based on this literature from the background, technology offers a substantial support both for nurses as first contact care workers and the elderly population as well in achieving possible optimal health of elderly individuals.

Nurses, as the first contact of health care seeking individuals, especially the vulnerable ones, which include the elderly, have been constantly executing multiple tasks regardless of the area they are working on. Health information technology (Health IT or HIT) holds the potential to transform the quality of care and to establish linkages between nursing care and patient outcomes (Dykes and Collins, 2013). This modernization under the health care system facilitates reliable and immediate decision making as well as cuts down and simplify numerous and complicated tasks to lighter and more manageable ones. Nurses sometimes become the innovators themselves in their working field, thus creating different roles through which delegation could be done.

New job titles and roles are emerging, particularly in population health management, patient coaching, informatics design and analysis, geriatric care, and managing patient care transitions. Some programs use nurses to improve organizations' capacity to coordinate care. For example, Minnesota's Health Care Homes program established the job category of Nurse Planners, who are responsible for supporting integrated care across multiple Health Care Homes. Their specific responsibilities include developing resources such as care coordination and patient and family engagement toolkits and offering technical assistance to help Health Care Homes improve their capacity to function in an integrated way (Fraher, Erin et.al 2015).

Technology and work force go hand in hand. Innovations can never dominate human's capabilities and strengths since these are created from an individual's imaginations and ideas. Instead, these serve as partners in achieving the most favorable quality of life one desires, particularly when reaching the age where a person can no longer function normally as it was before. Like any other production of a commodity or device, machines do not work without an operator. Likewise, in the health care field, improved devices are needed for easier and better functioning, but nurses are still needed to make the machineries work. Delivery of elderly care will be more efficient and convenient with these technological advancements. These innovations serve as tools in rehabilitating or maintaining older individuals remaining capacities.

7.3 CRITICAL DISCUSSION

In a much quoted passage in his inaugural address, President Kennedy said, ``Ask not what your country can do for you – ask what you can do for your country``. It is a striking sign of our temper nowadays that the controversy about this passage centered on its origin but not on its content. Neither half of the statement expresses a relation between the citizen and the government that is worthy of the ideals of free men in a free society. The paternalistic `` What your country can do for you`` implies that the government is the patron, the citizen, the ward, a view that is as at odds with the free man´s belief in his own responsibility for his own destiny. The organismic, `` what you can do for your country`` implies that the government is the master or the diety, the citizen, the servant or the votary. (Friedman M, 2002).

There has been striking issues nowadays with regards to technological advancements in lieu with the demands of the society. There are governments, which run their nation with the helping power of their citizen while other nations are being run by capitalism or that the government decide solely for their own benefit. This greatly affects the technological innovations as there might be some inventions which indeed answers the queries and needs of the people on their current situations, however, there are as well those rulers of society who are just inflicting dilemmas among their people but have reserved solutions which unfortunately entails money movement before these solutions can be accessed.

This critical issue has not been elaborated in this study, hence, can be a basis and ground for a new topic, research to be discussed and published. This study nonetheless explains the acceptance and application of technological innovation regardless of the kind of government a country has. Finland is always concern with its citizens. The government is continuing in bringing up solutions with the best services, laws, and other benefits to sustain the Finnish society. The most remarkable change in the age structure will occur within the next 10 years when the baby-boom generation, those who were born during the second half of the 1940s, will retire (Sisäasiainministeriö 2005: 8). The government is taking action to provide good quality health and care services to the increasing number of people who need them. As the ageing population is paralleled by a decrease in the labor

force - the number of caregivers and taxpayers – many are looking at technology development as one partial solution. In Finland, the Ministry of Social Affairs and Health published quality recommendations for ensuring good aging and services in 2017-2019, in which using technology is raised as one recommendation in parallel to for example developing housing services. In particular, robotic and automation as an enabler for new services for elderly people supports autonomy and independence of older persons, improve services, and develop care work. (Niemelä M., et al, 2017). With this matter, therefore, there is a demand for additional health care providers. However, Technological advancements come in to fill in the gaps in facilitating maintenance and promotion of health among the Elder People. The Finnish government embraces these innovative solutions for its people without taking advantage of the situation as a big profit industry. For as long as the elder people and the whole citizen of the nation are receiving the utmost services and care of the government and vice versa fosters a unified and peaceful living supporting each individual's quality of life that upholds an outstanding society.

8 CONCLUSIONS

According to the analysis of the information found, contribution of technological innovation to the quality of life of the elderly can be clearly visualized. Technologies have proven benefits and have a significant effect on the life of the elderly drawing from the array of existing technological innovations used in managing the ageing population - the segment of the population that has the greatest demand for health and long-term care services. This study shows that many of these technologies offer a way of reducing the burden of elderly patients as well as their families and mitigate the workforce insufficiency and financial burdens inherent to long term care while improving elder individuals' safety, security, social interaction, self-esteem, self-confidence, comfort and most importantly independence and their quality of life. Beneficial technologies do not only offer significant potential in assisting older adults in the maintenance and promotion of their quality of life, but it can also provide a promising method in helping to address some of the challenges currently facing the world's health care system.

When looking at this study through the lens of Orem's nursing theory, it leads one to believe quality in life can be ensured if people can maintain self-reliance, and be responsible for their health, and well-being. Elder people will recover quickly and holistically from their illness by performing their own self-care as much as they are able to. When an adult is incapable or is limited to the provision of continuous and effective self-care, the help of health care provider is required. However, the shift of having a growing aged population puts a strain on available medical services and health care professionals. These drivers identified are all compelling reasons to state that we need technological innovations in improving the health care system for elderly individuals. Nevertheless, for these technologies to realize their full potential in improving the efficiency of health care delivery, reducing health care cost, improving health care outcomes, and maximizing the independence and quality of life of elderly individuals, these technologies must be rapidly expanded and introduced in homes and community-based care settings.

Based on this study, many of these technological innovations already exist and they continue to evolve. It can be recommended that the benefits of technological innovation

should be marketed more in order to increase awareness about its effectiveness to the elderly. Increasing awareness would encourage public sectors and non-government organizations to adapt technology-based services in addressing the problems of increasing ageing population. Elderly need education and support for them to start using and including technology in their everyday lives. Therefore, the use of technological innovation often requires a prompt for the health care providers and the family members in assisting the elderly individuals. They are the key factors in providing education and support to the elderly in understanding how technological innovations work. Yet, there are not enough studies about the health care provider's and family's perspective about its implementation and familiarization. Moreover, there are limited publications that show how elderly people cope with technological innovations. Therefore, further study is needed to explore the ability of the elderly, their family and health care provider to smoothly adapt to technologically assisted health-care setting. Furthermore, additional research is needed to examine if these technologies can help solve functional problems for those aged individuals having early-onset long-term disability and with frail elderly.

8.4 Limitations and Strengths

Doing the research in a group provides a better understanding of the articles being analyzed and thus, adds more insights into how the research is studied and presented. A broader range of skills is applied in doing our study thus increases productivity and performance. Moreover, collaborating with others help us identify our weaknesses and strengths and help us develop our interpersonal skills. As with the majority of studies, the design of the current study is subject to limitations. Even though the authors tried to cover all the main points of these articles, this study does not provide a complete picture of these assessments. It is also possible that these thirty articles do not contain all the relevant information regarding the subject of the thesis and its research questions, so more accurate and more resources are required. We only utilized studies written in English language and have not looked into other scholarly articles drafted in other languages, thus, various aspects of technology could have been covered and yielded results might slightly be different. Moreover, the authors do not have access to a larger range of scientific literatures as these literatures need to be purchased, thus, data collection is time consuming. In addition,

this is the researchers' first time in doing qualitative study. The volume of data gathered makes analysis and interpretation time consuming. Yet, while there are merits in having group work as mentioned above, there is also limitation because sometimes it is challenging to put plenty of ideas in a cohesive manner.

REFERENCES

Ahantapillai, A. J., 2015. Assistive Technology to Monitor Activity, health and Well/being in Old Age. *The Wrist wearable unit in the USEFIL project> Technology and Disability Journal,* Volume 27, pp. 17-29.

Akintoye, A., 2017. *Jedm.aouife.edu.ng.* [Online]
Available at: Jedm.aouife.edu.ng>uploads>2017/03/07
[Accessed 22 February 2017].

Bateni, H. a. M. B., 2005. Assistive Devices for Balance and Mobility: Benefits, Demands and Adverse Consequences. *The State of Aging and Health in America,* Volume 86, pp. 134-145.

Borg, J. L. A. a. L. S., 2009. Assistive Technologies in Developing Countries: National and International Responsibilities to Implement the Convention on the Rights of Persons with Disabilities. *Lancet,* Volume 374, pp. 1863-1865.

Bowling, A., 2005. *Ageing Well: Quality of Life in Old Age,* Berkshire, GBR: McGraw-Hill Professional Publishing.

Colombo, R. F. a. F., 2009. *The Long Term Care Workforce: Overview and Strategies to Adapt Supply to a Growing Demand,* s.l.: OECD Publishing.

Dobkin, B., 2013. Wearable Motion Sensors to Continuously Measure Real World Physical Activities. *Current Opinion Neurology,* 26(6), pp. 602-608.

Faruqui, S. a. J. T., 2010. Ambulatory Assistive Devices in Orthopaedics: Uses and Modifications. *Jam Academy Orthopaedic Surgery,* Volume 18, pp. 41-50.

Freedman, A. a., 2011. A Quality-of-Life Scale for Assistive Technology: Results of a Pilot Study of Aging and Technology. *Physical Therapy Journal,* Volume 91, pp. 1780-1788.

Gorman, M., 1999. *Development and the rights of older people.* London: Earthscan Publications Ltd..

Granheim U. H. and Lundman, B., 2004. Qualitative Content Analysis in Nursing Research: Concepts, Procedures and Measures to Achieve Trustworthiness. *Nurse Education Today,* Volume 24, pp. 105-112.

Grant, C. a. O. A., 2014. Understanding, Selecting and Integrating a Theoretical Framework in Dissertation Research: Creating the Blueprint for your "House". *Administrative Issues Journal: Education, Practice and Research,* 4(2), p. 1226.

H. Hsiu Fang, S. S., 2005. Three Approaches to Qualitative Content Analysis. *Qualitative Health Research,* Volume 15, pp. 1277-1288.

H. Van Remoortel, S. G. Y. R., 2012. Validity of Activity Monitors in Health and Chronic Disease: A Systematic Review. *Int. Journal on Behaviora, Nutritional and Physcal Activity,* Volume 9.

K Edwards, A. M., 2010. A Survey of Adult Power Wheelchair and Scooter Users. *Disability Rehabilitation: assistive Technology,* 5(6), pp. 411-419.

K Gabner, M. C., 2010. ICT enabled independent living for elderly. *a Status Quo Analysis on Product and the Research Landscape in the field of Ambient Assisted Living (AAL) in EU,* pp. 1-91.

Kachouie, S. K. C., 2014. Socially Assistive Robots in Elderly Care: A Mixed-Method Systematic Literature Review. *International Journal of Human-Computer Interaction,* Volume 30, pp. 369-393.

L.M. Verbrugge, A. J., 1994. The Disablement Process. *Social Scientific Medicine,* 38(1), pp. 1-14.

M McPherson, L. S.-L. E. B., 2006. Social Isolation in America: Changes in Core Discussion Networks over Two Decades. *Sage Journals,* 71(3), pp. 353-375.

Marketta Niemelä, K. W., 2018. *Meaningful Technology for Seniors-Safety, Comfort and Joy.* Tokyo, s.n.

McDaniel, P. a., 2016. *Facilitating Telemedicine Project Sustainability in Medically Underserved areas: A Healthcare Provider Participant Perspective,* s.l.: BMC Health Services Research.

Minkler, M., 1999. Personal Responsibilty for Health? A Review of the Arguments and the Evidence at Century's end. *Health Education Review,* 26(1), pp. 121-141.

Miwa, H. et al., 2017. *Comparison of Japanese and Finnish attitude regarding technology use in Nursing-Care Service.* Viennä, VTT Technical Research Centre of Finland.

Molin, P. J. K., 2007. Living at Home with Acquired Cognitive Impairment-Can Assistive Technology Help?. *Technology and Disability Journal,* Issue 19, pp. 91-101.

Nandapalan, C. S. A. J. T. H. L., 1995. Objective Measurement of the Benefit of Walking Sticks in eripheral Vestibular Balance Disorders Using the Sway Weigh Balance Platform. *Journal on Laryngology and Otology,* 109(9), pp. 836-840.

Pressler K.A., a. F. K., 2010. Assistive Device Use as a Dynamic Acquisition Process in Later Life. *Gerontologist,* 50(3), pp. 371-381.

R Smith, S. Q. J. A. K. B., 2002. Assistive Devices: Self-Reported Use by Older People in Victoria Australia Health Review. 25(4), pp. 169-177.

Ramachandran, R., 2011. *Information Technology and Its Impact on Aging Society.* Shanghai, SSRN.

Rautasalo, P. e. a., 2004. Geriatric Rehabilitation Nursing: Developing a Model. *International Journal of Nursing Practice,* Volume 10, pp. 207-214.

Reisinger, R., 2014. Assistive Technology Provision within the Navajo Nation: User and Provider Perception. *Qualitative,* Volume 24, pp. 1501-1517.

Resnik, B., 2011. *www.niehs.nih.gov.* [Online]
Available at: http://www.niehs.nih.gov/research/resources/bioethics/whatis/
[Accessed 27 November 2018].

S Karlson, A.-K. E. A. W. I. H., 2008. Functional Ability and Health Complaints Among Older People with a Combination of Public and Informal Care vs. Public Care Only. *Scand J Caring Sci.,* Volume 22, pp. 136-148.

S. M. Allen, A. F. K. B., 2001. Receiving Health at Home: The Interplay of Human and Technological Assistance. *Journal onG erontology, Psychological Science, Social Science,* 56(6), pp. S374-S382.

S.T. Fry, M. J., 2012. *Ethics in Nursing Practice,* Oxford: Blackwell Publishing.

Shibata, W., 2011. Robot Therapy: A New Approach for Mental Health Care of the Elderly- A Mini Review. *Gerontology,* 57(4).

T Kleinberger, M. B. E. R. A. H. P. M., 2007. *Ambient Intelligence in Assisted Living: Enable Elderly eople to Handle Future Interfcaes.* Berlin, Constantine Stephanidis.

THL, 2018. *www.thl.fi.* [Online]
Available at: http://thl.fi/fi/web/ageing/ageing-policy
[Accessed 21 March 2019].

Westerterp, G. P. a. K., 2007. Physical Activity Assessment with Accelerometers: An evaluation againts doubly labled water. *Obesity,* 15(10), pp. 2371-2379.

WHO, 2014. *www.who.int.* [Online]
Available at: http://www.who.int/bulletin/bulletin_board/83/ustun11051/en/.
[Accessed 20 December 2014].

WHO, 2014. *www.who.int.* [Online]
Available at: http://www.who.int/healthinfo/survey/ageingdefnolder/en/.
[Accessed 9 November 2014].

APPENDICES

APPENDIX 1. EXAMPLE OF A CONTENT ANALYSIS TABLE

Table 1: Acceptance and use of health information technology by community-dwelling:1 elder. Fischer S. et. al (2014)

Meaning Unit	Condensed meaning Unit, Using the words from text	Condensed meaning Unit's latent meaning	Codes	Categories
A number of reviews have examined the impact of a variety of technological innovations for improving health care of the elderly or disabled, often called *assistive technology*, which includes items to improve mobility, monitor for safety, and facilitate communication in emergencies.	Technological innovations improve mobility, monitor safety and facilitate communication for elder people	Technological innovations like assistive devices, facilitates communication and safety impacting health	Health, safety and communication are supported by technology	Health promotion
Early reviews often found positive effects of various kinds of assistive technology such as video monitoring, remote health monitoring, electronic sensors and equipment such as fall detectors, door monitors, bed alerts, pressure mats and smoke and heat alarms can improve older people's safety, security and ability to cope at home	Assistive technology has positive effects and can improve older people's safety, security and ability to cope at home	Assistive technology is linked with positive effects like safety that facilitate independence and coping at home	Assistive technology enhances independence when living at home	Independence
The multi-national ENABLE project (enabling technologies for people with dementia)	Enabling technologies show effectiveness in independent living	Enabling technology designed for the elderly	Enabling technology fa-	Independence

in which twelve existing products were studied, overall showed their effectiveness to facilitate independent living and found that devices may reduce anxiety in people with dementia as well as those caring for them.	and reduce anxiety for elder persons	can facilitate independence and relieve stress	cilitates independence for the elderly	
The remaining technologies for elders are mostly "assistive technologies," not necessarily actively used by the elder but which provide monitoring or other types of assistance, sometimes in place of people, for support.	Assistive Technologies that were used to monitor were the most common form for elder care	Assistive Technologies that monitor elderly are popular	Assistive Technologies serves as support system for elder people.	Technology; Support System
Assistive technology can potentially substitute or at least supplement personal assistance in certain cases	Assistive Technology serves as a to substitute for personal assistance	Assistive technology elicits personal support mechanism for people	Assistive technology improves independence	Assistive technology; positive effect, independence
Regarding technology...for many, prolonged independence, enhanced quality of life, and improved health outweigh privacy concerns that might restrict use.	Assistive Technology usage limits people with good health, independence and better quality of life	Independence, Quality of Life, and health concerns brings about Assistive Technology Restrictions	Independence and quality of life affects Assistive Technology usage.	Independence Quality of Life
In a longitudinal study investigating the attitudes of users of in-home sensor monitoring technology, a majority of older adults were accepting of technology, though they did express concerns and their concerns increased during the year of observation	Older adults express concerns about the Technology Utilization but however they accept it.	Older adults express acceptance of technology but with some concerns.	People accept Technology	Technology, Acceptance

Limitations affecting elders ability to use technology include decreased cognitive capacities, loss of memory and poor recall, decreased navigation skills, sight loss, hearing loss, decreased kinesthetic ability, and less experience with technology, as well as less confidence in these systems	Elder people face different challenges in using Technology due to Physical and Cognitive changes	Common challenges that limit elder people are related to the use of technology.	Limitations aging affects Technological Utilization	Technology;Limitations
Many seniors, especially those with cardiovascular risk factors like hypertension and diabetes, have executive impairments that make it difficult to plan, organize, and multi-task. Therefore, windows-based platforms may be difficult to use.	Seniors with certain health issues are having a difficult time in using window based platforms	Some seniors experience difficulties in window based platforms	Window based platforms are challenging for Seniors	Technology,Limitations
Given the aging population and need to improve care processes and care for the elderly, technology offers great promise, yet the potential is tempered by lagging adoption by older patients and human factors challenges.	Considering some factors challenge seniors in adopting to new technologies	Elders faced challenges impacts the proper use of new technology	There are challenges in Technology Utilization for elders	Technology,Limitations

Appendix 2. Example of Category Formulation

Table 2 illustration of finding: Major and minor categories formulated during content analysis of 30 chosen articles

Article Number	Categorized condensed meaning unit's according to Graneheim & lundman (2004) (Categories names in Bold and Italic characters)
1	***Independence*** Early reviews often found positive effects of various kinds of assistive technology such as video monitoring, remote health monitoring, electronic sensors and equipment such as fall detectors, door monitors, bed alerts, pressure mats and smoke and heat alarms can improve older people's safety, security and ability to cope at home. A project called multi-national ENABLE (enabling technologies for people with dementia) in which twelve existing products were studied, overall showed their effectiveness in facilitating independent living and found that these devices may reduce anxiety in people with dementia as well as those caring for them. Assistive technologies that are not actively used by the elder but provide monitoring or other types of assistance, sometimes in place of people, is used for support. Assistive technology can potentially substitute or at least supplement personal assistance in certain cases. ***Technology: acceptance*** In a longitudinal study investigating the attitudes of users of in-home sensor monitoring technology, a majority of older adults were accepting of technology, though they did express concerns and their concerns increased during the year of observation ***Technology: limitation*** Many seniors, especially those with cardiovascular risk factors like hypertension and diabetes, have executive impairments that make it difficult to plan, organize, and multi-task. Therefore, technologies with windows-based platforms may be difficult to use. Given the aging population and need to improve care processes and care for the elderly, technology offers great promise, yet the potential is tempered by lagging adoption by older patients and human factors challenges. ***Support system*** Assistive technologies that are not actively used by elder adults but provide monitoring or other types of assistance, sometimes in place of people, for support. ***Quality of life*** For many, prolonged independence, enhanced quality of life, and improved health outweigh privacy concerns that might restrict use of technology. ***Positive effect*** Assistive technology can potentially substitute or at least supplement personal assistance in certain cases. ***Health promotion*** Several reviews have examined the impact of a variety of technological innovations for improving health care of the elderly or disabled, often called *assistive technology,* which includes items to improve mobility, monitor for safety, and facilitate communication in emergencies.

Appendix 3. Example of tables created using deductive method

Table 4. The answers to three research questions by each unit of analysis.

Studies	What are the available modern technologies used in elder care?	How are these technologies incorporated in the elderly care
(1) Fischer S. et. al., 2014	Modern technology talks about Assistive technology. Assistive technology can potentially substitute or at least supplement personal assistance. Assistive technology includes video monitoring, re-mote health monitoring, electronic sensors and equipment such as fall detectors, door monitors, bed alerts, pressure mats and smoke and heat alarms. These Technologies facilitates independent living.	ENABLE Technologies facilitates independent living and found that these devices may reduce anxiety in people with dementia as well as those caring with them. These technologies also improve older people´s safety security and ability to cope at home.