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Yared Solomon Wolde

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The use of robots is common in most industries including the health care industry, robots has been developed to assist or work alone from lifting objects to assisting in surgery. The purpose of this master's thesis was to explore the use of SARs and their emergence into LTC sector. This study aimed to find out the functional categorization of SARs, and possible challenges of using SARs in an LTC setting.

This descriptive literature review used EBSCOhost and PubMed search engines and manual searches to collect data. Scientific articles published after 2008 were selected in this study and integrative review method was used to process and analyze the data. A total of 131 scientific articles were found on a topic level and went through the selection criteria. In the end, nine articles were selected for final analysis. This study selected articles which discussed SARs from a long-term care perspective.

The result showed that SARs were categorized based on the kind of support they aimed to provide; physical support, non-physical support, and unspecified support. Most SARs on the market fall into those functional categories. The study also showed many users have a positive attitude towards SARs however there was low acceptance of physical contact. Besides, SARs evaluated in the studies were viewed as safe and useful but some which give cognitive support were found to show no significant effect on the users.

This may indicate that the use of socially assistive robots in long-term care is yet under progress and SARs which provide non-physical support are more widely noticed in the LTC sector.

Keywords	Socially assistive robots, service robots, humanoid robots, long-term care, elderly care, aging, disability

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1.Introduction

The global population reaching the stage where life expectancy has grown and the baby boom generation going to retirement which will make the western society among the first to notice the demographic change. In a 2015 study, in the Western European countries, 21% of the population was over the age of 60 and this age group will be 33% by 2030. Moreover, by the year 2050, there will be more people over the age of 60 than those under the age of15. This will result in a decreased number of working-age people in the future causing higher cost of elderly care that will be a challenge to the health care system and the economy in general (Abdi, Al-Hindawi, Tiffany, Vizcaychipi 2017:1).

In many industries, the shortage of labor has been solved by technological innovations such as automation and robots. Currently, the health care industry is also being supported by automation and robotic systems especially in the sophisticated wheelchair technology, robotic limbs, and robotic surgery. But physically assistive robots are yet to solve the problem caused by a mental health problem, dependencies associated with aging and other disabilities. Recently socially assistive robots (SARs) are coming to the pictures. These robots are designed to perform a series of physical and non-physical tasks. The care provided by robots is understood to have huge potential for enhancing productivity and improve service quality by introducing different business models (Abdi, Al-Hindawi, Tiffany & Vizcaychipi 2017:2; Alto 2017:10).

Socially assistive robots (SARs) are expected to fill the gap where there is a shortage of workforce and help in a physically laborious task. SARs found in long-term care (LTC) can be two kinds: service robots and companion robots. Service robots are for helping users with their daily activities whereas companion robots are for engaging in activities aimed at improving cognition and entertainment. Some of such kinds of robots are Sony's AIBO, Paro, Care-O-bot, Pepper, Dinsow, robot nurse Bear. Despite such kinds of robots making the headlines their implementation was low (Abdi, Al-Hindawi, Tiffany, Vizcaychipi. 2017:2; Hosseini & Goher. 2016:2-5).

Most of the SARs mentioned above were invented in Japan where there is a high number of aged populations with a low birth rate. And the country is determined to improve the care service with assistive robots and other technological innovations. European countries and the US, having similar problems followed Japan's robot care system (Sharkey 2014:30). Due to advancements in robotics technology, robotics technology has started to broaden its focus to the health care service (Khosla, Nguyen & Chu 2017:510-511).

The purpose of this master's thesis is to find out the challenges of implementation of socially assistive robots in long-term care by reviewing previous researches in the area. The thesis also explores the positive outcomes and limitations of SARs and the future in the LTC.

2. Socially assistive robots (SARs)

The increasing number of elderly people and the shortage of health care workers are inviting innovative and new ways of giving services. Even though robotics has been playing a big role in medical care fields such as surgery and automation, it is recently that it was incorporated in different forms into the long-term care (Hosseini & Goher. 2016:11-12).

Due to the progress in robotics technology, robots now can perform complex tasks, are skillful, flexible, and can learn from their environment. Because of that the potential robotics has immensely expanded and resulted in several application areas. The current demographic change demand for new ways of carrying out tasks, and the economic crisis, as well as the opportunity created by information technology, make the way to the emergence of assistive and health care robotics. Assistive robots' sale of different kinds for the elderly and handicapped people was 6,400 units between the years 2013 and 2016. (Hosseini & Goher 2016:12). SARs development has been researched more in the last decade and the interest to integrate them into the care sector is increasing (Khosla, Nguyen & Chu 2017:511).

Researchers have been working on robots that can assist elderly and disabled people in their daily activities and facilitate social interaction. Robots such as Paro, AIBO, NeCoRo, and iCat has been developed to be companions to people and help in relaxation, and socialization. And these pet-like robots were found to have a positive impact on elderly people. Even though these SARs have been successful, they have limitation such as unable to have human-like natural interaction, gesture, emotion, and other human-like characteristics which create a smooth communication and interactions with their users. In addition to that, robots like Kabochan Nodding communication robot has brought memory function and other cognitive improvements. It is also reported that PaPeRo robot (also called Matilda) has positive engagement in elderly care centers crossing technological barriers (Khosla, Nguyen & Chu 2017:511-513).

SARs with human-like features such as Nao robots, Brian 2.1 robot, and Hobbit robots has been proved to improve communications among elderly people and increase the initiations to participate in daily activities. (Khosla, Nguyen & Chu 2017:511). Giraffe telepresence robot is one good example that lets family members and health care workers communicate in a video call through the Giraffe robot enabling them to talk, see how things are and give direction such as reminding an elderly to take medicine. Giraffe robot has been a practical and helpful virtual tool to help, communicate and guide elderly people who live alone (www.giraff.org). The Sanyo Bath Robot was planned to physically wash clients and Mealtime Partner, My Spoon, and Winsford Feeder robot are designed to feed disabled users (Bedaf 2015:96).

A robot called Care-O-bot that can communicate with the elderly and help lifting the person or support walking is also available. This robot is designed to carry and lift things and connect the elderly with the outside world through an audio-visual portal. The robot can learn and recall the clients' daily routines and help them by reminding them of scheduled activities they should remember (Hosseini & Goher 2016:12-13).

According to the study made my Alto university (2017) ROSE (Robot and the future of welfare services) project, in Finland several municipalities already

implemented telepresence technology for remote care in one in ten clients in home-care.

2.1 Functional classification of SARs

Robotic technology is enabling interactive assistance to people with different limitations. The main driving force for robotics care in the LTC is the increasing aging population that needs constant care (Alto 2017:8). SARs are of two kinds based on the kind of service they provide: service and companion robots. The Japanese nurse robot Bear is a good example that assists people by physically lifting and moving. On the other hand, Companion robots are made for being a companion and to improve the users' psychological and overall well-being. These kinds of robots are widely used in elderly care and for people who live at home alone. Some of the companion robots are Robot Paro, Robot Dinsow, iCat, and Pepper (Abdi, Al-Hindawi, Tiffany, Vizcaychipi 2017:2; Hosseini & Goher 2016:13-15).

3 Aging and the need for Long-term care

The world has a common global population phenomenon which is an increase in the number of aging people. The United Nations (2017) described the world population as “aging” in its 2017 world population report. In this report, the global population over 60 years of age doubled in 2017 unlike the previous decades. And the global population of elderly people will be twice bigger than the current number by 2050. According to the 2017 population data, population aging is greater in Europe and Northern America which shows one in five people are over the age of 60 years. Although the aging population is also growing in the other regions of the world, in 2050 it is estimated in Europe and North America elderly people will constitute 35 percent and 28 percent of the total population respectively. As shown in figure 1, the global population shows an increase in different age group including people aged 60 and over, and 80 and over (United Nations 2017:4-7).

In 1980 all of the top ten countries with the largest number of people aged 60 years and above were European countries, similarly, this rate was nine out of ten in 2017. It was projected that in the year 2050 five of the top ten with the highest number of people over the age of 60 are European countries. The UN said the increased aging population is caused by the low fertility and better quality of life which happened first in Europe starting in the late nineteenth century (United Nations 2017:4-7).

In Europe, Finland is one of the countries who has the oldest population and in addition to that one of the fastest aging population. This aging population is expected to age in a better condition having a better functional ability than the preceding generation. According to a 2016 population projection by the national institute for health and welfare (THL), the Finnish population segment which is over 65 years old will be 29 percent by the year 2060 increasing by 9 percent from the current 20 percent. It is expected that functional ability to decline and people with such a problem will need more and more support as they reach the late old ages (THL 2018).

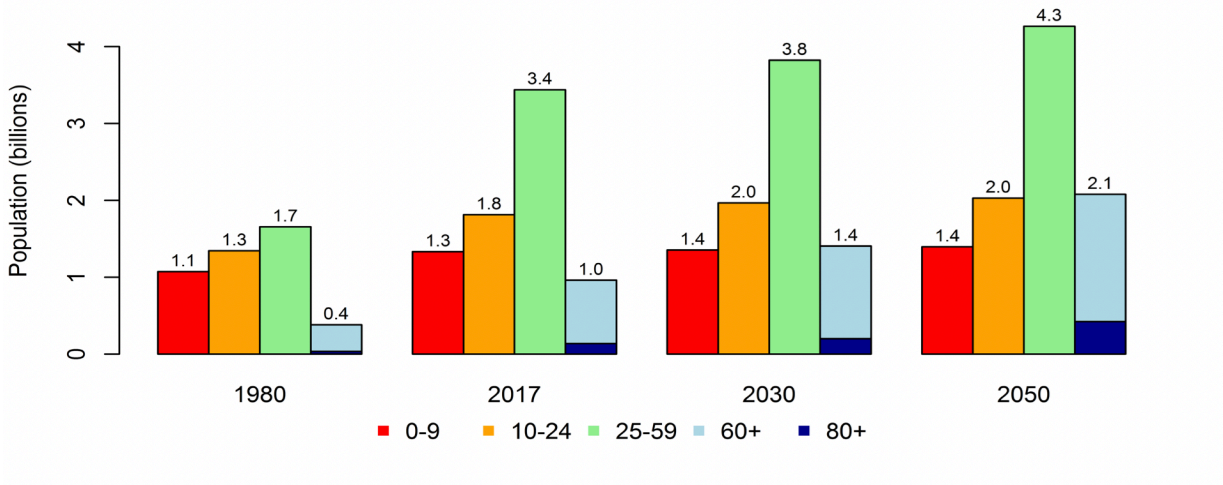

Figure 1. World population prospects:2017. (Data source: United Nations (2017))

In Finland, the work is already underway to find new ways to support and help people with decline functional ability. Finding innovative and effective way is

expected to lower the high cost of social and health care. The Ministry of Social Affairs and Health formulated policies on aging and promote elderly people active participation in society. The ministry sets acts and legislation which gives older persons to get social and healthcare services based on their needs. The Act of supporting the capacity of elderlies that came to action in 2013 gives the right to older persons to receive the social and healthcare services based on their individual needs. (THL, https://thl.fi/fi/web/ageing/ageing-policy)

Finland has a publicly funded and universal system of long-term care which is available for every citizen. Section 6 and 19 of the Finnish constitution gives the right to have long-term care and the Finnish law makes the public sector responsible for providing quality long-term care services for elderly people. The Ministry of Social Affairs and Health in its National Framework for High-Quality Services for older people provides ethical principles of long-term care services. These ethical principles allow elderly people to participate in the LTC service decision making and get enough information. The principles are also to make the LTC equally provided for all people but consider each individual as a separate individual with unique needs, allowing the elderly people to participate in their society and security of the home and care centers against fire and other security risks (Johansson 2010:1-4).

According to Gereve (2017:143) defined long-term care (LTC) as reliable and continuous help and support required to carry out daily living activities when a person is suffering from physical and/or mental disabilities.

In Finland, the Primary Health Act and the social Welfare Act are the two regulatory laws of the LTC services. The lower Finnish administrative system which is the municipality responsible for public social and health care services where LTC is provided. The Finnish LTC includes services for elderly people from home cares to institutional cares (Johansson 2010:3).

The need for long-term care (LTC) is believed to increase as a result of the aging population increase and in Europe, between the years 2008 and 2060, the number of people aged 80 years and older is projected to triple. Daily activities can

be limited due to age-related activity limitations or diseases as result care and assistance needs are expected to increase. Long-term care can be provided in homes, care home and day centers (Gereve 2017:143-144).

LTC expenditure is a large and increasing component of GDP and health care costs in the public and private sector. As shown in the graph on figure 2 total and public LTC expenditure as % GDP in the EU has been increasing between the years 2003 and 2015. (European Commission, 2018)

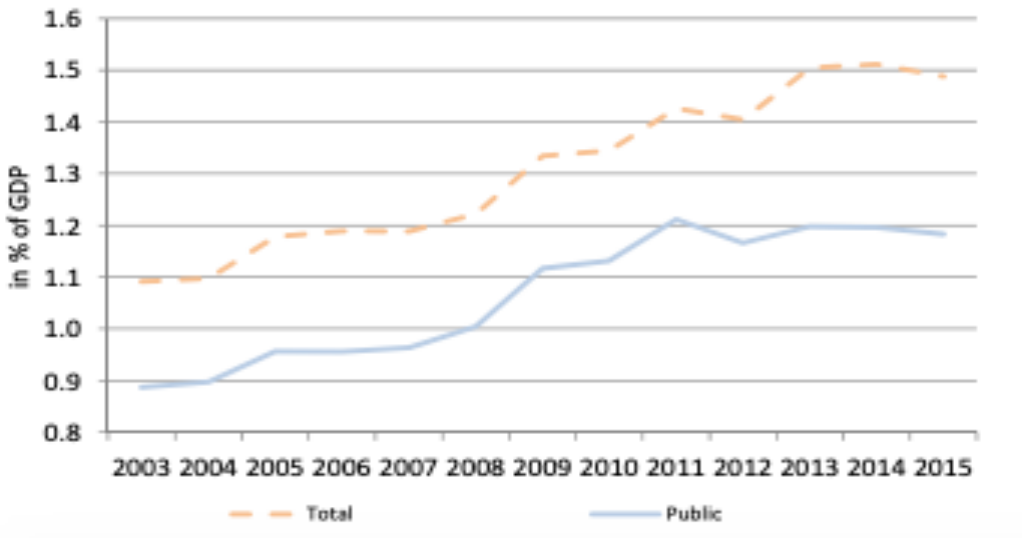

Figure 2. Total and public LTC expenditure in the EU, as a percentage of GDP
Source: European Commission 2018.

EU countries financially support the LTC either by directly giving the services or give out the money to the service recipients and the recipients get the service from other LTC service providers. The countries also give out cash to informal caregivers such as family members. The percentage of LTC recipients from the general dependent population is high in Finland in home-care, institutional care and those who get cash benefits. (European Commission, 2018)

In 2006 in Finland LTC costs 2,559 million Euros which is around 1.5% of the GDP. These expenditures on LTC was also distributed to different facilities that provide care in different levels as shown in figure 3. This chart shows the LTC

services are provided in different levels of the health care system and these levels share the expenditures on LTC (Johansson, 2010:4).

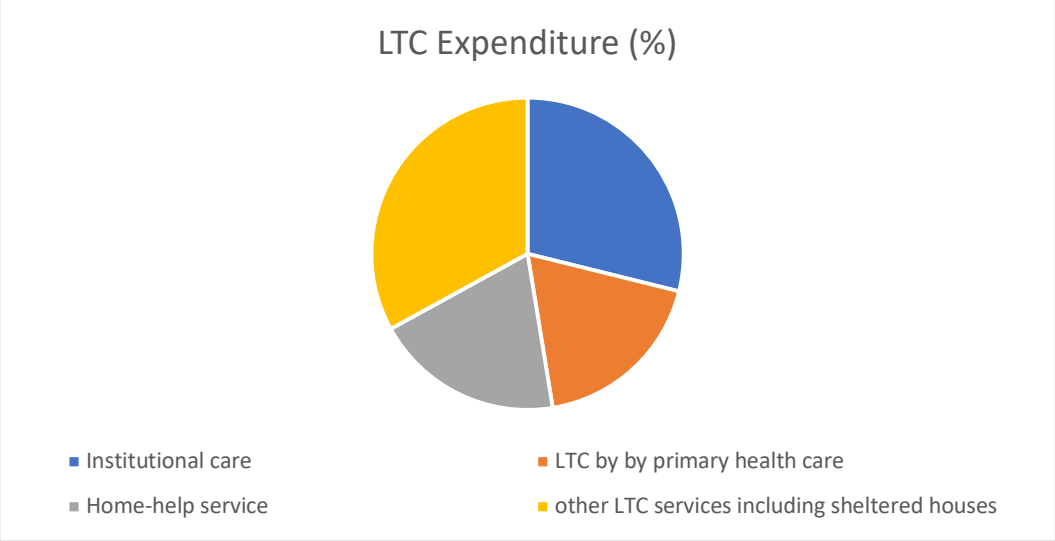

Figure 3. Expenditure of LTC in Finland

In Finland the LTC services are provided by government and private institutions, the private sector provides 28-29% of the service needed. (Johansson 2010:4-5)

The demand of LTC in Finland is being associated with the increasing aging population especially age 65 and over and 80 and over, and the inability to carry out an active daily living (ADL). The population increase age 65 and over and 80 and over was shown above in figure 1, which shows in Finland these groups' numbers will be high. According to a population survey called Health behavior and health among elderly Finns age 65 and overdone by National Public Health Institute, 18% of the respondents need help in heavy household activities. (Johansson 2010, 5-6)

A good comparative data of the status of Finns' need for LTC was published by the European Statistics on Income and Living Condition (EU-SILC) survey which

examines living conditions in addition to income, poverty and social exclusion. In this survey Finns' need for LTC was compared with other EU countries and it was shown more Finns (23.3%) who are 65-74 years had limitation in active daily life or daily activities than those in other EU countries (14.3%). The same is true for those who are 75-84 years old, where more Finns in this age group have limitations to daily activities than people with the same age group in other EU countries. The European Commission reported in 2009 274 000 people are thought to be dependent and this number is expected to reach 485 000 in 2035. (Johansson 2010. 6-7)

The severity of the mental and physical disability is strong on people of the very old age group such as 80 years old and over and that will lead to dependency, as shown in figure 4, dependency rate increases with age. People's need for LTC will increase due to their age-related disabilities or diseases and their dependency on others will increase as a result. (European Commission, 2018).

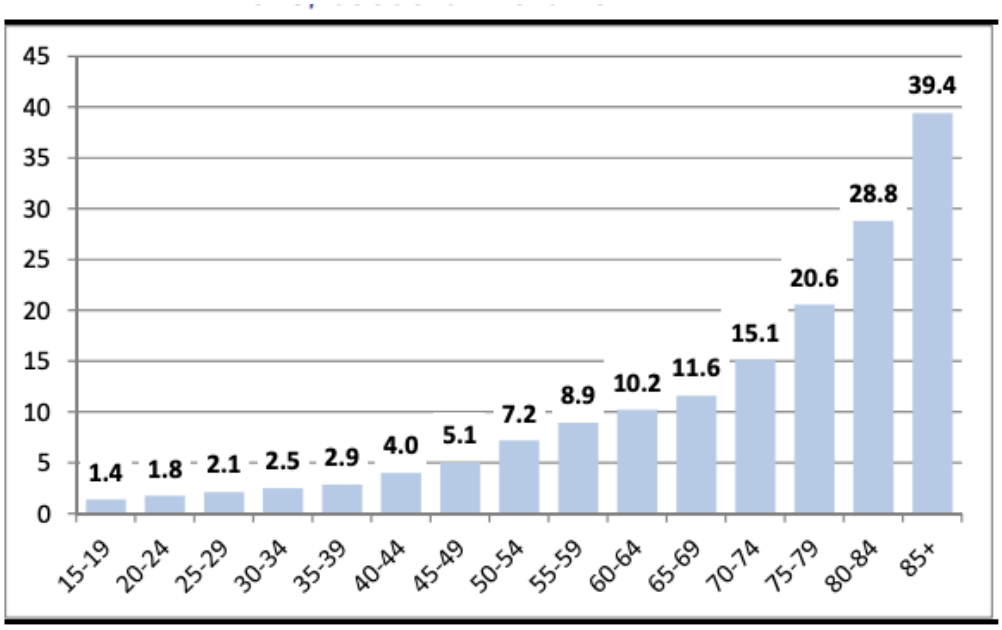

Figure 4. Median dependency rate by age-group for EU countries.
Source: European Commission 2018

According to the 2018 European commission aging report LTC is a labor-intensive sector which is expected to be affected by an increase in the aging population. The workforce which carries on the LTC is a low salary and recognition group which is affected by high turnover shortage of staff. The aging population will

result in a decrease in the working-age and that leads to the shortage of people who can work in the low skilled LTC sectors. Some countries tried to solve this problem by formulating policies to bring migrant workers which may help in the short-term period, but the long-term effect of this approach is not known (European commission, 2018).

Another study made in 2006, in Finland the LTC sector has around 67,000 full-time workers, of these 12,000 worked in home-care. In the same year, it was recorded 18,538 persons were in residential homes, 11,201 persons were in an LTC inpatients in certain health care centers. Also, there were 8,692 persons in a 24-hr service home, 55,000 persons aged 65 and over get regular home care services and 20,00 persons age 65 and over get informal care and support at home (Johansson, 2010).

3.1 Availability of LTC service in Finland

In Finland, LTC is given at different levels based on the care demand of the clients. One of the basic levels of care is the one give at home or home care. In this kind of service nursing care, personal and social support will be provided. In the home care service, people receive a regular or on-demand visit by health care workers and receive help and support. On the other side, there is institutional care where people can get the service in nursing homes and inpatient department of healthcare centers. Between the home care and institutional cares, there is a new type of service that came to serve in the past 15 years- the service homes. The service home also can be divided into two, ordinary service houses or sheltered homes and sheltered houses with 24hr medical services. There is also another kind of service provision which is similar to day-care for elderly people which provides the meal, care or some kind of medical services (Johansson 2010:7).

In the Finnish LTC people entitled to receive the service can get the benefit in kind or cash. The benefits are paid by the Social Security Institution (KELA). The Finnish LTC system is intended for formal care even though there is informal care which can be supported by the allowance for home caregivers (Johansson, 2010:3).

4. Aim and purpose

The purpose of this study is to identify the current status of SARs in long-term care and to review the emergence, development, and future of robotics into the growing area of long-term care.

This study aimed to find out the challenges of SARs use in long-term care, the challenges and limitations, and challenges from the point of acceptance, safety, the usefulness of the technology.

5. Method

In this study, a descriptive literature review was used and integrative review steps were followed to ensure a systematic approach. Integrative review is an all-inclusive methodological way of review and it will let the writer incorporate experimental and non-experimental researches. This method of review also uses theoretical and empirical studies. Integrative review can be used for different purposes in research, for example, defining concepts, reviewing theories and evidence and analyzing methodological problems, it can also reveal up-to-date knowledge about a certain topic (Souza, Silva & Carvalho 2010: 102-103)

Integrative review can be done in six phases: (1) formulating the research questions (2) literature search (3) Collecting the data (4) critical analysis of the selected studies (5) Discussing the results (6) presenting the review. (Souza, Silva & Carvalho 2010:103-105)

Using the Population Intervention context outcomes (PICO) the research questions and literature search questions were formulated. The study questions are the following:

1. What are the most common functional categories of SARs in long-term care?
2. What are the main functional challenges of SARs users in long-term care from the point of (1) acceptance of SARs (2) feeling of safety and (3) usefulness of SARs as aid in daily activities?

The PICOs in the two search questions are listed below in Table 1.

Table 1. PICOs in the two search questions

The PICOs for question 1	**The PICOs for question 2**
Population: long-term care users(elderly)	Population: long-term care users(elderly)
Intervention: SARs assisted care	Intervention:
Context: ling-term care (?)	Context:
Outcomes of Interest: identification of functional categories of SARs	Outcomes of Interest: challenges of acceptance of SARs, the feeling of safety, usefulness.

5.1 Database search

Integrative review method let us combine researches made in different methods (Suaza.2010). Different research articles were collected using the following search engines and databases: EBSCOhost search engine which contains the following databases: CIBHAL; Academic Search Elite; MEDLINE and ERIC, and PubMed search engine. Additional studies were collected by hand search.

The EBSCOhost search engine was used to collect the research article for this thesis. Keywords were identified which I thought are representative of the main concept and idea in this study. And these keywords were searched with their combination in the search engines to be searched in the title or the abstract part of the articles. In search engines, Boolean search mode was used. The keywords searched were:

- humanoid robots OR socially assistive robots OR service robot OR robot care AND

-long-term care OR elderly care OR old adults OR aging OR disability AND

- acceptance OR receptivity OR adoption OR compliance OR admission OR adherence

Using the above keywords combinations, the result of the search was 110 articles from EBSCOhost and 10 articles from PubMed and from that only 44 articles were directly related to the topic and idea of this thesis. Besides, 11 studies were found by hand search going through studies relevant to this study.

5.2 Selection criteria

The search was performed in EBSCOhost and PubMed at different times between 1 February and 8 March 2018. The following different limiters were used to narrow the search: articles with full text, the publication year 2008 to 2019, peer-reviewed articles, language English, and only research articles. And the expanders used in the search were applied related words, search within the full text of articles and apply equivalent subjects.

Inclusion criteria for studies selected were targeted on humanoid robots as socially assistive robots in long-term care, socially assisted robots help in daily activities of an elderly or disabled person, implementation of socially assisted robots in long-term care, acceptance and challenges of SARs by older adults, the need for SARs in the long-term at present and the future. This study also included peer-reviewed quantitative and qualitative studies.

The selection of studies excludes all studies about SARs and/or humanoid robots which are used for surgical or medical care in the health care industry, humanoid robots aimed for transportation use or automation of medical settings, humanoid robots made to ease off physical work in a normal household or other robot-like household devices and humanoid robots or robot-like automation in any industrialized works. Figure 5 the number of studies selected at different levels of examining the literature found. From the three methods of literature search, a total of 9 studies were chosen for the final analysis phase because of their relevance to this study.

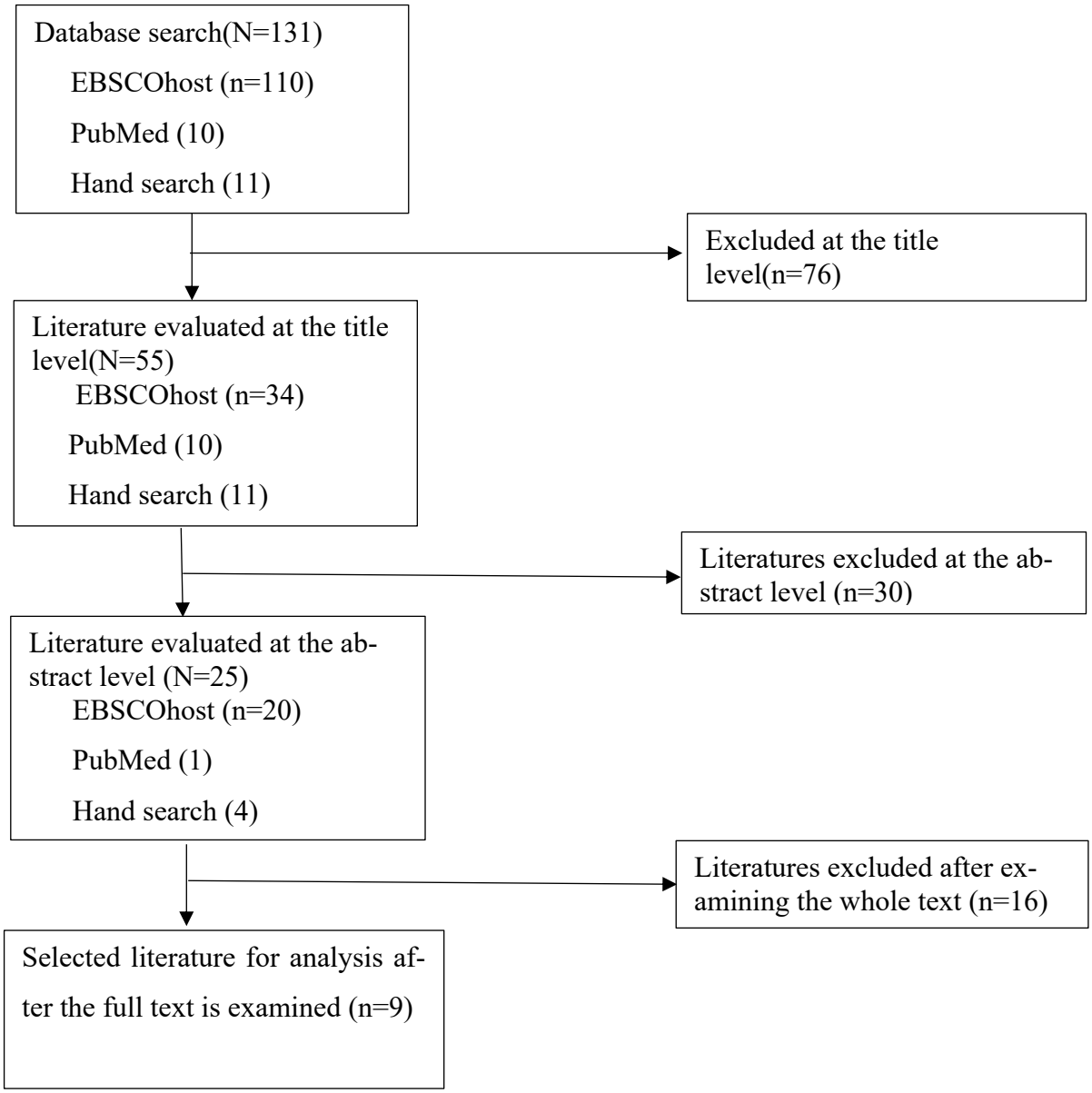

Figure 5. Flow chart of the selection process of the literature.

5.2 Assessment of Quality

Creating methods of assuring the quality of studies is important in the selection phase and a consistent and reliable method is needed (Polit & Beck 2005:91). In an integrative review with different empirical sources, it may be acceptable to evaluate the quality of methodology including authenticity, information value, and representativeness of the primary source (Whittemorer and Knaflk 2005:547).
The literature searched and collected were qualitative, quantitative and mixed researches. The STROBE checklist of shortened version was applied for assessing researches made with different methods. Table 3 shows critical assessment of the studies in the shortened format of STROBE checklist.

Table 2. Assessment criteria of the studies

References	**Assessment criteria of the studies**									
	1	2	3	4	5	6	7	8	9	10
Louie, et al.2014	**	**	*	*	**	*	*	*	*	**
Marasinghe.2016	**	**	**	**	**	**	_	**	**	**
Broadbent, et al.2016	**	**	**	**	*	**	*	**	**	**
Koceski, et al.2016	**	**	*	*	_	*	*	**	_	**
Khosla, et al.2017	**	*	**	**	**	**	*	**	_	**
Bedaf, et al.2015	*	*	**	*	_	**	_	**	**	**
Kachouie, et al.2014	**	**	**	**	_	**	*	**	**	**
Abdi J.,et al.2017	**	**	**	**	**	**	*	**	**	**
Pigini, et al.2012	**	**	**	**	**	**	**	**	*	**

1. Study background and theoretical framework are clearly defined.
2. Purpose, aim and research questions are clearly defined.
3. The design is clearly stated.
4. The setting is clearly described.
5. Independent, dependent, and confounding variables are clearly defined.
6. Data sources and analysis methods are clearly described.
7. Describes any efforts to address potential sources of bias.
8. Answers the research questions logically.
9. Discusses the study's limitations and generalizability.
10. Relevance to the topic.

** satisfies the assessment criteria
* partly satisfies the assessment criteria
_ hardly or not at all satisfies the assessment criteria
x assessment criteria do not apply

From theme-based analysis of the final relevant studies it was found there are two themes functional categories of SARs in LTC and functional challenges of SARs. Under the first theme two themes were identified; physical support and non-physical support. Under the second theme usage rate, difficulty of operating or using, limitation of mobility and interaction, lack of technological ability, safety issues, acceptance by users, families, and caregivers, and usefulness.

Table 3. Theme formation

Themes	
Functional categories of SARs in LTC	Functional challenges of SARs
Physical support	Usage rate
Carrying and transporting objects	Low usage rate of SARs in LTC
Walking aid	Low demand and trust
Dressing up	The difficulty of operating or using
Washing	Ease of use
Eating and drinking	Limitation of mobility and interaction
Preparing food and cleaning	Limited mobility of the SARs
	Architectonical barriers in the living areas of the uses
	Limited interaction with the users
Non-physical support	Lack of computer use know-how
Reminder for daily routines	Technical and technological limitations of the SARs development
Monitoring the users and their surroundings	Safety issues
Providing different kind of basic information	Safety, trust and attitude concern from the users, their family, and caregivers
Security and fall detection	
Social interaction or means distance communication	Acceptance by users, families, and caregivers
Entertainment	Usefulness
Rehabilitation	Impact of the SARS on the daily living activities of elderly people, behavior or motivation
	Actual usefulness

Author & publication year	Title	Country	Aim and purpose	Design	Data and method	Main results
						19
Louie, et al.2014	Acceptance and Attitudes Toward a Human-like Socially Assistive Robot by Older Adults. Canada	Canada	Investigate the acceptance and attitudes of elderly people towards SARs	Data collection, measurement, and analysis	Questionnaires and experiment	The research has found out in the questionnaires that the majority of the elderly have a positive attitude and acceptance to SARs and their use.
Marasinghe.2016	Assistive technologies in reducing caregiver burden among informal caregivers of older adults: a systematic review. Canada	Canada	Investigate, evaluate and analyze existing studies to find out the effect of assistive technologies on reducing the burdens of the caregivers.	Different databases were searched and a systematic literature review was applied.	Systematic review	In two theories the study found out caregivers' burden could be relieved by the use of assistive technologies.
Broadbent, et al.2016	Benefits and problems of health-care robots in aged care settings: A comparison trial. New Zealand	New Zealand	Aimed at investigating the possible benefits and problems of multiple health care robots in an elderly care facility.	The study used 53 residents and 53 staff in a non-randomized controlled trial for 12 weeks period.	A comparison trial/non-randomized control trial	The study found out the multiple healthcare robot examined in the research has no major benefits or harm.
Koceski, et al.2016	Evaluation of an Assistive Telepresence Robot for Elderly Healthcare. Macedonia	Macedonia	This study investigates the acceptance level of a developed robot system.	Using 35 persons in two groups, caregivers(5) and elderly clients(30)	Questionnaires and experiment	The questionnaire used to evaluate the acceptance of robots were presented in perceived usefulness and

						Perceived ease of usefulness.
Khosla, et al.2017	Human-Robot Engagement and Acceptability in Residential Aged Care. Australia	Australia	Aimed at examining the engagement and acceptability of social robot named Matilda demented elderly people	Statistical computation was used in the study using SPSS.	Engagement assessment method and robot acceptance model	The study found there is a statistically significant improvement of elderly peoples' emotional, visual and behavioral engagement.
Bedaf, et al.2015	Overview and Categorization of Robots Supporting Independent Living of Elderly People: What Activities Do They Support and How Far Have They Developed. The Netherlands	The Netherlands	This study aims to categorize robots which are used to support independent living and to find out how which activities they support and their developmental stage.	Database search for supporting literature were used and analyzed	Systematic review	Robots currently in use were categorized based on their respective functions and their developmental stages.
Kachouie, et al 2014	Socially Assistive Robots in Elderly Care: A Mixed-Method Systematic Literature Review. Australia	Australia	Evaluates the impacts of SARs on the wellbeing of elderly people.	Combines qualitative and quantitative studies. Reviews	Systematic review. Review interventions and their classification and made measurement and review outcomes.	The study revealed the positive effect of SARs which is enhanced wellbeing of elderly people
Abdi J., et al.2017	Scoping review on the use of socially assistive robot technology in elderly care. UK	UK	Aimed at examining present time use and future role of SAR	Scoping review	Supporting literature were collected by searching for different databases and manual search and were analyzed.	It was found that SARs has positive effect and five roles of SARs were identified.

Pigini, et al.2012	Service robots in elderly care at home: Users' needs and perceptions as a basis for concept development.	Italy, Spain & Germany	Aimed to formulate user requirements and realistic usage scenarios.	A qualitative and quantitative study in three countries based on focus groups surveying elderly people, family members, and healthcare workers.	Quantitative and qualitative survey.	SARs were judged to be a preferred solution only in some situations such as monitoring, caring heavy objects or reaching and fetching things in unreachable places. But tasks done by SARs which have direct physical contacts were not accepted.

Table 4: Description of the selected references.

6 Results

6.1 Description of the selected researches

The nine selected studies were studies that are relevant to this study and have similar focus areas. As shown in Table 5 studies were made in different counties: two in Canada, one in New Zealand, one in Macedonia, two in Australia, one in The Netherlands, one in the UK, and one of the studies was made in collaboration in Italy, Spain, and Germany. Four out of the nine studies were quantitative, three were qualitative and two were a combination of qualitative and quantitative studies. Among the nine studies selected seven of them(Louie, et al.2014, Broadbent, et al.2016, Koceski, et al.2016, Khosla, et al.2017, Bedaf, et al.2015, Kachouie, et al 2014, Pigini, et al.2012) are directly related to this studies whereas two (Marasinghe, et al.2016 and Abdi J., et al.2017) are not directly related but focus on a similar concept.

From the seven studies which are directly related, three of them (Louie, et al.2014, Koceski, et al.2016, Bedaf, et al.2015) focus on acceptance, problems, and benefits of SARs, attitude towards SARs. Impact and use of SARs were discussed in four of the studies (Marasinghe, et al.2016, Kachouie, et al 2014, Abdi J., et al.2017, Pigini, et al.2012)

6.2 Functional categories of SARs in LTC

Bedaf et al. 2015 made the distinction of SARs based on the kind of support they provide, those providing physical support, does not provide physical support and unspecified support. Robots that provide physical support can help their users in carrying and transporting objects, as a walking aid, going on stairs, dressing up and washing, eating and drinking, and provide help in preparing food and cleaning up. Whereas the non-physical supports a robot can provide are: (1) setting a reminder for daily routine such as reminder for taking medication or doing some kind of health measurement or ordering or receiving goods or services. (2) monitoring the users and their environment-this includes fall detection, home security and activity follow up. (3) Providing information to the users about controlling

household equipment and appliances, doing emergency calls and doing different health measurements. (4) Social interaction i.e. creating communication means. (5) Entertainment is the other non-physical support. There are also other non-specified supports such as generally supporting daily life, aid in medication and other non-specified supports (Bedaf, 2015:90).

Similarly, the robotic system can also be categorized in four main application areas, as identified by the ROSE project (Alto, 2017): (1) Robots for hospitals which includes robotics systems lifting patients or medical transportation. (2) Rehabilitation and physical support- rehabilitation devices, prostheses, and external body support. (3) Personal physical support such as movement, lifting and transporting objects, cleaning, walking, etc. (4) Individualized cognitive and social support this includes telepresence or cognitive support (Alto 2017). Both Bedaf et al and the Rose project (Alto 2017) categorized the socially assistive robots in a similar functional way.

Started between the year 1997 to 2013 Bedaf et al. found 95 different kinds of SARs in their developmental stage and aimed to give physical, non-physical and unspecified support for the elderly people living at home or in a long-term care facility. In 2015 Bedaf et al. found 6 robots commercially available: IFno, Mealtime partner, My spoon, Parow, Sanyo bath Robot and Winsford Feeder (Bedaf et al. 2015:94-96).

6.3 Functional challenges of SARs from the point of acceptance, safety and usefulness.

Louie et al. 2014 studied people's perception of robotic and robot-like technologies by a questionnaire developed to measure and access people's attitude towards robotic technologies. Besides that other measurements of perception of people towards robots has been developed such as Negative Attitude Towards Robots Scale(NARS) which measure attitudes of users before use of the intended robot, the Perception to Humanoid robot (PERNOD) measures people's

perceptions and the Almere model evaluates elderly people's acceptance and attitudes of socially assistive robots (Louie et al. 2014: 141).

Louie et al. 2014 measure elderly users' acceptance and attitude of their socially assistive human-like robot Brian 2.1 and they found out the elderly users had a positive attitude and low anxiety towards the robot.

From a different perspective, Marasinghe.2016 found two opposing results about assistive technologies. In the first finding, assistive technologies such as activity monitor and video communication of virtual natures could add to family member caregiver burdens because of the constant need for attention. And in the other finding, it was observed assistive technology can reduce caregiver burden by being a tool and help in the physical daily activities of caregiving that require physical strength by the caregivers.

Khosal et al. 2017 studied the engagement and acceptability of socially assistive robots in residential care centers. They found improvement in emotional, visual and behavioral engagements of elderly people who participated in different activities and entertainment programs carried out by socially assistive robots. And the positive engagement rate has brought acceptance among the participants.

In the study made in three countries, Pigini et al. 2012, found out semi-autonomous remotely-controlled were accepted only in certain activities of daily life. The SARs were thought to be useful in monitoring, carrying heavy objects and fetching objects from unreachable places. Whereas activities which require direct physical contact between the clients and robots were not accepted (Pigini et al. 2012: 303).

7 Discussion

The use of SARs as an aid to a person of different needs has been mentioned in different scientific publications and media. This study aimed to find the different kinds of SARs and its categories based on their function. Also, this study examines the functional challenges from the point of acceptance, safety and usefulness by the users (caregivers and patients and/or individual users).

The study designed was chosen to review literature that tells us the current trends and futures of SARs. Unfortunately, there are not much researches done on SARs since it is a new technology. From the 131 research materials found at the first search less than half of them were found to be related at the title level and only nine of them were relevant enough for analysis. And most of the studies found and not considered for analysis were done were from the technological and technical perspective or developmental stages of the technology. The strength of this study is reviewing the general level of SARs use from the functional and usefulness perspective giving a comprehensive information. This study shows the need for more studies that examine the user perspectives of SARs emphasizing users' and caregivers' experience, safety issues and applicable area in the long-term care.

7.1 Functional categories of SARs

The different researches reviewed in this study categorize SARs in a similar categorical classification. Abdi et al. 2012 classified SARs two: service and companion robots based on the service they intended to give. Similarly, Bedaf et al 2015 categorized SARs in three groups based on the kind of service they provide; robots that can provide physical support, non-physical support and unspecified support (Bedaf et al. 2015:90).

In a more detailed way, Alto (2012), listed the classification of SARs in four categories which are robots for (1) hospitals for lifting and transportation, (2)

Rehabilitation and physical support, (3) personal physical support, (4) individualized cognitive and social support (Alto 2017).

The functional categorization of the SARs helps us to understand their intended uses the service they provide. Most researches use or refer back to similar functional categories based on the kind of support robots can provided mainly physical support or non-physical support. The majority of the SARs falls into these categories and this study found it is the most explicit classification.

7.2 Acceptance, safety and usefulness of SARs

This study focused only on robots that are commercially available for use and examines the acceptance level, safety concerns, and usefulness of the technology. The studies reviewed found out that there is a positive attitude and acceptance of the SARs. The safety concern was another issue raised while implementing this technology, the result found most users felt safe with most of the SARs except with the ones which have physical. The usefulness was observed in different areas of clients' daily life and reducing caregivers' burdens.

Even though few similar studies were found some have strong specific focus areas such as acceptance and attitude of users towards SARs, human-robot engagement and acceptability, and benefits and problems.

Broadbent et al. 2016 made a non-randomized controlled trial that participated in 53 residents and 53 staff. They studied the benefits or problems of six robots that can provide leisure activities, social interaction and health checkup services and they compared it to a control group. The findings of this study get mixed feedback of positive, neutral and negative but the study concluded that there was no major benefits or problems because of the use of such kinds of robots. (Broadbent et al. 2016:24-28)

Louie, et al. 2014 studied acceptance of SARs by elderly people between 62 and 91-year. This study examines a questionnaire after the demonstration of a human

like-robot called Brian 2.1 made for the cognitive intervention of older adults. The questionnaires were used to study the users' attitudes towards the robots, perceived sociability of the robots, perceived usefulness, trust, anxiety, perceived adaptability, and ease of use. The study also evaluated the likeability of the robot characteristics such as the voice, appearance and facial expressions. The weakness of this study is the study did not let users use the robots for a while before studying the reactions of the users instead the robots were demonstrated to the people. This study was carried out by the robot developers themselves. This study showed that the majority of the people showed a positive attitude towards the SARs and the intended applications. (Louie, et al. 2014: 140-150)

Khosla, et al. 2017 assess robots called Matilda in a residential age care center by studying the interaction of people with dementia. The study focuses on the service design and the effectiveness of the human-robot interaction mainly human-robot engagement and its acceptability. 115 people with dementia age between 65 and 90 years participated in the study and participants were given a demonstration on how to use the robot and 4-6 hours of use for more than one time. This study found out there a statistically significant improvement of engagement of older people with SARs throughout the study and the robots found acceptance by the users. (Khosla, et al. 2017: 514-517) Compared to Louie, et al. 2014 this study gave the users enough time to use the robots in multiple occasions and compared the results of the different occasions which enables to get a better assessment of the views of the users.

Another study to consider is Abdi, et al. 2017, this study has a similar objective to this thesis, it has aimed to review the current use and future of SARs. It is a qualitative literature review which uses different databases as a data source. The strength of this study is it managed to collect more researches and identified and studied 11 robots and their functions. (Abdi, et al. 2017: 3)

This study found out that even though there are hundreds of socially assistive robots are available in different developmental stages the technology is far from being part of the long-term care system. But SARs intended for entertainment,

remote assistance and reminding clients to perform some small tasks, telepresence and activity monitors have been in use in many countries in different levels. The most common ones found are small animal-like robots used for entertainment. These kinds of robots are more common and can be found in many care centers for elderly people. Most robots intended for lifting, showering and other functions of direct physical contact with the users are under different developmental stages and few has been tested and is used (Louie, et al. 2014: 140-150; Khosla, et al. 2017: 515-517; Broadbent et al. 2016:25-28; Abdi, et al. 2017: 5-11). This study can be a supplement to the current studies around SARs and aid for future studies.

Many studies found out the number of aging populations is increasing with a high rate and the labor-intensive sector of the long-term care will need an innovative way to handle it. This is an indication technological innovation such as SARs can play a big role shortly and more studies need to be done to understand the care needs and technological requirements (Abdi, et al. 2017: 1-2; Louie, et al. 2014: 140-141).

7.3 Ethical considerations

When research is planned and conducted researchers should give careful thoughts to the ethical requirements and should consider the safety humans and integrity of information (Polit and Beck 2005:157). In this study, descriptive literature review method and data collection were all from previous study therefore there is no direct human contact during this study. But the integrity of data was kept while using the right referencing method to the sources.

The Finnish national board on research integrity (TENK) and ARENE advice and set ethical standards for quality of researches to require researches to conduct ethical considerations and evaluation. The copyright act in ARENE requires researches to state the origin, author and source following the law (ARENE 2018). While conducting this study I followed the correct referencing process from data collection to analysis and reporting section. I also strive to keep the correct

meaning of ideas and interpreted data while incorporating them into this thesis. The correct ways of referring to other researches enable the readers to refer back to the source and confirm the evidence or information taken is true. (TENK 2009; ARENE 2018)

According to Polit and Beck 2005, one of the ethical challenges while conducting research is methodological challenges which questions, if the method used, can give accurate and valid results. In this thesis follow of methodological steps were carried out to get correct and valid results

The sources used in this thesis were checked whether they had ethical considerations while conducting their research in their respective countries or not. Broadbent et al. 2016 involved humans in their research to evaluate benefits and problems of robots in elderly care centers and has approval from the Human participant ethics committee of New Zealand and obtained consent from all the participant in their research (Broadbent et al. 2016:24). Pigini et al.2012 also received ethical committee approval in the three European countries they performed the research (Pigini et al.2012:305 & 310). The other research which involved humans, Khosla et al. 2017 did not include ethical requirements in their research. It was noticed from the three researches which have involved humans in their studies only two included ethical considerations. Only these two were also the ones with ethical considerations included in their research among the nine researches used for analysis in this thesis.

8 Conclusion

This thesis made an effort to find out the current use of SARs, the implementation challenges, and functionality in a long-term-care setting. The growing number of the aging population is making long-term-care more expensive and labor-intensive. Most of the SARs intend to reduce the cost and physical burdens of the caregivers. In this belief, many SARs and assistive technologies have been developed and being tested or are in use.

Different assistive technologies and devices, semi-autonomous robots, and human-like robots have been in use to help older adults in their daily life for entertainment, physical and cognitive help, remote monitoring of clients and other activities at their home and in residential care centers. In most of the studies, it was found that there is a positive attitude and acceptance towards SARs. All the researches studied found the usefulness of SARs in providing care for older adults at home or in a care center. Only one study found out that the use of assistive technologies can add to the burdens of the caregivers in some area while it is reducing the burdens of the caregivers in another area. Besides, one study found that physical contacts of older persons and robots were not appreciated whereas fetching and caring objects and similar activities by the robots were more accepted.

The literature collection part of this study has some limitation on which there were not much research done from the health care side of the technology, rather most of the literature done concerning socially assistive robots (SARs) were done under computer science, robotics, and other technical fields. Most of these researches were not selected for this study because their focus was more on the technical part of robotics or the technology. This study focused on the functional aspect and usefulness of socially assistive robots in a long-term-care setting. Because of that, the selected researches for the final analysis were fewer than expected but they were relevant enough to answer the research question.

This thesis aimed to examine how close we are to the reality of using robots in the long-term care, to examine the challenges and limitations, perception of the users towards SARs and the usefulness of the technology. The results of this thesis can be useful in understanding the need for the growing demand of the elderly care and how far we have come to the use of robots and other assistive technologies in this health care area of a growing number of clients.

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