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Smart Home Systems as a Way to Improve Senior Citizen's Public Care

Master's Thesis

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Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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Abstract

Countries around the world face an increasing challenge, that is, the ageing of their population. This natural process demands higher resources from the government, for once, providing health care to a population that loses faculties within time. To provide a solution to the increasing demand for public care for senior citizens, governments worldwide are looking into smart home technologies (SHTs). The thesis aims to pose a public smart home system (SHS) as a way to improve senior care services. Furthermore, its objective is to provide a guideline for the successful implementation of such a technology. The research is conducted through qualitative research, and the author will use the exploratory case study method building on data collection and empirical research done through interviews. To provide a background for the study, the author reviews the literature on ageing-in-place, smart living environment (SLEs), smart homes, and smart city technology. The author then will use the theories of technology adoption as the main theoretical framework. Throughout the studies, state of the art is elaborated, out of which Singapore is selected as a successful model where smart homes helped provide better senior public care. Additional to this, Estonia is chosen for exploring the adoption of SLEs and smart homes in public senior care services. Interviews are the primary source to collect direct information in both cases. Triangulation is used to get different perspectives and reduce bias. After studying and comparing both cases, learnings are draft.

To conclude, the research shines a light on the main reasons for implementing an SHS to improve public senior care services, and it provides a guideline for successful implementation. The results could be a base for future implementation work.

Keywords: Ageing in Place, Smart homes, Smart-Living Environments, Smart Cities, Technology Adoption, Technology Organization Framework.

This thesis is written in English and is 72 pages long, including 6 chapters, 6 figures and 2 tables.

List of abbreviations and terms

AAL	Ambient Assisted Living
ADL	Activities of Daily Leaving
API	Application Programming Interface
A*STAR	Agency for Science, Technology and Research
ERDF	European Regional Development Fund
EU	European Union
IoT	Internet of Things
IS	Information Systems
ICT	Information & Communication Technology
IT	Information Technology
LTC	Long Term Care
PIR	Passive Infra-red
SHT	Smart Home Technology
SHS	SHS
SLE	Smart Living Environments
SLEaw	Smart Living Environments for ageing well
SMU	Singapore Management University
TCS	Tata Consultancy Services
TOE	Technology, Organisation, Environment Framework
WHO	World Health Organisation

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1 Introduction

It is said technology would be the solution to many world problems. Technology makes it possible to connect people across different countries immediately; it helps transform bureaucratic governments and organisations into efficient ones, saving hundreds of working hours and money. On an individual level, it helps to make life more convenient. It does so by developing smart devices that simplify human lives. One type of devices gaining traction in adoption for the way they simplify life is under the umbrella of the Internet of Things (IoT). This term refers to a series of internet-connected objects, which exchange data online without human intervention [1]. The connected objects could be anything, an automobile, a watch, a refrigerator, a medical device, etc. The only condition it needs to fulfil is to connect to the network and share data collected from sensors. Some of these IoT devices are helping people with disabilities to perform tasks as essential as navigating the street or talking to others, etc. Other devices tell us about our heart rates and activity levels to monitor them and live healthier lives. Other devices know our buying behaviours and help us to choose better. Therefore, with the increasing adoption of this type of technology, it is a hope that IoT can help humans to live even better lives. With its help, it is expected that some of the world problems diminish.

One of the problems humanity faces is the one of the Silver Tsunami. This phenomenon refers to the changes in the distribution of the human population where seniors (+65) conform to a more significant part of the population [2]. The Silver Tsunami phenomenon is expected to impact different aspects of society significantly, for instance, creating a larger base of pensioners, increasing the number of requests on the healthcare system, housing market, and workforce. While the term was coin in the middle of the sixties, it is still a current preoccupation, one that is shared by many of the developed countries.

According to the "Ageing Europe" report from Eurostat published in 2019, the number of senior citizens, those above 65, expects to reach 28.5% of the total population by 2050 [3]. In Estonia, population projections expect to have a quarter of the country's population aged above 65 by 2030 [4, p. 9]. The population is ageing rapidly and not ageing as

healthily as other European peers [5, p. 44]. Above all, there is a growing number of seniors living alone, currently 39,8% [3]. As mentioned, such conditions put higher demands on the government to provide more services catering to supporting seniors' health and living, otherwise called senior care services. For reference, senior care services are a specialized type of care developed to cater to the specific needs of the seniors at different stages of ageing[6]. In the area of senior care services, long-term care (LTC) is usually used to define non-medical assistance with daily activities provided to seniors. LTC can be provided in different ways. It can be done at home or nursing homes[7]. Nursing homes are the places where seniors are transferred to, live with other seniors and receive assistance with their "activities of daily living" (ADLs). Traditionally, nursing homes, also called institutional care, are the primary way governments provide care.

In the country of Estonia, in 2017, the World Bank Group presentation "Reducing the Burden of Care in Estonia" suggests a need to reform LTC (supported mainly by nursing homes) because nursing homes couldn't cope with the demand [5]. It suggests explicitly increasing support for informal carers, those who currently carry the burden of care, and strengthening local governments'' capacity for service delivery. The same study also shows that Estonia's expenditure on seniors' public care is lower than in other European countries and could face strains with the increasing demand. In line with this, in 2018, according to The Nursing Care Network Development Plan 2004–2015, it was proposed Estonia enables small hospitals as providers of LTC, converting them into "nursing hospitals" [8, p. 137]. The initiative was supported by the European Regional Development Fund (ERDF) from 2007 till 2013. However, the rise in the number of nursing services couldn't meet the demand. That is why in 2019, the Ministry of Social Affairs published a green paper, "Increasing the use of technology in a person's daily life to support coping and well-being at home" [4], In the report, the need to promote innovation and technology as a way to change the delivery of senior care services was recognized.

In the past, countries undergoing similar problems have looked at implementing technologies to cover up the gap in demand for care services for seniors. The technologies are implemented to support senior citizens' independent life and aim at delaying, as much as possible, sending the citizens to institutional care. The most important technologies evaluated correspond to the smart living environments (SLEs) range, that is, environments enabled to make life easier. Those could be smart homes enabled with

monitoring systems, alarm systems, others. In that regards, studies such as “Smart Cities and The Ageing Population” [9], “Toward Useful Services for Elderly and People with Disabilities” [10], and “New Domestic Healthcare. Co-designing Assistive Technologies for Autonomous ageing at home” [11] are only some examples of the extensive literature that can be found about how technologies can be an ally to enable autonomous ageing and deliver care to senior citizens in their own homes.

This thesis aims to review different literature, look at cases where smart-home technologies have already been implemented and propose a framework for an SHS. The SHS, for the context of this study, refers to a smart home enabled with movement sensors able to collect patterns that caretakers will utilise to improve the care of seniors in their own home. In particular, the author will cover the implementation of this system in Singapore as a model to be aspired and learnt from. The research will collect empirical and secondary data. Its main aim is to review the bases for implementing an SHS to provide care. Following that line, an exploratory case study will be examined in Estonia's current care delivery. Estonia is well-known as a pioneer in digital public service delivery for many decades, both at the state and local level [12], [13], and has, for example, linked all state registries via x-road [14]. However, there is still a need for further development in the area of welfare and care services.

The European Union has already initiated some activities, such as the HOPE Project [15] under the AAL Association [16], to integrate technology such a smart homes that will enable the senior citizen's age gracefully in Europe. In the Baltic Region, the project Osiris [17] aims at promoting technology innovation as a pillar for tackling the problem of a growing elderly population. Estonia is part of the program, and it is indeed a country that could benefit from new approaches in the delivery of senior citizens care services.

In summary, throughout the research, the author does not aim to create new ways of using technology. Instead, the author seeks to develop guidelines for implementing an SHS as part of public services. The results aim to contribute to future research in the matter, specifically to the scientific community: scholars, researchers, or students working on the same topic. It is believed, in the short term, the study would be of interest to different specialists, local governments and private initiatives in countries where re-thinking elderly care is also needed. In the long term, if further implementation is done, it could improve the lives of the senior citizens in Estonia.

1.1 Research Motivation

As the world population ages, it is increasingly important to look for an innovative solution to cover senior citizens' needs. With the idea of providing a solution, researchers and some government officials have identified SLEs as a possible solution. Much has been written about SLE technology design and its interaction with seniors and caretakers and how it is helping to improve senior's independence while reducing care costs. Little has been researched about what is needed to implement this technology as part of the public care system. As part of e-Governance, practical appliances of technology to improve public services is the aim. One of the author's motivation is to expand the knowledge on how SLEs can be used as part of public care services and the key activities for successful implementation.

An initial interest in SLEs was raised from the author's participation in an entrepreneurship project back in 2019. The author and a team participated with an idea for a solution that monitor's senior citizens' activity. As part of her participation in the project, the author became more aware of the Silver Tsunami phenomenon and its challenges. As the author got familiar with assistive technology solutions, she became highly interested in researching how smart home solutions can be used to overcome the challenge of a growing silver population by supporting care to senior citizens.

As Estonia has identified its interest in developing such a technology, the author places the case study in this country. Estonia is a country facing the challenges of an ageing population and is currently looking at innovative solutions to overcome it. It is also a country that claims to be 99% digital and open to innovation. In Estonia, technology adoption is high among citizens, although senior citizens seem to remain left out of the benefits of digitalisation [18]. Henceforth, Estonia provides the right environment for the case study to take a holistic approach to SLEs within senior care.

1.2 Research Questions and Objectives

To conduct the research, the author poses the main research question, **how an SHS could support senior care service delivery?** This question aims to describe the functioning of existing SHSs for Seniors. While answering the question, the author will ponder the benefits of implementing such technology at both a user and a governmental level and the

considerations taken to implement the systems. To answer this question, it would also be essential to understand the health theories and technology adoption theories behind them. Hence the author will cover how Ageing in Place is related to the use of SHSs in senior care and the reasons why SHSs are an attractive solution, among others. Also, it is essential to understand the way other countries implemented SHSs. Particularly the case of Singapore will be used as a model of successful implementation.

Furthermore, as the research takes Estonia as a research focus, it is important to answer the main question within the Estonian context. To achieve that objective and to further support the main question, two additional research questions are established:

How are SLEs used to support senior care in local governments in Estonia?

By posing this question, the aim is to understand the acceptance and usage levels for such technology in the local environment. To give this question some context, the role that ICT plays in senior care will and the motivations to use it will also be evaluated.

What is needed for governments to implement a Smart Home System?

With this question, the aim is to dig deeper into the issue of smart home implementation. It is needed to understand the senior care local context, strengths and opportunities, and the obstacles and threats that would affect such an implementation. With all of these, it will be possible to assess a suitable route for implementation.

As mentioned in previous chapters, this thesis's main objective is to explore how an SHS can improve care service delivery. As part of it, three research objectives have been identified. The first one is to understand how SHSs are used to support senior care in different countries. The second one examines the current senior citizen care situation in Estonia and SLEs usage in the local governments'. The third and final one is developing a guideline for implementing an SHS that supports senior care. All of these objectives will be achieved through extensive literature review and empirical research done through non-structured and semi-structured interviews with experts from existing projects and representatives from high-level and local-level entities in charge or related to senior care.

1.3 Research Design and Methodology

To answer the questions above, the author has defined qualitative research as the central methodology to be used. As Starman [19] explains, qualitative research uses an interpretative approach by which an individual's own subjective experiences where meanings are emphasized. In qualitative research, the different research participants' views are viewed as important to understand the studied phenomenon better. The qualitative methodology is chosen for this particular study because through it, a comprehensive perspective of the phenomenon can be obtained.

Once qualitative research has been defined as the main research methodology, the author pondered between the case study and the design science approaches. From one side, the case study is used when the objective is to understand a real-world case that could be influenced by important contextual conditions [20]. On the other side, design science is mainly a problem-solving approach, where the researcher aims to create an innovation that can be effectively applied[21]. This research aims not to create any new solution but instead to explain the usage and potential implementation of an existing solution, the exploratory case study has been chosen. Furthermore, the exploratory case study has been selected as it is best suited to investigate contemporary phenomena in their context in a practical way [22]. As per Baxter [23], these characteristics ensure that the exploration is done through different lenses, allowing the discovery and understanding of multiple aspects of the phenomenon. As per Yin [20], this methodology is appropriate for questions where "how" or "why" is asked. Its advantages rely on the fact that the researcher can better understand the participant's actions through the stories they shared during the research [23]. Among all, the case study methodology was chosen because the research aims to expand the understanding of how SLEs can be used to support senior care services. It is to be mentioned that throughout the research process, one main tool for data collection is the use of interviews. Interviews are a direct method for data collection [22]. By performing interviews, the researcher has direct contact with the interviewees and can better control how data is collected. Yin highlights that interviews are helpful as they explain "hows" and "whys" of critical events as well as the relative perspectives from the participants [20]. Another approach to data collection that was considered was the survey. However, through this method, the researcher doesn't find the depth of information wished for; instead, standardized information is common for this

type of method [22]. As the author aims to get as much overview as possible, it was decided to use interviews.

As mentioned, the first part of the research comprises an extensive literature review. As part of it, theories of ageing were explained to provide a background for the study. Furthermore, the concepts of SLE (specifically SLEaw), smart homes and smart cities are introduced. Throughout the literature review, SLEaw current state of the art was analysed. As part of the Theoretical Framework, innovation adoption theories are explored, paying specific attention to the Technology-Organization-Environment framework.

As part of the analysis of existing SHSs, the author will refer to the pilot SHINESeniors, in Singapore, which will be used as a successful practice model in the public sector. In the project, the idea of "Aging in Place" is introduced as the main driver. Following such, SLEs, specifically movement sensors installed in the private homes of a selected group of senior citizens, was used to monitor the senior inhabitants' health through activity data. With the data collected, care agents identified problematics situations. They acted accordingly, usually providing visits to the senior citizens in their own homes, allowing them to live independently and safely. As a result, the solution reduces the pressure on nursing homes, reduces care delivery costs, and improves the delivery of care services [11]. To get more insights into the project, the author interviewed three different parties involved: the Singapore Management University (SMU) in charge of the design, TCS, the technology provider and GoodLife, a non-governmental organisation in charge of delivering care to the seniors. The complete list of interviewees for Singapore can be found in Appendix 1. For the case of Singapore, interviews were non-structured as they were done early in the thesis development process. The discussions took place in September 2020 and took around one hour. While interviews were non-structured, the list of questions asked can be found in Appendix 2.

The second part of the research is dedicated to the development of the Estonian case. It comprises both secondary data collection and empirical research based on non-structured and semi-structured interviews with relevant stakeholders in Estonia. The list of interviewees for the Estonia case can be found in Appendix 3. With the data obtained from the data collected and the interviews, the author aims to answer the second and third research questions.

The secondary data collection comprises documentation (administrative documents, reports or green papers) taken from the archives of the different relevant entities (e.g. The Ministry of Social Affairs, Local municipalities, etc.).

As for the empirical research, it was done through interview sessions. The interview questions were open questions so that the respondents are free to speak. Just as in any other data collection process, the source is critical. Hence, it is needed to determine the 'appropriate' interviewees and make sure there are enough sources to support triangulation [22]. The empirical research consisted of three different batches of interviews, targeting different types of interviewees. Depending on the interviewee's role, the interview questions were designed following the Funnel Approach or Pyramid approach. The funnel approach meant starting the interview with open and general questions to go into specific ones [22, p. 52]. This method was used for the 1st and 2nd Batch of Interviews.

The 1st batch of interviews aimed to understand the country's senior care situation and the vision towards using SLEs as part of senior care. Hence, the first batch of interviews included a Ministry of Social Affairs representative, a consultant in senior health technology, two representatives of the Estonian Health Clusters and a private sector entrepreneur participating in different pilots for senior care solutions.

The first four interviews were performed between March 26th and April 05th and had an average duration of 1 hour and serve as pilot. The fifth interview was scheduled on April 14th. The set of questions asked are specified in Appendix 4. It is through the process of interviewing this first batch that local governments are identified as relevant parties in the implementation. In Estonia, senior care services are run by municipalities.

The 2nd batch of interviews was targeted towards the local government. These interviews took place between April 13th and April 26th. Six local governments took part in the process, and representatives in charge of senior citizens care services were chosen. A different set of questions was established for them. Those can be found in Appendix 5. Five of the interviews were conducted through video calls and one through e-mail. Interviews were performed in both English and Estonian. As the author is not an Estonian speaker, help for the translation was found. The conversations were recorded, and transcripts were written. Through the second batch of interviewees, it was discovered that

there is already an existing solution in Estonia that uses smart home devices to monitor senior's health and cooperates with municipalities. Hence a decision to interview the project was made.

The 3rd batch of interviewees was arranged to get inputs from real solutions for senior care similar to the one studied. As part of it, two solutions were chosen. Smart Care, a pilot project run within the Tallinn region, aimed to prolong senior's stay at home and Koduandur, an existing home sensors solution for senior care run by the private sector. The list of questions for each representative can be found in Appendixes 6 and 7.

For the 3rd batch of interviews, the pyramid approach was utilised. The approach suggests starting the interview with specific questions and opening to general ones [22, p. 52]. It was found more suitable for this kind of interviews as the idea is to understand the Solutions to the detail and then open up on how they work in the big scheme of things.

Triangulation is suggested as a critical aspect of research. Triangulation means taking different perspectives to provide a broader picture, as it is important to strengthen the research validity [22, p. 15]. One perspective is not sufficient; therefore, not only did the author used the data from key informants but also key documentation from the government. Furthermore, triangulation of point of views was utilised through the research as the interviewees involved different parties, the high-level institutions, the local governments and the private sector.

To analyse the interviews, the program NVIVO was chosen. The programme enabled content analysis based on coding that allows for the identification of patterns. The coding themes are specified in Appendix 8.

After detailing each of the cases, Singapore and Estonia, a comparative analysis is done using the TOE framework. Finally, conclusions are drawn.

2 Literature Review

E-Governance is defined as the process by which the Government uses ICT as a tool to achieve better government. E-Governance is seen as “customer satisfaction”, “processes and interactions”, and as “a tool for Governments”. That being said, e-Governance is about enhancing service delivery with ICT and is a dynamic process that enhances interactions between different actors to improve government processes [24].

As part of e-Governance, different technologies and approaches are discussed to make citizens life more efficient. One of those discussions goes around the topic of smart cities. Smart cities are now a trend by which the government focuses on integrating different services through ICT use. Smart cities are designed to tackle the cities' specific challenges, such as traffic control, waste management, public information, etc. Different governments have different approaches to smart cities. Recently smart cities are also pondered upon to solve the challenges of a growing elderly population. One of the key elements of smart cities is technology. One of those technologies is under SLEs. SLEs refer to environments enabled through technology or architecture, which help to make life more efficient and sustainable [25]. A smart home is an SLE. While smart homes are usually seen as an innovation that enhances an individual's life, it is also now being studied how they could help improve the lives of senior citizens. On top of this concept, the author argues that if implemented in a holistic view, they could improve the overall performance of senior care service delivery.

Throughout the literature review, SLEs and smart houses will be explained in detail. Additionally, it will be explained how they become part of a holistic picture through a smart city program. However, the smart city concept will only be reviewed, intending to be a teaser for future research. Later during the empirical part of the research, we will look at the perceptions towards adopting SLEs and SHSs in Estonia.

To understand how SLEs, specifically SHSs, could help solve the problem of a growing senior population, it is necessary to comprehend the theories of ageing. These theories

will help create a context for defining the relevance of the SHSs in ageing and understanding how Governments Implement senior care services. Therefore, the literature review chapter will be divided into three main topics: theories about ageing, SLEs, smart homes and smart cities and, technology adoption.

2.1 Theories about Ageing

As human beings, familiarity with ageing is a norm; there is an understanding that deterioration of body functions impacts different areas of life with ageing. However, beyond this understanding, it is essential to review the theories of ageing as they showcase what is recognised to be the secret of ageing well and serve as a base when designing technology that assists ageing.

In 2015, the World Health Organisation (WHO) released a framework for healthy ageing [26], which emphasised the development of health practices for seniors that consider seniors' point of view. The report also disclosed that seniors care for a role or identity, relationships, the possibility of enjoyment, autonomy, security, and the potential for personal growth [26].

Active ageing represents a new paradigm of ageing by which it is possible to postpone the expected declines of life to a later stage in life. In another way, it means that it is possible to constrict morbidity to a future and a short period of time while decreasing morbidity in the cumulative lifetime [27]. Morbidity is measured based on the capacity of a senior to perform activities of daily living (ADL). When morbidity occurs, the current approach to take care of senior citizens is to send them to LTC, also known as institutional care [28]. LTC is seen as expensive and places a burden on both citizens and governments.

In current times, morbidity seems to have been reduced and can be postponed. While the postponing of morbidity could be seen as a successful case of health care policies, it does create an environment of challenges where it is needed to maximise seniors participation and security in society [28].

According to the World Health Organization report, the declines in morbidity often demand that senior citizens change or adapt to a new environment that supports their ageing. However, this change is seen as a drawback for the senior’s sense of identity and autonomy. Therefore, WHO has identified that one typical policy response to the problem

of the Silver Tsunami is to apply what is known as “ageing in place”. That is the possibility for seniors to remain living in their own home and community in a way that allows for safety, independence and comfort regardless of age, income or intrinsic capacity. This approach is seen as a better way for the elderly to generation, and it is related to hold advantages in financial terms [26].

As it has been mentioned, due to active ageing, seniors nowadays suffer a slower deterioration and experience morbidity much later in time. Therefore, they prefer to live in their own home independently as long as possible, delaying their movement to long-term care facilities. Mincollelli et al. citing Lecovic [11, p. 3], explains, “The move to an institutional long-term care facility is often the result of the living inadequacies at home to meet the changing needs for older people due to decline in health and self-care abilities, loneliness, accessibility barriers within the home and the surroundings, the unavailability of necessary services and a poor quality of care”.

Therefore, ageing in place is born as an approach that enables independent living throughout various implementations in-home and surroundings of the senior citizen. By it, seniors gain the ability to take control of decisions and choices at the moment, that is, to live independently.

Ageing in place constructs around four connected spheres: one is the physical sphere, the home and neighbourhood, for example; the second one is the social sphere which involves the different relationships built among the community; the third one is the emotional and psychological sphere, and the fourth one is the cultural sphere which relates to how older people perceive their values, beliefs, others[11].

Additionally, the World Health Organisation suggests that ageing in place can be enabled by the emerging technologies that allow the monitoring, communication and engagement of the senior citizens by ensuring security [26].

It is considered that Ageing in Place can be beneficial to keep a person independent. However, it may not be the most recommended approach for isolated older people, those with higher needs and inadequate housing, or those living in unsafe or less supportive neighbourhoods. In fact, it has been recommended that ageing in place requires community support such as family connections, caregivers and a nearby medical centre [26].

Therefore, before implementing solutions around the "ageing in place" paradigm, it is important to consider the senior's profile and the four different spheres previously mentioned.

2.2 Smart Living Environments, Smart Homes and Smart Cities

According to the European Commission, Smart Living refers to the trend enabling people to live better through original and innovative solutions, making life more efficient, controllable, economical, productive, integrated and sustainable [29]. One of the elements that foster smart living is the internet of things. When living spaces are implemented with different connected devices, automation and data can be utilised for living optimisation, becoming SLEs. Namely, the idea is to extract real-time data about the house environment conditions and its residents' behaviour and put it together in a system that can process that data to help to improve different living aspects [25]. SLEs can then cover a range of human activity, from improving consumption at home, security or home-owners health.

One of the areas where SLEs are seen as an optimal way to optimise life is ageing. These are then called smart living environments for ageing well (SLEaw). SLEaw is taking relevance and seen as a potential solution for improving senior's ageing conditions and living independently [30].

Among the SLEaw, assistive technology, such as devices that continuously monitor the elderly's activity and detect risky conditions, is considered one of the most studied types of technologies. Much has been written about the considerations to design the technology; however, little has been written about implementing it as part of existing public services. Therefore, through the study, the focus will be on how SLEs can be integrated into public services.

When talking about SLEs, people tend to refer to smart homes. Mark Weiser [30, p. 11] defines a smart home as "the physical world that is richly and invisibly interwoven with sensors, actuators, displays and computational elements, embedded seamlessly in the everyday objects of our lives, and connected through a continuous network". The technologies that form part of the smart homes are known as smart home technologies (SHT). Petersen et al. note that while smart homes technologies are becoming more popular as regular citizens now have at their disposal smart devices, these devices are

used independently. Citing Smith, he remarks that “the development of a smart home involves more than simply plugging in yet another hi-tech appliance. Substantial alterations are required to standard wiring and switch systems, central control systems may be required, and the systems can be further enhanced by the inclusion of smart appliances” [31]. Smart homes are related to different terms, such as connected homes, digital home, adaptive house, aware home [9]. As smart homes can involve a series of technologies, in the context of this study, we will refer to those that are enabled with moving sensors and provide data to caretakers for action.

On the other hand, when SLEs and SHSs are integrated as part of public services bigger pictures, they form smart city initiatives. It is essential to define the different levels where SLEs can play a role in improving public services.

As Dewi et al. put it, “Smart city adoption is seen as a smart solution to solve urban problems” [32, p. 1]. And, it is that with the greater challenges of urbanization, many cities are becoming “smart cities”. Cities then buy into technology and adopt strategies that will convert them into such. Washburn defines a “smart city” as the result of combining different ICT technologies (software, server, networks and client devices) to improve the infrastructure and services a city provides. Those services include administration, education, health, property, transportation, security and public safety [33].

For Washburn, the key in a smart city is the use of smart computing. Smart computing is defined as “a new generation of integrated hardware, software and network technologies that provide IT systems with real-time awareness of the real world and advanced analytics to help people make more intelligent decisions about alternatives and actions that will optimize business processes and business balance sheet results” [33].

When considering the implementation of a smart city model, It is not only required to use suitable technology infrastructure, but other elements such as well governance and talent are also essential [32].

Finally, when exploring the adoption of SLEs, there is a need to consider the concept of smart cities, as they are interconnected. Within the current research, the author aims to define what is needed to implement an SHS. To achieve this objective, it is required to assess the readiness towards adopting this technology. In the following, the author will discuss different frameworks for Innovation Adoption.

2.3 Innovation Adoption

Innovation is defined as the use of a new idea or method [34]. Innovation adoption, therefore, is the utilization of a new theory or method into one's action. According to Damanpour and Schneider [35], adoption usually starts with need recognition; it then progresses to the searching of the solution, after which the initial decision to try to adopt a solution is taken, and finally to proceed with implementation. When talking about organizations, the adoption process is complex [36]. Aarons et al. [37] suggest that different individuals in an organization may experience difficulties when assessing or selecting appropriate innovations. Their decision is affected by organizational factors, such as hierarchy, culture, values.

In their study, Wisdom et al. [36] analysed 20 key adoption theoretical frameworks and recognized integrative themes. The first one is that adoption needs an interactive, multi-level understanding. The second one recognises that adoption is a process, pre-adoption and actual adoption. The third one that in some frameworks, adoption is differentiated from implementation.

According to the study, it was possible to identify five adoption constructs: socio-political and external influence, organizational characteristics, innovation characteristics, staff and individual characteristics and client characteristics. A summary of each construct is found in the figure below. It's based on the table created by Wisdom et al. [36].

Construct Level	Coverage
Socio-political and external influence	It looks at the positive and negative external influences from elements such as policies, regulations, standards, others that will support or hinder innovation adoption. It validates the role of external forces.
Organizational characteristics	It looks at the different elements found within an organization that once again support or hinder innovation adoption. For example, support from the leadership fosters innovation, while a top-down hierarchy may hinder it.

Innovation characteristics	It evaluates the innovation itself and its relationship to adoption. Under these criteria, innovations that are easy to use, aligned with the organization and user's values, cost-effective, etc., are more likely to be adopted. Likewise, if innovation is hard to obtain, hardly understood is less likely to be adopted.
Staff and individual characteristics	It looks at how the behaviours and skills of individuals inside an organization contribute towards innovation adoption. For instance, its motivations, attitudes towards change or involvement in the process play a role positively or negatively. Also, individuals with a lack of skills may be less likely to adopt innovation.
Clients' characteristics	It assesses the clients' behaviours towards innovation that is similar to the way individual characteristics affect adoption. Studies are relatively new in this area.

Table 1. Summary of Constructs and its coverage based on Wisdom et al. [36].

From this table, one can observe that there are different levels of influence towards adoption and that many elements can determine whether adoption will be successful. One framework towards innovation adoption that takes an interactive and multi-level understanding is the Technology-Organization-Environment framework (TOE). As per the name, the Technology-Organisation-Environment framework focuses on these three elements impact on decision-making concerning technology innovations [38]. As such, Technology focuses on how the characteristics of the IT innovation influence its adoption. The Organization aspects focus on the different components of an organisation (e.g. culture, size, resources, decision-making processes) and how they play on adopting an innovation. Finally, the Environment element establishes how the external factors of the organisation will play a role to facilitate or hinder the innovation implementation [39].

Under the TOE framework, it is assumed that the adoption of innovation in an organization will occur once internal and external factors are evaluated [39]. As explained by Dewi et al., the TOE framework offers a generic approach which makes it widely

applicable to different discipline and contexts. Its main advantage is that researchers are able to select different dimensions of evaluation based on the innovation and organization itself [32].

TOE framework could be used for the particular case of adopting a smart-home technology. Other researchers have used the TOE framework to analyse cities' readiness towards adopting the smart city approach [32], [40]. The author will aim to use the TOE framework in a similar way to assess the adoption of SLEs in the context of the Estonian local governments.

3 Singapore's Experience

Through this chapter, the author will answer the first research question of how an SHS could support senior care service delivery. As mentioned in the methodology, this will be done by understanding what is currently being done in other countries using smart homes for supporting senior care. Specifically, the Singapore Experience will be elaborated. Additionally, at the end of this chapter, the author will evaluate the Singapore case using the TOE framework in order to explore potential answers to the third research question of what is needed to implement SHS.

Previously, during the introduction chapter, it has been mentioned that there many initiatives in the European Union and around the world to establish smart homes that will support senior care delivery. In this chapter, the author will expand on the existing initiatives and describe why Singapore is chosen as an example. As SHTs include a variety of tools, from remote monitoring to robots to telecare, the focus for this study will be on the technology of remote monitoring for the purpose of this study. Within this range, three initiatives will be highlighted. For more information regarding projects related to the use of technology in supporting seniors, one can refer to the AAL projects website [41].

The first one is the GIRAFF+ [42]. According to the project objective, the system aims "early detection and adaptive support to changing individual needs related to ageing". The system in place consists of a network of home sensors. These sensors measure parameters such as temperature, blood pressure, movement, or falls inside a room. The data collected from the sensors is deciphered by the system in terms of activities and can be analysed over time. The system then can generate alarms or reminders to caregivers.

Additionally to the sensors, the project also includes a telepresence robot, the Giraff. This robot can help the senior maintain their social contacts. The project was initially delivered in three European countries (Sweeden, Italy and Spain), reaching a total of 325 users [43]. By delivering the project, the aim was to test the technology and finalized a business model for GIRAFF. The project ended in 2014.

The second project is in CASA [44], the project aimed to assist and protect frail senior citizens, prolonging their independent life. The objective is to be achieved by using citizen-centric technologies and integrating solutions for health and environment monitoring. The technologies used are called home sensor networks and human monitoring sensors (HMS). These technologies aimed to provide user behaviour profile to implement different alert and communication services for caretakers. Data is accessible and shared through a smart personal platform, which provides the behaviour analysis application and includes the ability to access policies to preserve privacy, plan daily activities and therapies, all in the coordination of social and health care services. The project targeted seniors living at home alone and with a sufficient level of autonomy and self-care ability. Once again, the focus is on developing the technology and later on developing a business model. The project lasted from 2010 to 2013.

The third project is USEFIL: Unobtrusive Smart Environments for Independent Living [45]. The project aims to "address the gap between technological research advances and the practical needs of elderly people by developing advance but affordable in-home unobtrusive monitoring and web communication solutions". The project lasted for three years and started in November 2011.

These examples prove how SLEs are used to support seniors to live a more independent life, and as it can be seen, it also provides a glimpse into how different technologies work. When reviewing the lists of projects at AAL, it is also noticed that there are already lots of working devices, and more are being designed to support the elderly population. In fact, most of the research focuses on technology development and not on how these technologies can be integrated into existing care services. This last point is of our interest, and the Singapore Experience will be able to provide an understanding of how to do so. The project in Singapore was chosen because it runs for over five years with successful stories on how it has helped carers provide support to seniors' independent living better. This has resulted in SHT is being part of Singapore's Smart Nation initiatives [46] and Housing Development Board services [47].

3.1 Singapore's Context

Singapore is a country where the number of senior citizens, those aged above 65, is expected to duplicate from 440,000 in 2015 to 900,000 by 2030. Above this pressing fact, the number of those living alone is also expected to increase from 35,000 in 2012 to 83,000 by 2030 [48].

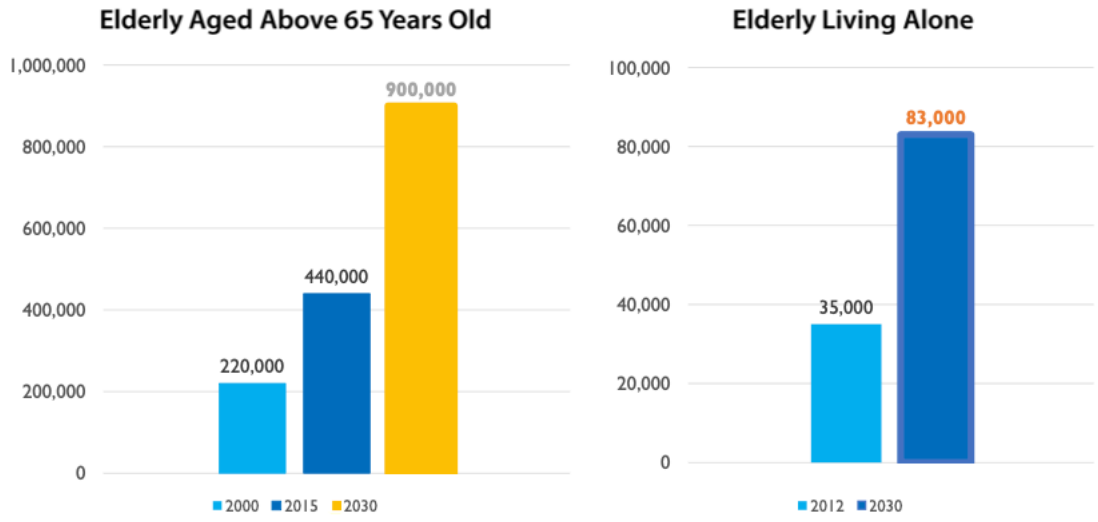

Figure 1. Elderly aged over 65 years old and living alone in Singapore [48]

It is known that the elderly living alone are at higher risk in terms of access to healthcare when an emergency occurs and are more likely to be socially isolated—both impacting mobility and cognitive decline—hence requiring more and more assistance with their daily activities [48]. According to The Sun Daily, in Singapore, since 2007, there was more than 50 elderly who died alone in their own homes, only to be found much later. In Summary, Singapore's rising ageing population is a concern for the country.

In 2015, Professor Goh Lee Gan, the President of the Gerontological Society of Singapore, delivered a speech, "Ageing in Singapore in the Next 50 years"[1]. In his view, the country of Singapore could either be swallowed by the Silver Tsunami, where the rising of the elderly population will pressure the economic and health system, causing

[1]Ageing in Singapore in the Next 50 years – Available at https://www.moh.gov.sg/news-highlights/details/speech-by-mr-gan-kim-yong-minister-for-health-at-the-sg50-scientific-conference-on-ageing-on-19-march-2015

intergenerational tensions. Or could avoid such a scenario in the coming years by aiming for a system of Productive Longevity, which will transform the elderly population into a force of positive impact. For this positive change to happen, he specifies that the country needs to develop an economic program that will re/incorporate the senior citizens into the labour market and re-organise the health systems to make health services appropriate for the ageing population.

Traditionally Singapore counted with a series of institutionalised care shelters or nursing homes that are the ones providing care for senior citizens. However, these institutions are considered costly and are not enough to supply the country's demand. To overcome the lack of institutional care, many voluntary welfare institutions were created under the Ministry of Social and Family Development supervision in the past years. The entity demands the welfare institutions perform preventive care by visiting the elderly every week to check on their health status and monitor their development in their own homes [49].

This activity falls into what the country calls the "Ageing-in-Place" Programme and is part of the Alexandra Health System. With it, the government aims to cover for the lack of institutional care homes. The Ageing-in-place programme provides care for seniors citizens located in the nearby community of the Alexandra Health System.

While the volunteer caregiving institutions play an important in the government's strategy of Ageing in Place creating a comprehensive system of support along with the hospital, the country acknowledged more was needed to be done to tackle the issue of the Silver Tsunami.

In the same speech, Professor Goh Lee Gan mentioned that a technological implementation was needed on top of this comprehensive system. According to him, there was a need to re-imagine the city in a way that will make life in it more sustainable.

To make the change happen, back in 2015, Singapore imagined using technology to transform the home-care system in Singapore. With that in mind, Singapore granted funds to a project that would enable smart devices inside the senior's home to help monitor and assist and integrate preventive care. That is the aim of the SHINESeniors Project, to provide aid towards the strategy of Ageing-in-Place.

The SHINESeniors project is a pilot project run by Singapore's government, in alliance with SMU (Singapore Management University), Tata Consultancy Group and NGOs who deliver care to senior citizens. The pilot took place in Singapore from 2015 until 2018, and it continued running as of now. The SHINESeniors project is the example case that sets the base for further analysis in the Estonian case. By studying Singapore experience, the author aims to evaluate how impactful it could be to implement smart-home technologies for ageing in place to reduce the burden of care.

SHINESeniors was selected as a public home care project that was successfully implemented and claimed significant results. The project was funded under the Land and Liveability National Innovation Challenge (L2NIC) grant and started in 2015 and resulted from a multi-lateral partnership, one among the public sector, the private sector, the academic sector and the third sector. The public sector is represented by A*STAR, who leads the project and the SMU-TCS iCity Lab researchers. The public sector provided the economic funding while the private sector (TCS) and the academic sector (SMU) provided the researchers. A central player was also the third sector. Specifically, the organisation GoodLife was in charge of delivering the project by helping the seniors adapt to the monitoring systems and provide preventive care based on the data supplied by the Sensors.

In the project, the idea of "Aging in Place" is introduced as the main driver. Following such, IoT, specifically movement sensors, are installed in the private homes of a selected group of senior citizens and monitored the senior inhabitants' health through activity data. With the data collected, care agents identified problematics situations. They acted accordingly, usually providing visits to the senior citizens in their own homes and allowing them to live independently and safely. As a result, the solution reduced the pressure on nursing homes, reduces care delivery costs, and improves the delivery of care services [11]**.**

3.2 Smart Homes Implementation in Singapore

To understand the process of implementing smart homes for senior citizens in Singapore, the author conducted interviews with the Director of the SMU i-city lab and the Technical Lead. They were in charge of running the project along with the Project Manager from the TCS side. Interviews with both parties provided helpful in understanding how the

project was created and what considerations were taken in place. Additionally, an interview was also conducted with caretakers from the third sector organisation (GoodLife), who helped monitor senior citizens. The third sector view provided a clear insight into user acceptance and allowed the author to dig more into some of the project's challenges.

One of the first learnings taken from the interviews is that the pilot project targeted 200 senior citizens living alone and had no kin to take care of them, hence needing additional support. The project chose the senior citizens living alone in the Housing Development Board (HDB) rental flats. According to the interviewees, the fact that the enabled homes belonged to the Housing Development Board made it an important point for project sustainability. For example, in the case that the senior living there moved out, the sensors could still be used by another senior citizen.

Another equally important condition was “living alone” because no data noises would be encountered when the sensors were installed in the seniors’ homes. When asked why the project managers chose the sensors as the IoT device, the TCS Project lead highlighted, “*We analysed different types of technologies and settled for the sensors as they were the least intrusive type of technology available. In Singapore, a survey showed that the seniors preferred non-intrusive technology”.*

The sensors utilised to enable the smart homes were the passive infra-red (PIR) motion sensors and reed switch contact sensors. The first kind of sensors detects the seniors' motion within a coverage radio, while the second type is used in the doors to detect its activity[48]. The sensors detected different environment conditions (air quality, noise levels, temperature, humidity, etc.) and the seniors' activity levels (non-movement, fall detection, physical activities, medication adherence, mobility patterns, etc.) [50]. The sensors were distributed around the different rooms, covering the bedroom, living room, bathroom. A picture of the sensor’s location can be found in Figure N. 02.

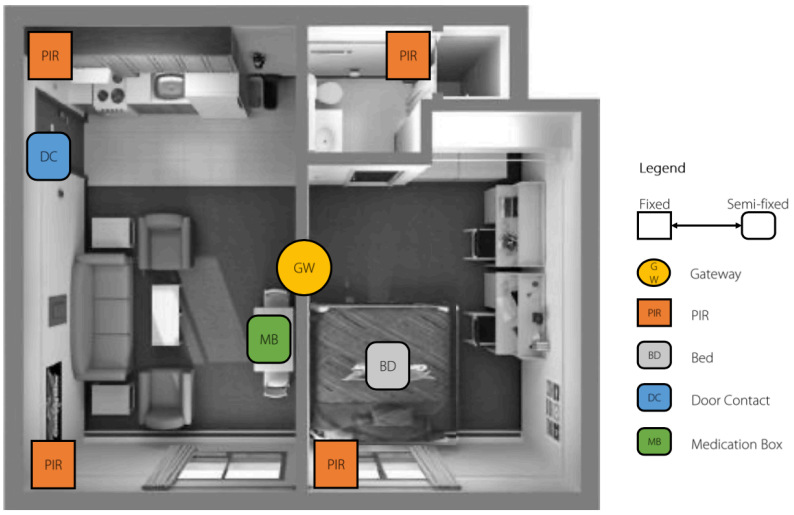

Figure 2. Sensors Installed in the SHINESenior's pilot project

After the sensors collected the different data from the senior's activity level, the data was distributed through a platform to which the caretakers were connected. In the platform, trends about activities, reports and alerts were implemented for the caretakers to act upon it. Therefore, two types of users can be identified, the senior citizens interacting with the different sensors and the caretakers interacting with the care platform and making actions based on the data provided.

According to GoodLife, despite the fact that the sensors were non-intrusive, it took some time for the senior citizens to adjust to living with those. "*There were two groups, a group of seniors were very sceptical, and others were very curious. Some of them thought the sensors were cameras and that through those, we (caretakers) could see them somehow. They had a privacy concern"*. For example, a senior covered "the camera" with a towel every time she goes to the bathroom. The caretakers said that the sceptical seniors started to feel more comfortable and receptive as they heard good experiences from the rest of the senior community. Some of the caretakers' roles also included explaining to the seniors why the sensors could make a difference to the senior's life. And with it, it helped to improve the technology acceptance.

It is worth mentioning that the project was built upon an existing care programme called "Close to Home", by which GoodLife already visited the senior citizens on their own. Then, when the research project being with SMU, the technology provided aid to their activities by sharing data about the health activity of the senior citizen. The organisation then took three roles. The first and most important was to respond to the sensors' alerts to

take immediate action when needed, analyse the data collected and then validate these data when visiting the seniors. The second role was to provide feedback to the researchers to keep improving the technology. In this way, they were one of the main users of the application built upon the sensors data. The third one was to educate the seniors regarding the sensors.

Goodlife caretakers claim that the benefits obtained from the use of the sensors were highly beneficial. One of the nurses gave the following example of how the data from the sensors could help to improve the caretaking "*We detected one incident where it showed the senior was going to the washroom very often at night. Every hour, there was movement detected by the sensors in the washroom and then back to the bedroom. This went for a few weeks. This hadn't happened before, and therefore it was abnormal. When we checked with the senior to find out, interestingly, the elderly was not able to remember what happened at night because she thought she was in bed for a long time. After this conversation, we checked further and found out it was due to a urinary issue; hence we provided medical treatment".* The ability to first use the data to start a conversation with the senior about their health and then to contrast data with the senior's stories was mentioned to be relevant for the caretaking activity. Another example given was an incident that happened with one of the seniors, he had been lying still for many hours, and the sensors noted the inactivity. The caretakers then received an alert and organized a checking-in with the senior immediately. It turned out the senior had fallen and needed help. These examples were some of the many the caretakers gave to prove the sensors were valuable in their perception. They highlighted that thanks to the additional data they had, they could provide better care to senior citizens and avoid events like an elderly dying alone at home without anyone noticing.

3.3 Analysis and Discussion

With the studying of the Singapore case, the aim was to answer the first research question about how an SHS could support senior care services. From the projects in AAL and Singapore's experience, it can be observed that one of the main ways SHSs supports senior care services is by allowing the seniors to stay longer at home without exposing themselves to risks proper of the age. As a result, this initiative reduces costs as seniors do not need to immediately transition to the expensive institutional care. Additionally, the

SHS helps caretakers to access more information within the times they are not with the senior, enabling them to detect patterns that could potentially affect the senior health. A few examples of how caretakers used the data to better assess the senior's condition and provide help were brought up through the case elaboration. Specifically, the project' report [51, p. 26] shows how sleep patterns collected by the SHS were able to predict the senior's fragility to accommodate preventive care. In conclusion, the implementation of SHS can indeed support senior care services.

The question, however, remains on what is needed to implement SHS successfully. The author believes it is possible to learn from the experience in Singapore to do so and hence will also provide further analysis for which the TOE framework will be used.

First, the Technology aspect will be evaluated; this means the SHT itself. It has been noticed that when the project started, the technology was in the mists of being designed. However, it was early decided the technology was to be non-intrusive as preferred by seniors. While sensors were available, the ability to connect patterns with relevant data was developed throughout the pilot by engaging the caretakers and senior citizens in the feedback loop. Finally, the technology was provided for free to the seniors. In this regards, one can argue that all the aspects related to technology play favourably towards adoption. However, it is worth noticing that while all these aspects were favourable, some seniors were reluctant to fully accept the technology due to concerns of privacy; education from caretakers took an important role.

Following, we should look at the Organizational aspect. In the case of Singapore, the internal motivation to implement the service was vital. The government had already decided the initiative will be implemented, and the funding was provided. Following, the set-up and share of responsibilities were straightforward. SMU-TCS were in charge of developing the platform, while GoodLife was in charge of delivering the care and reacting to the alerts and data provided. In the case of Singapore, it was conducive that a program of sporadic visits already existed (Close to Home), which meant that no new service needed to be created, but instead, the technology was going to support the existing service. Also, the government had Housing Development Board apartment, which meant it was up to the government to decide to implement the sensors. All of these factors were favourable towards the innovation adoption.

Finally, for the Environment aspect, it has also been found to be mostly favourable. The whole Government strategy of innovation and Ageing in Place is key to support the initiative. As the political will exists, it easier for the project to be implemented.

This analysis will help us to build up learnings and guidelines for SHS implementation in Chapter 5.

4 Case of Estonia

Once it has been established that SHS systems can support senior care service delivery helping to improve senior care as a whole. The following chapter explores the implementation process more specifically by studying the case of Estonia, a country still in the early stages of implementing technology as part of senior care. Before getting into the discussion and answering the questions, context regarding senior care services will be given as well as a summary of the interview outcomes.

Through the analysis and discussion part, the author will synthesize the answer to the second research question about how SLEs are used to support senior care in local governments in Estonia. After doing so, the TOE framework will be used to explore some initial ideas to answer the third question of what is needed to implement an SHS. The final answer to this question will be provided in chapter 5 by comparing the Singapore and Estonia cases.

4.1 Estonian Context

In Estonia, senior care falls under the Social Welfare Act [52]. According to It, "*Local authorities shall establish the procedure for the provision of social welfare assistance which shall contain at least the description and financing of social services and benefits and the conditions and procedure for application for social services and benefits"* [52, p. 4]. In that way, the provision of social services, benefits and social assistance is organized by the local government depending on the person's place of residence, as registered in the population register.

The Social Welfare Act also establishes that local governments should provide 11 social services. Local governments may also arrange other services on top of statutory [53]. Based on this, the local government assesses the person's conditions requiring welfare services and decides on the best way of assistance. The local government is enabled to charge a fee in exchange for service provisions. The local government determines the conditions and the amount. Among these services provided, home care services, transport

services, support person services and care homes services are provided to senior citizens across the different municipalities. Local municipalities are to provide the services according to the standards defined in the Social Welfare Act. Estonia counts with 79 Local governments, among which 15 are towns, and 64 are rural [54].

According to current statistics and as mentioned in the introductory chapter, the current provision of services can't supply the demand of services needed in both care homes (institutional care) and home care. Therefore, to tackle those circumstances, the Government of Estonia has approved an action programme for 2019-2023, which aims to support the launching of innovative solutions to support home living and care to reduce the burden of care [4]. As the Green Paper in Social Innovations establishes, this is needed because of the increase of senior citizens in the following years. Additionally, senior citizens in Estonia are more likely to need assistance in daily activities and self-care in comparison to other Europeans.

According to the green paper, the current Estonian welfare system is inclined towards institutional care. However, there is a need for change. It is needed to bring along new technologies and solutions that will help reduce the burden of care and create new ways to support ageing as healthy and active as possible. The paper recognizes that three groups are part of the ecosystem: The end-users, the technology providers, and the supporters of technology use. For the particular context, the end-users are the ones in need of care (e.g. senior citizens) and professional social services providers (e.g. caretakers). The technology providers are represented by the technology companies who will develop the ICT tools. Finally, the supporters of technology use are the organizations providing care services (e.g. local municipalities, NGOs, welfare centres).

Following this line, it establishes that for local governments to increase the use of technology, they should develop and implement cooperation models that are viable and sustainable. Although local governments are providing many services digitally [13] and many processes are digitalised in house [4], still most of the services are meant for active generation (not elderly) or businesses. Digitalization of welfare and social services, as well as engagement of the elderly, is low.

By understanding the Estonian context and how senior services are provided in the country, one can notice the important role local governments play in the acceptance of innovation tools. Hence, they are an important data point for this research.

During the interview processes and as mentioned before, the author collected different data points, two of which are mentioned relevant in the ecosystem for innovation explained by the Ministry's green paper. The following paragraphs will take a look at the Interview outcomes.

4.2 Interview Outcome

The following information provided results: first, collecting data through Interviews with high-level experts in senior care, local government specialists, and independent project managers. The different levels of interviews helped us to get additional perspective on the same topic.

As part of the interview analysis, three themes were identified. Those three themes are based on the research questions. Under each of the three thematic sub-topics have been identified. The first thematic corresponds to the state of senior care in Estonia. This theme is key to place context into the research. The other two thematics are directly related to implementation, collecting the Opportunities and Threats for implementing an SHS for senior care and providing clues on important activities to launch the service.

4.2.1 Current Situation of Senior care in Estonia

To paint the picture of senior care in Estonia and adoption of new technology in senior care in Estonia, as SLEs. It was needed to interview different high-level representatives and local governments, as they are responsible for senior care.

Through the interview, the author aimed to get different perspectives on the current situation of senior care in Estonia to use it as a base for the rest of the interview. With the questions asked at the interview, the aim was to identify the current challenges in senior care at different levels, the current activities done to overcome the mentioned challenges and then understanding what the role of Ageing in Place and ICT is in solving those. One additional topic identified was the Role of Regulation. In the following, the author will present the main findings per topic.

1) Identified Challenges

The following findings respond to the questions “What do you believe to be the biggest challenge in senior care in Estonia?” and “What is currently being done to solve it?”.

Referring to the first question, out of the different interviews at both high and local levels, three themes were identified: The lack of integration of health care and social care, high costs and lack of resources, and the need to cover the demand and a gap in quality standards.

Concerning the lack of integration between health care and social care, 4 out 5 interviewees from the high-level interviews mentioned this factor as an issue. The independent expert pointed out that *“There is no e-mail address or a website where you can check what’s already in place, and there is an overlap between the different parties”.* The Ministry of Social Affairs & the representative of Connected Health Clusters pointed out that healthcare is better funded than social care. The healthcare services are indeed handled by the Estonian Health insurance fund, while the municipalities fund the senior care services. “*Because every single municipality takes care of their own elderly people and they are separate units, while Healthcare is nation nationwide…, and because the funding of the services is so fragmented and based on the municipalities that's why I guess the implementation of the services is not nationwide.”*

Regarding costs and lack of resources, all interviewees agreed that the senior care department was underfunded and that for the local governments, it put a burden on delivery. It was mentioned that for the users, one of the highest issues was the high cost of the services, which is most of the time came out of pocket costs and not fully financed by the local governments. As the Ministry of Social Affairs representative puts it, *“Today there is a problem that the Health System is financed better, and the Social Welfare System is like the poor younger brother”.* It was also mentioned that currently, the pension fund benefits were not sufficient to cover the elderly care services. From the local governments' side, the Tallinn Local Government representative mentioned the same challenge. The representative from Pärnu local Government commented that one of the biggest challenges was “to ensure economically viable care for the elderly”, adding that institutional care is most expensive. Saku local government representative commented

that while the municipality home care services are affordable (4 euros/hour), many elderly citizens use them minimally to save on costs.

In conclusion, as the Saaremaa representative places it, *"Services costs are quite much, pensions are low and elderly people do not want to pay".* Specifically, to this topic, the representative from the Ministry of Social Affairs commented, *"The World Bank, in 2017, also pointed out that the costs of long-term care in Estonian public sector should increase at least 2 or 2.5 points percentage of the GDP to move towards a more efficient long term care system. But in 2019, over public expenditure on long term care services was only around 0.5% of GDP".*

Regarding covering demand, the independent consultant, the Ministry representative, and Local Government representatives from Pärnu, Saku, Vorumaa and Saaremaa brought up the topic of the gap between the demand for elderly care services required and the possibility to cover them. From different angles, the problem was raised. "*The needs of the elderly are often greater than what the local government has to offer*". "*There is also a deficit, and it's not easy to put people in homes because there is a lack of service places*". *"A challenge is …to create as many support services as possible".* From the Ministry side, it was mentioned that one of the biggest challenges was the lack of care homes, now estimated at 70,000 places, but with a need of over 100,000 places. All illustrative phrases of the situation. Additionally, in terms of services delivered at home, it was told that in 2019, around 7,000 people used the home-based services, but the need was estimated at 20,000 services. These figures represent the gap in service provision.

The final aspect commented as a challenge within senior care was the ability to cover for the different senior needs while ensuring cost efficiency. It was noted that there are different profiles within senior citizens. Some seniors need more assistance than others, making the delivery of services a challenge.

About the question of "What is currently being done to overcome the challenges?". The answers were quite diverse. From the Ministry side and the consultant, it was brought the development of action plans, strategies design and establishment of open calls that will enable innovation, modernization of senior services and support for funding. The ministry representative did highlight that despite the creation of new strategies and action plans and agreement from the higher levels of decision, those were not able to continue due to

government allocation of funds in other topics. From the local Government perspective, different initiatives were taking place to improve senior care services current condition. Viimsi, for example, had recently launched a Welfare Centre by which pretends to take full ownership of the delivery of home services and use it as a platform for the creation of new services. It was also mentioned that Viimsi municipality took place in different co-thinking activities to develop ideas for the improvement of services. Saku municipality, on its side, said about negotiating with other service providers in order to map elderly care needs and problems. They mentioned they try to get additional services and funding to provide additional services to their senior citizens. Võruma, on the other side, mentioned they had started development projects and are trying to create a digital infrastructure.

2) The Role of Ageing in Place

Throughout the interview, whether the Ageing in Place approach played a role in creating and delivering senior care services was brought up. All the interviews agreed that this concept was taken into consideration when designing services and should be one of the main objectives when providing senior care services. For the Independent Consultant, Estonia was not using the approach very systematically. The Ministry of Social Affairs Representative mentioned that these principles are part of the policymaking and development plans. For the entrepreneur, this was the way to go with regard to services. For the Connected Health Cluster representative, the approach definitely played a role.

From the local government perspective, they mentioned that ageing in place was one of the main principles to run their services. They all mentioned that the way this is achieved is through home care services and community houses. In some cases, community houses were yet to be developed, but all provided home care services.

For reference, home care services refer to the different services provided by social workers in which they help the seniors with various activities at home, from grocery shopping, cleaning, cooking, taking care of them (helping them with medicine, for example). Community houses refer to the houses enabled specifically for senior citizens built by the local governments and provided with a low price. In these facilities, seniors count with an accessible and affordable home space integrated in a community. Here they do not have any type of caretakers, but instead, they live alone independently.

3) The Role of ICT

Through the interviews, the author wanted to know what the interviewees thought was the role of ICT in senior care, whether they were using ICT tools and whether SLEs were used and seemed to have potential. In the high-level interviews, the interviewees were asked, “What do you believe is the role of ICT in senior care?”, answers agreed that it doesn’t have one role only, that it could be used for management, structure and service delivery. Two of the interviewees mentioned that they saw it to enable independent living by providing support at home.

From the local government side, the author asked, “How are ICT tools used in senior care in your municipality?”. Out of the six local governments interviewed, Viimsi and Vorumaa mentioned they are not any ICT tools at the moment. However, they both mentioned that they are taking the firsts steps to develop ICT projects. Vorumaa is trying to create a digital infrastructure to develop future e-services, while Viimsi is currently collaborating with a private developer to create prototypes and test ideas in ICT. Tallinn representatives mentioned that at the moment, they only have the alarm buttons, and they also now order groceries for the seniors through Tablets. They had also been part of a pilot project to test monitoring sensors and Telecare services. As for the others, Pärnu, Saku and Saaremaa, they all mentioned that they are using ICT Tools as part of their services, but they are not fully integrated into holistic services. Pärnu mentioned that private services were being used, such as GPS devices, sensors, and alarm buttons. The Saku representative mentioned that employees at the municipality use a computer program to enter information for each client in home care services to keep track of the volume and price.

Similarly, the pilot project has also introduced a similar program, using tablets and mobile phones, to track working time and activities. However, it was highlighted the main communication with customers takes place face-to-face or by telephones. As for Saaremaa, the representative mentioned that they considered themselves quite an innovative local government. Three other interviewees also brought up this fact about Saaremaa. Saaremaa is currently using Fleet Complete to track their service delivery and has also participated in VIRTU, a project by Telia to test Telecare. They also provide Alarm Buttons.

In line with the ICT tools implemented, interviewees mentioned the challenge to get senior citizens to use. As the independent consultant says, *"There is a lot to be done concerning awareness and demand creation".* Tallinn, on its side, mentioned the challenge is to get citizens to use the alarm button and that it took a lot of effort in explaining the benefits and sharing the user stories. The service they mentioned is running for seven years now, but it took a lot of effort to get people to use it in the early stages. They see that for any other service to be brought up, the amount of effort in educating both seniors and relatives on the benefits is considerable. Saaremaa representative mentioned, *"The elderly have been offered emergency button services, medication dispensers, etc., but people have not been very willing to use them".*

4) The Role of Regulation

One topic that constantly came throughout the interviews was the Role of Regulation and how it affected the delivery of services. The Ministry representative brought the Welfare Act, highlighting that the Act establishes how the senior care services should be provided in Estonia for both institutional care and home care. The local government representative on its side referred to this fact in different ways. Pärnu representative mentioned highlighted that "*support services are relatively similar across Estonia*". In contrast, the Saku representative brought up the facts that "*The Social Welfare Act lists the social services that a local government is required to provide to its residents. If possible, the local government may also offer or organise other services if it deems them necessary*." But stating that *"Today, local governments are financially quite bound by the statutory tasks".* Tallinn representatives refer to it as the list of social services that they have to deliver. While Vorumaa representative brought up the fact that "*Local governments try to work according to the law and the question is not about what kind of services they decide to develop*". In that line, she brought up *"It's not very often that municipalities start to invent some totally new service. They are working according to the rule which has very specifically written what kind of services municipality should provide"*

Another point brought up from the regulation that all agreed was important was the one of the Role of the Family, that is, according to Estonian Law, directly related blood relatives, that is, adult children and grandchildren are responsible for their parents or grandparents. It was brought up that in many cases, informal care is performed by the relatives, and in other instances, the relatives are covering for the costs of care.

4.2.2 Threats & Opportunities for SHSs in Senior care

The following findings have been classified under the umbrella of Threats and Opportunities for SLEs in senior care. Three main topics have been highlighted: the local governments' motivation, the existence of different senior profiles, the lack of resources and the existing European & national funds.

1) Local Governments' Motivation

From the High-level interviewees, one topic that came across was the perception towards the fact the local governments were not very interested in the use of ICT in elderly care because that meant an investment and "social costs are not that interesting". They also mentioned that even though someone would come up with an idea in the local government, someone may find themselves with resistance and that it seemed difficult to onboard the whole local government.

When asked whether they would be willing to implement an SHS in their municipality, the local governments' response was measured. All of them, except Vorumaa, reply they would be willing to implement it, but they had considerations regarding processes and costs. Also, when asked whether they would be interested in being the owner of the product, they mentioned they were not ready to be the owner of the services but instead preferred to have this in cooperation with a private party. One of the elements they mentioned that was important for them to implement such a service was there needed to be a validation of need with the users.

The author also asked the Koduandur representative regarding the reception from the local governments towards his proposal. He mentioned he is already working with four local governments and that the service has been so far well understood and the local governments thought the product was necessary but that, of course, some were willing to try, and some were not.

2) Senior Citizens Profiles

One point raised during the interviews was that not all senior citizens had the same level of understanding and acceptance of ICT tools as everyone nor needed the same amount of support in term of care. This variety of profiles presents an opportunity and a challenge. As many of the interviewees mentioned, the opportunity is that there are seniors who will

be willing to try and pilot the new solution. On the other side, the challenge is that seniors have different health levels, which meant that some senior citizens would need a different approach than the proposed SHS.

3) **Lack of Resources and Existing European & National Funds**

Throughout the different interviews, the point of limited resources was pointed out, both from the high-level and local government perspectives. The need to find funding was raised. The option of using different open calls or European funds was mentioned as an opportunity for local governments to pilot innovative solutions. However, it was brought up that locally finding the funding was a challenge, and most local governments would have to rely on European funds.

4.2.3 Key Activities for Implementation of SHS in Senior Care

The following paragraphs collect a summary of the answers from the different interviewees in regard to the implementation of an SHS. From the questions of "What type of considerations need to be taken in the case of an SHS implementation?", "What type of collaboration need to take place for launching such a system?". Three key ideas were drawn from the interview answers:

1) **Defining Clear Processes**

The first one was that for all the parties involved it was needed that the process and assignment of responsibilities needed to be precise. The independent consultant mentioned the need to "*Define what the roles of different parties, person, family, carer, municipality, even state and service provider and also financing are. Who pays for what? What is the information exchange? Who gets the alert? How does the pathway of actions must look like? Who responds to alert and do what? What happens with the system when seniors do not need them anymore?".* The first representative from Connected Health Cluster answered in the same line, *"All of these parts should be thought about how the information flows, how the service close, how the person kind of goes in the different specs, how the money goes, and how their responsibility goes legally".* The second representative from Connected Health Cluster highlighted, *"The solutions need to fit into the process. If we're trying to change too much the way of working, then it's really difficult to implement this kind of services". The* Saku representative also noted the need

to know more precisely how things work regarding data protection, the reaction from alarms, and how to deal with the system in emergency situations, adding, "*If the caregiver is far away, who will take responsibility?"*.

The question of data privacy was raised a couple of more times. Local government representatives were concerned about the sharing of data and whether it could raise cybersecurity or data leakage. Tallinn representative also specified that in their experience piloting the monitoring sensors, they had faced a problem where the relatives were looking at the data and used it to question the caretakers' behaviours, creating a negative environment.

2) Finding Funds

Once more, the funding topic took relevance. And it was mentioned that to implement the SHS, finding funds was critical to its development. If funds were not funded, then the initial costs would be covered by the relatives and families.

3) Validating Need

Finally, it was raised the need for validation of need and future usage, in the words of the. Throughout the interviews with the high-level interviewees, it was mentioned that running a pilot was needed so that they can test. Likewise, Vorumaa representative mentioned that specifically for their county, the pilot was seemed necessary as there were different conditions, such as distance between houses, that created challenges for future implementation.

Regarding this point, the Smart Care project manager recommended, based on her experience, the need to interview both the future users as well as the caretakers. She mentioned that during the Smart Care project, they provided additional data to nurses; however, they didn't seem interested in the data as the general practitioners who were already in charge of the senior citizens. She questions, *"Do carers really want access to additional data?"*.

From the side of Koduandur, he mentioned that it seemed more important to do some piloting, that Local governments, carers and seniors needed to have the first experience of usage so that they would see the benefits of the systems. That after clients have tried the sensors, they remain users of the systems.

4.2.4 Existing SLE in Estonia

One of the discoveries from the interviews is that there is an existing solution for senior care in Estonia. This information was introduced to the author by the Pärnu representative and then confirmed by the Viimsi municipality and the Tallinn municipality. It was noted that all of them had different understandings of the services and different experiences. Pärnu, for instance, was helping to promote the service to the senior citizens but was not fully involved in the delivery of the service. Tallinn had run a pilot with the solution but was not aware of those results. And Viimsi municipality was only familiar with the existence of the idea.

With curiosity, the author of this thesis decided to interview the Koduandur CEO to get insight into the development and gain insight from this private initiative.

The following lines aim to present the collected information regarding Koduandur SHT.

The sensors delivered by Koduandur are low-cost motion sensors that can be implemented in different rooms. The sensors come with a two-side tape which is then stuck in the wall, and they automatically started detecting movement. The sensors are not intrusive. As per the CEO's explanation, the communication chip linked to the sensor is able to work anywhere in Estonia. The sensors then collect information about Temperature, Movement in the room, Doors opening and closings. Then, the sensors send this information to the web and mobile platform, where a trend of these conditions can be observed. When something seems out of order, for example, there is prolonged inactivity, the application sends notifications to the caretakers or relatives for them to check up with the senior citizen. As per the words of the founder, "*The main problem is that the family members and social workers do not have sufficient knowledge about the person living alone in their apartments or the house".*

Sensors are set up in the room with the most activity and depend on the size and architecture of the house. The founder mentioned that usually, one or two sensors are needed. According to the pricing table available at the Koduandur website [55], the prices range from 30 to 100 euros for the equipment and between 20 and 40 euros as a monthly fee. Figure 3 shows the different pricing packages offered by Koduandur.

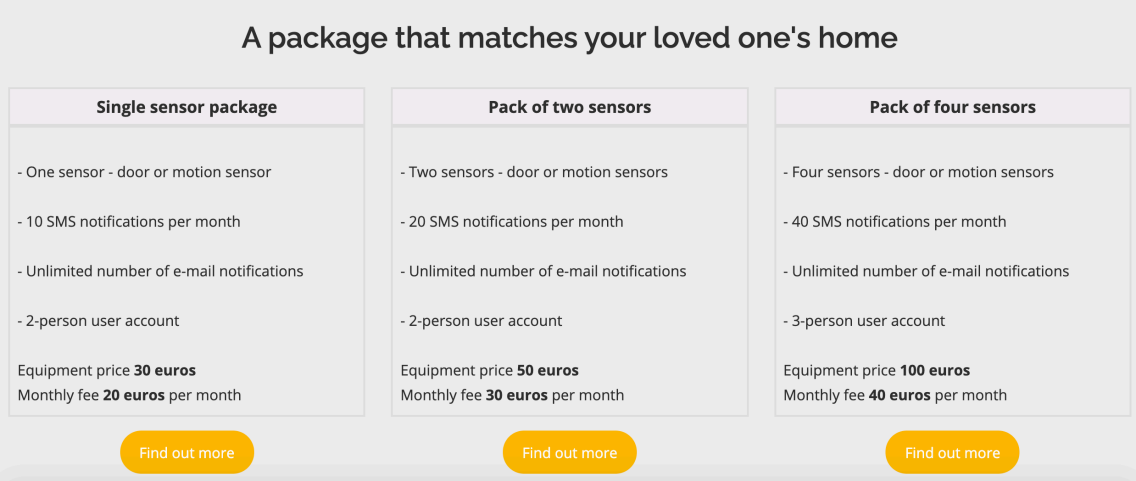

Figure 3. Koduandur offering

Figure 4 shows the Temperature graph drawn by the application based on the information collected by the seniors.

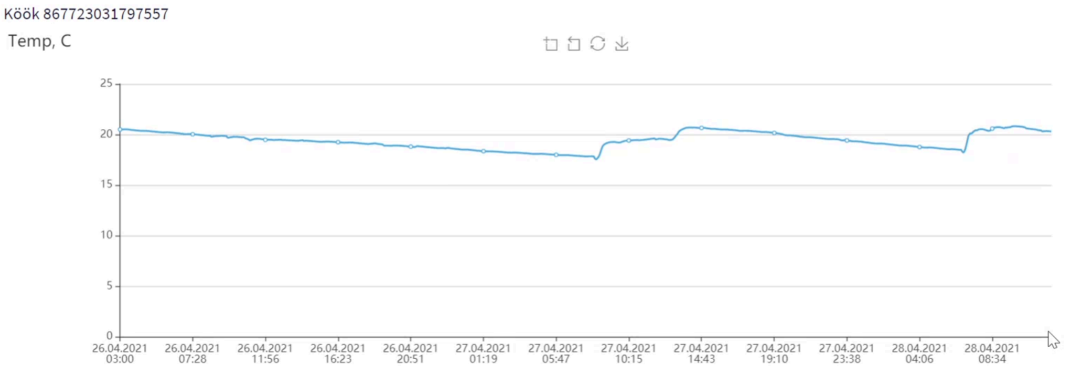

Figure 4. Example of a Temperature Graph shown in Koduandur

Figure 5 shows a weekly graph of the activity detected by the Sensors in the Kitchen.

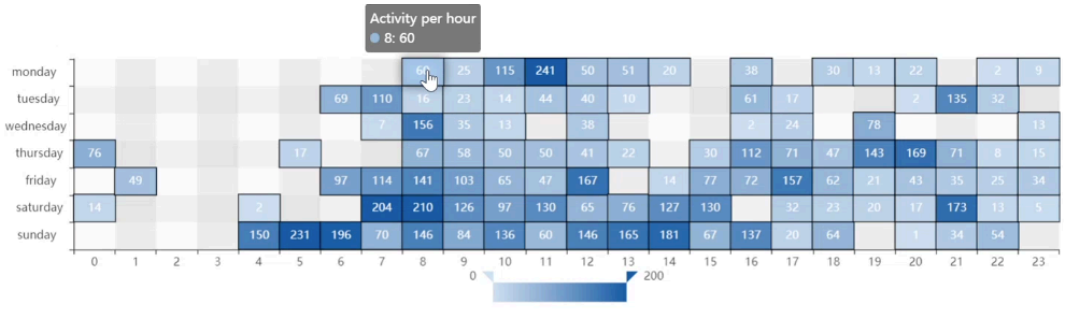

Figure 5. Activity Graph shown in Koduandur

In this figure, the darker the blue colour, the more activity is being recorded by the sensors. Based on this, it is possible to obtain a movement pattern and establish notifications when the pattern is broken. According to the Koduandur representative, notification can be personalised and set up together with the client.

These graphs are both accessible by the caretakers and the relatives. It also depends on the client who has access to this data but usually one or two persons.

As the graph shows, no detailed information is shown, which would make any privacy concern disappear.

4.3 Analysis and Discussion

The following paragraphs aim to share the authors own analysis based on the different interviews and document research in order to answer the research question.

To begin with, the question regarding how SLEs are used to support senior care in local government in Estonia. It has been learnt that local governments barely use SLEs to help senior care in Estonia and that the levels of usage overall are pretty different. From one side, some local governments are using alarm buttons consistently and exploring the usage of monitoring devices through a private provider. At the same time, others don't have any of those in place. Furthermore, when local governments use SLEs, they do not own the solution; hence, this technology's usage is entirely disconnected from their service delivery processes. When talking to the Koduandur representative, it was learnt that out of all the local governments they worked with, Türi took a more proactive and integrated approach. Overall, the lack of usage seems to be due to the resources limitation and the perception that senior citizens are unwilling to use this new technology. In other words, there is still a lot of space to develop the usage of SLEs to support senior care in local governments in Estonia.

To initially draft some answers to the question of what is needed to implement an SHS and to provide an analytical response, the Technology-Organization-Environment Framework (TOE) will be used.

To begin with, the Technology aspect will be studied. As explained noted throughout the interview, currently, there are not many Sensors provider in the country of Estonia. As of

now, it is only Koduandur who is offering this service as a private equipment for senior citizens and relatives. While Koduandur is also collaborating with local governments, the levels of integration with the local government are non-existent. In that regard, local governments seem to only interact with the tool through the care-takers profile and are not fully involved in the design of the service. Hence, it could be argued that the technology is yet in its infancy stages and that local governments need to develop their own digital infrastructure in order to provide a comprehensive SHS.

About the Organization factor, it was learnt that there was a lack of integration between the Health System and Social Welfare System and that the latest is underfunded. Organizational wise, this creates a barrier for implementing new technologies as funding is needed for the development of new tools. As mentioned in the Green Paper by the Ministry of Social Affairs, funding mechanisms play an important role because, in many cases, the price of technology is much more expensive than manpower [4].

Another factor in terms of the organizational aspect is the learning that local governments don't seem to have the same levels of technology usage; hence nuances in the local implementation must be considered. On top of it, local governments don't seem to have a clear strategy for adopting ICT tools. Also, they have limitations for implementing new services due to budget and statutory standards defined by regulation and funds. Another factor would be the mindset and perception from local governments in regard to senior citizens' usage of ICT, which is not favourable. Most Local governments interview seem to agree that seniors and technology are a complicated formula to navigate. The perception of difficulty creates resistance towards the adoption of innovation. On the positive side, the interviewed Local governments seem willing to try new tools, especially SLEs. All representatives also seem to understand the need for service modernization and have replied with the willingness to explore implementing an SHS.

Finally, while evaluating the Environment, there are a few positive points. First of all, is the availability of different funds across the European Union and the creation of new Open Calls by the Government that support the innovation and benefit local governments could benefit. Another factor is that relatives are indeed interested and bounded by law to support the caretaking of senior citizens. At the same time, younger relatives tend to be more technology savvy and could be an ally in seniors' engagement towards ICT enabled

services. Furthermore, as generations who are now in contact with digital devices grow older, the potential of ICT acceptance increases.

All in all, using the TOE framework, it is possible to evaluate that many aspects need reinforcement if talking about the adoption of SLEs and specifically an SHS. Especially from the Technology and Organizational side, the readiness for full implementation is low. Hence, a conclusion is that local governments have to start setting up the bases for implementation. In chapter 5, we will build upon this analysis in order to provide a guideline for the implementation of the de SHS service.

5 Comparing the Cases of Singapore and Estonia

The following chapter aims to bring together the learnings from both of the country's experience in order to answer the third research question of what is needed to implement an SHS and create a guideline implementation.

In order to be able to make a comparison, we will once again use the TOE framework for defining the different aspects influencing adoption and then make a conclusion and guideline. Below is a table summarising both countries TOE analysis.

	Singapore	**Estonia**
Technology	• The technology was designed throughout the pilot and adapted based on feedback. This made it easier for the process of implementation. • The technology chosen is non-intrusive and is subsidised by the government.	• The existing technology is provided by a private party, which means that the Public Sector is not the owner of the technology and hence less influent its adaptability. • The technology chosen is non-intrusive but has a cost to the seniors.
Organization	• The local organization was the project and had control of the development. • There was motivation to run the project. • Existing services like Close to Home and the Housing	• The local organizations are currently restrained by regulation and lack of funds. • Local motivation exists. • Some local governments provide services like home care and community houses

	Development Board flats set up a basis for implementation. • Roles and responsibilities among the different parties involved were clear. • Support from higher levels of government and funding was provided.	that could act as a basis for implementation. • Roles and responsibilities aren't yet defined. • Support from higher levels of government is not clear.
Environment	• The country strategy focuses on Ageing in Place and supports the development of technology. • Budget from higher management is allocated.	• The country supports Ageing in Place and encourages the development of new technology. • European fund and Estonian Government open calls exist to support projects. • The local budget is limited.

Table 2. TOE comparison analysis between Singapore and Estonia

Based on this comparison, it is possible to note that there are differences among both countries in regard to the conditions that facilitate the adoption of the SHS technology. It is notable that Singapore counted with more organizational and environmental factors that played in favour of adopting the project. Specifically, the local political will and provision of resources play significantly in implementation. It can be argued that the question of technology adoption is not much related to the technology itself but instead to the factors within the organisation and environment that will mobilise the adoption.

Therefore, based on this understanding, the author would like to suggest some guidelines for implementing the SHS, which can be observed have more to do with organization than the development of technology.

1. *Build upon existing services.*

In the Singaporean experience, the SHS was implemented on top of two existing services, which set the base for the project to be successful. The first service was the Housing Development Board Rental Flats, by which seniors could rent government-owned apartments and belong to a senior community. The second service was the "Closed to Home" service provided by GoodLife, by which carers visited the senior citizens at home to check on their health status and help them every other week. By installing the sensors in government-owned apartments, the sustainability of the project was ensured. And by building upon the "Close to Home" service, there was no need to redesign a new service but instead adapt the new technology in a way that will facilitate the delivery of the service.

In the Etonian Case, those services could be home care services or community houses. This approach shall reduce the resistance to change and slowly let the local governments experiment with technology. In the case of Estonia, this is also relevant due to the minimum service standards set by the regulation. Additionally, from the interviews, Tallinn representatives mentioned they would be more willing to implement the service if the sensors were installed in their own community houses premises as they are more "in control". Furthermore, the experience from Singapore, which used a combination of both services, seems to be the best approach to enable SLEs as part of the public service provision, that is, not to create an entirely new service but instead to leverage from existing ones.

2. *Take a user-centric approach*

In Singapore, the project was also successful because it took into consideration the preferences of the senior citizens concerning monitoring, such as the fact that the system should not be intrusive. This factor played a role in the senior's acceptance of the technology. Additionally, the development also considered all feedback provided from the caretakers to improve the systems, helping to make the project more likely. Likewise, it is noted that Koduandur runs a similar approach as they allow to personalise the alarms for the caretakers, creating then a better-suited service. While a challenging task in public service design [56], user-centricity is noted as a key element for creating better services[57].

3. *Take a collaborative approach*

In the Singapore experience, one can notice a strong collaboration among the different parties involved. The government provided the funds and structure (housing), and it relied on the SMU-TCS to develop the idea and the technology. The SMU-TCS heavily cooperated with GoodLife to build the technology and implement the addition to the care services. Thanks to the collaboration of all these entities, a comprehensive service was created that is now consistently running. Already, academics have identified the role of the Triple Helix (Higher educations, private institutions and government) in fostering innovation [58]. Likewise, any public institution looking towards implementing a similar project should look at cooperating with different entities and strengthening the ties for developing such technology. According to the Triple Helix model [58], universities could, for example, provide support in research activities, the private sector could provide laboratory equipment, and the government could provide sponsorship.

4. *Run validation and document it.*

In Estonia, it is currently difficult for the local governments to assess the potential benefits of an SHS. According to the adoption frameworks, it is easier to adopt new technology when the need and benefits are apparent [36]. In this particular case, this would only be possible when local governments start piloting the idea. Furthermore, testing the idea from a far-viewpoint may not be sufficient. For example, Pärnu municipality is promoting Koduandur's services to their residents, and they are the ones paying for the service. While this is a positive initiative, it would be suggested that the local government tracks the usage of the service, costs and benefits to evaluate a future comprehensive implementation properly. When asked regarding their experience with Koduandur, both municipalities Tallinn and Pärnu representatives were not aware of the results of these initiatives and weren't very clear on the benefits of the solution. Reports are essential to confirm the validation.

5. *Take the effort to educate seniors to accept new technologies*

In Estonia, it was recognized by local governments that engaging the senior citizens with technology seemed a challenge and specifically for Tallinn to implement the alarm button system. It took a lot of time to educate seniors on the advantages of this technology. Through the Singapore experience, it was also noted that the caretakers made an effort to

explain and share stories with the seniors, which will facilitate the acceptance of the monitoring devices. According to adoption frameworks, education does play an essential role in it. Hence, it is recommended that the public sector consider a need to establish a consistent effort to educate the user on the benefits of the technology when implementing any innovation.

6. *Establish a clear approach and support towards the problem of ageing across all levels*

Finally, while this is probably out of the guideline for the public organizations, it is noted the environment plays a prominent role. In Singapore, there is a clear approach towards Ageing in Place communicated by the government and followed through at different levels. Throughout all the initiatives this is the main objective to be delivered. It is reflected in the development of the de SHS, and it is also reflected in the budget allocation. Furthermore, the political will is supportive towards the development of the project. As mentioned, the pilot was initiated thanks to an influential Government official who facilitated the funds and arranged the collaboration between SMU and TCS. While in Estonia, the approach is clear in the paper, the financing has not yet caught in regards to supporting the use of technology, and political will does not drive the initiative. Therefore, it is up to the higher levels of government to make this a priority.

While these recommendations may not be new to those who study the development of e-Governance, these recommendations do seem new to the area of developing SLEs and SHSs as part of public services. Most of the literature focuses on the development of the technology instead of its integration into existing public services.

6 Conclusion and Recommendations

The presented research was conducted to contribute to future research and implementation of SLEaw as part of public services. Throughout the study, it has been learnt that indeed many initiatives are being designed and executed to create technology that supports ageing well, in place and independently, but that is not necessarily integrated as part of public service. That is the reason why studying how SHS implementation supports senior care was a relevant topic. Furthermore, exploring the potential of the idea of an SHS in the context of Estonia, which the author learnt is young in SLE implementation in senior care, shed some light on the considerations needed to implement such an idea. In the following lines, the aim is to summarize our main outputs of the presented research.

Aiming to answer the first question about how smart homes support senior care, the author embarked on an analysis of the existing literature, state of the art, and specific analysis of the Singaporean Experience. Throughout this part of the research, it was identified that indeed SHT and SLEs are useful to support senior care because they enable carers with information about patterns otherwise missed when seniors are at home without supervision. However, it was noted that aiming to simply develop the technology without integrating it into an existing service is not enough. Hence, with Singapore, it was stressed how important it was to incorporate this type of technology into existing care services. To develop such a service, it is important to take into consideration a user-centric approach and to enable collaboration among the private, public and even educational sector. Another point is that it takes time to educate seniors about monitoring technology and that human interactions play a role. That is the sharing of success stories among seniors and the education performed by caretakers, whom seniors already trust.

The second question is locally specific and aims to study the adoption of SLEs as part of senior care in a specific context, that is, Estonia. To first understand the phenomenon, the author studied the current state of senior care and the usage of SLEs on it through data collection and interviews. The findings shed light that in regard to senior care and

implementation of SLEs, Estonia is yet on infancy levels, even though digitalisation in other areas is consistent and prominent. With this question, it was also possible to observe the perception of local government representatives towards the use of SLEs. When making a balance of this perception, it was found that while the motivation to try using SLEs exists, there are specific barriers that make the wanting for implementation lower. Those are the considerations of costs and perception of need.

With the third question, then it was expected to identify steps needed to implement an SHS. This was achieved by using the TOE framework to understand the level of readiness for accepting this new technology. Through this analysis highlighted three actions to be taken for implementation. Those can be found in the previous chapter. Considering that Estonia is at infancy levels of SLE adoption, the author concludes the lessons learnt from the case could be shared with other governmental organizations willing to explore and implement SHT and SLEs as part of senior care services.

6.1 Future Work

As part of the research, it was identified that the implementation of SLEs as part of senior care in Estonia is in the early stage. As the technology adoption theory determines, there is a process of four steps to adopt a technology, being the last one, implementation. An interesting study to follow up in the future will be the phase of implementation for those local governments that are currently working on it. Within it, paying special attention to the factors of Organization and Environment, it can be observed that the difference among implementation is not so much the technology itself but the factors influencing it.

Additionally to this topic, it would be interesting to follow through on how the SHS could be integrated into smart cities, as Skouby et al. suggested [9]. Estonia, a country focused on developing smart cities [59], may provide the right conditions to do so.

Finally, in a separate line from technology adoption and smart cities, the author noted that knowledge sharing among the local governments was low. Hence, local governments were making similar efforts but were unaware of the experience of the rest. Knowledge management and sharing as a base of innovation could also be interesting topic to investigate in the context of Estonia.

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Appendix 1 – List of Interviewees for Singapore Case

The following are the list of interviewees part of the SHINESenior Projects:

- The Project Lead from SMU University
- Two TCS representatives in charge of the technology development
- Five nurses representing GoodLife

Appendix 2 – List of Questions for Singapore Case

1) How was the project developed?
2) What were the objectives the project aimed to achieve?
3) What was your role within the project?
4) What was the impact of the project?
5) How was the cooperation between all the parties involved?
6) What were the obstacles found while executing the project?
7) What were the key elements for the project to be successful?
8) What are your main learnings?
9) What happened after the pilot finished?

Appendix 3 - List of Interviewees for Estonia Case

The following are the list of high-level Interviewees:

- A private consultant in senior care (currently working at Estonian Insurance Fund)
- Two Representatives from Connected Health Cluster
- One Representatives from the Ministry of Social Affairs of Estonia
- One representative from the private sector specialised in smart home technology

The following are the list of interviewees from the local government:

- Head of Senior and Health Care Services at Viimsi municipality
- Head of Social Services at Pärnu municipality
- Head of Social and Welfare Services at Saku municipalities
- Head of Social and Health Care Services at Tallinn municipality
- Head of the Welfare Department at the Development Centre of Võru County
- President of the Welfare Centre in Kuressaare

The following are the list of independent interviewees related to the

- Smart Care Project Manager
- Koduandur CEO

Appendix 4 – Interview Questions for Estonia High-Level Representatives

1) How familiar are you with the senior care situation in Estonia?

2) In your understanding, what is the biggest challenge presented in senior care in Estonia?

3) What do you believe is the role of ICT for improving Estonian senior citizens care?

4) How familiar are you with ICT initiatives currently being run to support senior's care in Estonia? If yes, could you mention some?

5) From your perspective, how aware are senior citizens of the mentioned ICT initiatives? If not, what can be done to raise awareness?

6) How familiar are you with the terms Ageing in Place or Independent Living?

7) Would you say Estonia currently focus on creating initiatives that encourage ageing in place and independent living?

8) How familiar are you with the term of Smart Living Environments?

9) In which way do you think that SLEs (e.g. smart home with activity monitoring sensors) could support senior citizens in Estonia?

10) How willing do you believe senior citizens in Estonia would be to use smart living environments (e.g. smart home with activity monitoring sensors)?

11) If Estonia were to launch an SHS, a house with monitoring sensors that inform and alert caretakers about the elderly conditions to take action when needed, how successful will it be?

12) What needs to be taken into consideration for the launching of the SHS?

13) How could Estonia leverage its existing technologies and systems to launch an SHS for senior citizens?

14) If Estonia were to launch an SHS for senior citizens, what do you think are the challenges the project could face?

15) How could the private and public sectors cooperate to bring about a solution like the SHS for senior citizens?

Appendix 5 – Interview Questions for Estonian Local governments

1) From the municipality perspective, what is the biggest challenge in senior care?
2) What is currently being done to overcome this challenge?
3) How satisfied are you with the current quality of senior care services in your municipality? (I am satisfied, rather satisfied, rather dissatisfied, dissatisfied)
4) Do you believe senior care services in your municipality need modernisation?
5) Within the municipality, how are ICT tools used for senior care service delivery?
6) How does the "Ageing in Place" or "Independent Living" approaches play a role when designing senior care services in your municipality?
7) Do you currently offer any type of service for senior care that includes Smart Living Environments?
8) How does the municipality decide on what type of senior care services to implement?
9) What is the potential for Smart Living Environments to be used in senior care within your local municipality?
10) Suppose a Smart Home System (SHS), that is a House installed with movement and activity sensors that monitor the seniors while at home and sends data to the caretaker to take action when needed (e.g. patterns change, falling, sleeping problems, etc.), were to be proposed to your local government. Would you be willing to implement it?
11) What do you think are the obstacles and threats regarding the SHS?
12) How likely do you think seniors in your municipality would be to use this service?
13) From the municipality point of view, what type of collaboration is needed to launch such a service?

Appendix 6 – Interview Questions for Smart Care

1) What is the main problem that Smart-Care aims to solve in Estonia?
2) What was the role of ICT during the project?
3) Were "Smart Living Environments" part of the technologies used in the project?
4) If yes, How?
5) What role did the ¨Ageing in Place¨ or ¨Independent Living¨ approaches play a when SmartCare?
6) Which entities were involved in the project?
7) What were the key activities to implement the project in Estonia?
8) What were the obstacles found when implementing the project?
9) How receptive were senior citizens in Estonia to the technology used in the project?
10) What do you think are the obstacles and threats regarding the Smart Home System (SHS)?
11) What needs to be taken into consideration for the implementation of the SHS?
12) Which entities would need to be involved in creating a solution like the public smart home, and how should they cooperate?
13) How could this project be done Nationwide?

Appendix 7 – Interview Questions for Koduandur

1) What is the main problem that Koduandur aims to solve?
2) Could you briefly describe how do the sensors work?
3) How is the information collected by sensors shared for care support?
4) How many users do you currently have?
5) What is the senior citizen's reception to this service? / Have you run any pilot?
6) What is currently working well under the service implementation?
7) What are the challenges found for the implementation of the service?
8) I understand Koduandur collaborates with local governments to promote/deliver its services. How does this relationship work?
9) What are the main challenges of working with municipalities?
10) In your opinion, what is the potential of integrating the type of services you provide with the home care services provided by municipalities?
11) What do you think are the obstacles and threats regarding the Smart Home System (SHS)?
12) What needs to be taken into consideration for the implementation of the SHS?
13) Which entities would need to be involved in creating a solution like the SHS, and how should they cooperate?

Appendix 8 – Interview Outcome Mind map for Estonia Case

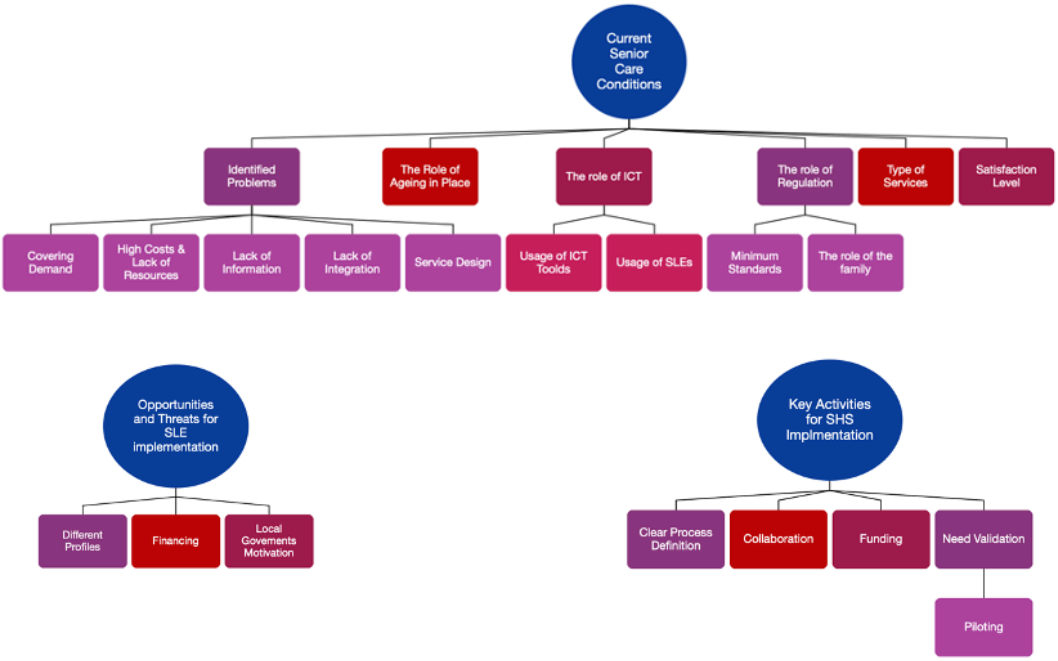

Figure 6. Key Concepts from Interviews for Estonia Case

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