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# Using Information and Communication Technology in Home Care for the Elderly

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Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/intechopen.72083>

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## Abstract

Due to population aging, countries' financial capacities to maintain the current level and scope of services and institutional care for the elderly are decreasing, which is why there are increasing demands to rationalize services and residential care for the elderly as much as possible. The society has responded to such issues with the idea that the elderly should be able to remain in their home environment as long as possible, where they would be able to lead their lives with the best possible quality of life. People support the idea broadly because it meets the desires and needs of the elderly. Most want to stay at home, and in the same social environment, they want to maintain their autonomy as long as possible. To make to the elderly, the possibility to remain in their living environments and moving elder-care activities to their homes can be achieved with the help of information and communication technology (ICT) by which home care could be provided remotely.

**Keywords:** aging at home, the elderly, information and communication technology, smart homes, remote home care

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## 1. Introduction

European countries as well as other western countries are dealing with an aging of population. The United Nations Department of Economic and Social Affairs [1] reports that in the 1960s (1950–2010), the population of the elderly almost doubled, and there was an increase from 8.2 to 16.2%. This rate of aging will also increase in the coming decades. According to Eurostat data [2], by 2060, the proportion of people over 65 years of age would constitute 29.3% of the total population in the Member States of EU, as well as Norway, Switzerland, Iceland, and Liechtenstein, if natural fertility continues to decline and will have no regular

(or significant) entry of young immigrants. Because people will live longer, the demographic structure of seniors will also change: the number of seniors over 80 years will increase significantly; it should double by 2040, and by 2060, it will almost be three times more. As a result of the aging of the population, in particular, the rapid increase in the number of very elderly and sick people who generally need a lot of care and because families are finding it increasingly difficult to take care for older members due to a modern rhythm and lifestyle, there is increasing pressure to move them to social and medical institutions, where they receive appropriate services and care. This creates an increasing expenditure on health care and social protection systems. This is particularly problematic in countries that have by now developed only the institutional form of care for the elderly, which is the most expensive of all forms of housing care.

The financial security of services for the elderly is already a concern, and the European Commission [3] estimates that the future costs of pensions, health care, and long-term care will increase by 4–8% of gross domestic product (GDP), and total health expenditure and social services are expected to be doubled by 2050. By 2050, only social security costs in EU Member States are expected to account for around 35% of GDP [4]. The effect of the generation of the baby boom generation should be revealed in the provision of care services to the elderly, as this generation will become a huge user of these services. Given the dynamics, in particular, the impact on social health expenditure or maintenance of use, the future fluctuation of the dependency ratio is very important. This ratio shows how many older people depend on the workforce. The forecasts suggest that in the future, there may not be enough workers to support the health and social care system. The relationship between age, which is the ratio between the number of workers (15 to 60 years old persons) and the number of retirees (over 65 years), rose from about 5:1 in 2000 to 1.9:1 in 2060 [2]. In the case of the unchanged growth rate of the elderly, the unchanged level of the right to productivity, and the unchanged employment rate, the increase in the share of GDP in aging-related public spending is the same as the dependence on the age [5].

Due to a decline in the financial capacity of countries to maintain the current level and scope of institutional services and care for the elderly, the need for rationalization of housing and services is rising. Since the home is of primary importance in later life [6], these requirements are possible, as the main idea is to stay older for the elderly and to move health and social care for the elderly. The idea includes the concept of “aging at home” or “aging in place”. This concept has been the main topic of many research programs, strategic plans, and actions in some countries in recent years, for example, in the United States, the United Kingdom, Canada, Japan, etc. The aim is to reduce the rising costs of service delivery, thus reducing the pressure on public funds to meet the health and social needs of the aging population. The advocates of this idea derive from the preferences of the elderly. Studies show that elderly people stay as long as possible in their homes and in the same known environment and maintain their independence as long as possible [7–11]. Although the preferences of the elderly depend on cultural differences, in most regions, older people have a negative attitude toward institutionalization, and they feel that this is primarily a traumatic experience. Many times they find their last refuge, their last resort before their death. Such perception is deeply rooted in societies without diversification in institutions

and in collective dwellings for the elderly. Extensive institutional care is as long as possible; therefore, it is in the interest of the elderly and is also in the public interest, it seeks to limit the demand for institutional care only for the elderly who really need this form of social assistance.

Moving elder-care activities to the homes of the elderly demands that effective service provision and service quality should be adapted to the living environment, as well as the implementation of new organizational procedures and technological solutions. With the development of the information society, the idea of moving elderly care activities to their living environment and implementing efficient and high-quality health care and social care services at home can be achieved with the use of information and communication technology (ICT), which can convert an elderly person's home into an innovative living environment and provide remote home care. This is a system that remotely connects the homes of the elderly with the control center and, via this center, with health care centers and other care facilities.

This chapter presents the role of ICT or their applications to the needs of offering remote home care support to the elderly. It discusses its importance and functioning, the efforts and achievements made to date in developing this innovation, and the premises for implementing it in practice based on opinions of the elderly about staying in these ICT environments. The chapter is an analysis from critical perspective of the relevant studies and scientific literature on the topic, as well as on our own research findings, and offers new knowledge, results, synthetic ideas, and critical perspectives. The chapter also sets questions for further consideration and scope for future research and applied work in this field.

## **2. Modern technologies used for providing an innovative living environment**

Aging population and the development of modern technologies are parallel and interconnected processes in developed countries. A modern diagnosis of health and treatment methods is used to extend life, and modern technologies offer housing and life support to the elderly. This link has also been developed by new interdisciplinary areas, such as gerontechnology and domotics. Gerontechnology is a combination of the word "gerontology", the science of aging and age, and the word "technology". According to Ref. [12], the term was expressed by Graafmans and Brouwers in 1989. It explores and develops technologies based on researchers' findings on the aging process, with the aim of improving health and facilitating the daily lives of the elderly, enabling them being independent and participating in social activities [12–14]. Domotic derives from the Latin word *domus* "home" and the English word "informatics". It explores the use of information technologies that can be integrated into the living environment [15]. With regard to the development of technology for the elderly, it is possible to define two directions [16]: the improvement and development of assistive technologies that make everyday life easier for the elderly and develop and disseminate information technologies that exceed telecommunication beyond the limits of physical space.

“Assistive technology” means any device, equipment, product, or tool that maintains or improves the functional capabilities of persons with disabilities who may use them to facilitate and safely perform a particular task that they would otherwise be unable to perform or execute [17–19]. According to Ref. [20], assistive technologies allow the user to control the environment more efficiently with minimal physical effort. The environment in which support technologies are integrated should take into account not only the general standards but also the specific needs of individuals [21]. With the help of assistive technologies, differences are reduced between the individual’s abilities and the environment, allowing an autonomous life [22]. We distinguish between low-, medium-, and high-tech technologies [23]. Low-level technologies include minor mechanical modifications or adjustments in a particular type of product (e.g., furniture); in contrast to the first, the second includes simple devices that require an energy for working (e.g., automatic alerts); and the third devices are programmed with integrated electronics [18].

The development of modern information and communications technology (ICT) opens new opportunities and solutions for assistive technologies. The term “information and communication technology” refers to the system of electronic integration of providers, hardware, software, and Internet users. It is used to obtain, save, manage, process, transmit, and disseminate data through the telecommunications system [24]. It reduces the physical distance and expands the social dimension of space. Together with computer hardware and software, ICT makes it possible to control and manage assistive technologies in the home. This reduces physical distance and expands the social dimension of space [25]. The concept is known as an ambient intelligence or a smart environment. According to Ref. [26], we use those terms for defining technologies and methods that are always prepared to perform for persons and their needs and wishes. Such environment is combining computing and advanced technologies (intelligent and innovative devices) and special interfaces (sensors) that detect and interact discreetly with users. The equipment must be environmentally nonintrusive and in the smallest measure, with the smallest possible use of space and energy, provided by intelligent materials, various nanotechnologies, etc. A complex and heterogeneous network (i.e., the telecommunication infrastructure) operates on the discrete manner in such environments. These environments recognize the presence of people in a room based on physiological characteristics (e.g., voices and gestures) and are always ready to respond to a request for environmental assistance. This enables the measurement of biological functions and safety of the user. Controlling the operation of environmental intelligence ensures security in terms of innovative technologies and ethics (e.g., the security of user personal data and other data) [27, 28]. A smart home is an application for the environment, which is an example of an innovative living environment.

It is a system that responds to desires, needs, and activities of people and is adapted to the abilities (cognitive and physical) of users. These homes are equipped with interconnected equipment, tools, and technologies. Electronic systems in smart homes monitor the living environment and can even perform certain tasks (shutters, opening and closing doors, and turning on and off heating) with minimal physical force using various methods (remote control, wheelchair, voice control, and even moving eyes). These homes have an integrated communication technology that allows electronic access and integration in different environments:

a living environment in the form of social buildings and infrastructure, a social environment (interaction with family, neighbors, and service providers), and a secondary environment (culture, politics, trade, ecology, etc.) [28]. Some authors [29] believe that these systems define the vision of the information society in the future—they will support a number of human activities transmitted electronically, will have access to many services and applications, and will make technologies less costly and the availability of different types of telecommunications. Therefore, smart home technology can support the health, safety, and independence of the elderly. While these technologies offer significant benefits to seniors and their families, seniors become the primary adoptive users of a new 24-hour lifestyle that monitors, manages, and maintains their health and well-being periodically [30]. However, smart homes cannot serve their purpose with the best technical and technological support if the living environment does not adapt physically from the start: without architectural barriers and adapted to the needs, capacities, and requirements of the elderly. When adapting the physical living space in an intelligent home, the principles of inclusive design [31] or design for all [32], also called universal forms [33–35], must be followed. The principles of such a concept are [33, 36] (1) equitable use for all users the same means must be provided, (2) flexibility of use—the design must correspond to many individual strengths and capacities, (3) simple and intuitive—the use must be easy to understand not looking for the knowledge, skills and experiences, (4) perceptible information: different forms (images, verbal, tactile) must be used for the redundant presentation of most important information for living, (5) tolerance for errors—the hazards and adverse consequences of random or unintentional acts must reduce, (6) low physical effort—effectively and comfortably with minimal fatigue must be provided, and (7) size and space for access and use—size and space must be provided for access, scope, handling, and use.

With these principles, the access of a living environment is emphasized. In such cases, layout must be functional and user-friendly as much as possible. Nothing should be complicated and difficult to use, and (at the same time) product should maintain their esthetic and practical value [37]. Some examples: the doors and halls must be wide, the passages between the rooms must be without thresholds, the furniture, electrical installations, and windows must be at an appropriate height, the floor must be level and not slippery, bathrooms must have handrails, seats, backrests, and appropriate furniture, rooms must be adequately lit, have adequate contrast between shades of bright and dark colors, and so on. Smart homes are therefore a combination of a living environment without architectural barriers and information and communication technologies that are integrated into such a living environment. The home environment in a smart home must always be accessible to everyone.

### **3. Four generations of ICT systems for enabling remote home care for the elderly**

The ICT application for enabling remote home care is called telecare. The authors in Ref. [38] define this as the use of ICT to support health and social protection at a distance. Telecare is a

mixture of telecommunications and computer technology and relevant information services to help individuals at home. All this have to be managed [39]. The most typical model is known as the business to customer (B-2-C) model. In this case, health and social services are provided directly to end-users (patients) at their homes [40]. According to Ref. [41], ICTs that are included in the remote home care system are divided into three generations.

The first generation of these systems is the most basic and simplest remote home care application. It was developed in some western European countries more than 25 years ago. The system was created in some countries of Western Europe more than 25 years ago. The system consists of a special telephone device. This is because users had a special phone for remote triggers that were wireless. The users worked with the trigger themselves and had them, for example, in the form of a pendant or bracelet. This enabled users to activate the wireless trigger anywhere in the apartment or house, as well as anytime (even if the phone could not be accessed). By pressing the trigger, the system automatically names the administrator (relative, neighbor, or friend) or calls the help center [42]. The system may also include a reminder. This is a feature that sends a reminder to the user at a certain time, in which the user has to perform a specific task. You can send reminders to one or more addresses at a time, including the user's caretaker. Users always had to confirm that they received a reminder. If this was not confirmed, the reminder was resubmitted, and the caretaker was informed that users did not confirm the reminder [43]. These simple versions of the safety alarm system are intended for elderly people with various health problems such as forgetfulness and various forms of disability [44]. The extent of usage differs and varies from one country to another. The ICT & Aging—European Study on Users, Markets and Technologies [45] showed that the share of users over 65 years was the highest in the United Kingdom and Ireland (around 15%), followed by Scandinavian countries—Denmark, Sweden, and Finland (up to 10%), and the United States, the Netherlands, Japan, Spain, Germany, Hungary, Italy, and France (up to 3%).

With the development of smart technologies, the system has evolved further. Today, there are already many providers of advanced information systems. These systems work by collecting information about the user's life functions by themselves. Systems send this information from users' homes to health and other help centers. This is facilitated by networks and broadband communication channels. The United Kingdom is at the forefront of the implementation of these advanced services for the elderly in the form of ambient intelligence. The British government has identified the implementation of these advanced systems as one of the most important national strategic priorities for sustainable development. According to Ref. [46], 175 million pounds was spent in England, Scotland, Wales, and Northern Ireland between 2006 and 2011 to carry out pilot projects aimed at obtaining as much practical experience and evidence as possible, on the basis of which smart homes can be implemented successfully and with greater certainty. The results were extremely good and encouraging. For example, in Scotland, for every pound that was invested in the establishment and implementation of this system, six pounds was saved (8 million pounds were invested and 48.4 million pounds saved) [47]. This included, inter alia, a reduction in the number of admissions of elderly people to elderly homes (47.5%), a reduction in the number of unnecessary hospitalizations for old people due to rapid hospital dismissal (42%), the reduction in unexpected hospitalization due to the rapid response of the system to injuries happened at

the old man's home (9.1%), and reduction in the number of calls for quick home help and nightly shifts in hospitals. This is also the purpose of remote home care and advanced smart systems for the elderly.

These advanced systems of an innovative and smart living environment (second generation of remote care) operate in a way that different sensors are built into the user's home environment. The sensors are built into the user's home environment quite discreetly (e.g., on furniture handles, door handles, under carpets, in watches, etc.). The sensors measure and monitor the user's operation and its life cycle. They can measure the physiological functions of users (e.g., blood pressure, heart rate, and so on). They also monitor all activities of the user (e.g., when they go to the carpet next to the bed in the morning, how many times they go through the door, when they open the refrigerator, when they prepare meals, etc.). Sensors also warn those users who have different cognitive or sensory deficiencies (e.g., the system warns them to take medicines, also give users instructions on how to manage things and appliances in the dwelling). In addition to the devices that monitor and measure the health and psychic state of the users, they contain the smart domes of another device. These are the triggers/sensors that identify any unusual state or situation in a living environment that deviates from the normal. In this way, these devices provide security and control in the user's environment. These devices include detectors that detect motion (e.g., sensors for detecting falls of users, sensors that allow the lights to turn on and off automatically, sensors that allow the door to open automatically and close, etc.). In addition to sensors that detect movement, smoke detectors, fire sensors, gas sensors, water sensing sensors, and so on are also included among these devices. All the information recorded by the system in the user's smart home is transferred to the help and control centers via multipass telecommunication systems. If the system that is built into the home environment of users detects any changes that deviate from everyday or normal parameters, an automatic alarm is triggered. This alarm is transferred to a control center or help center (also to administrators). In the help centers, they immediately decide what to do. Some authors [24] therefore define such a system as a "response mode" or "r-mode". Within the descriptive supply system, control centers are a kind of intermediary between users and providers of services or services. They also provide information coordination between service providers and helpers (health and medical personnel, social workers, firefighters, relatives, neighbors, and so on). Depending on the problem and severity of the problem detected by the system at the user's home, the responsible person in the control center also provides the user with appropriate instructions (recommendations) or informs the service provider about the needs of users [48].

There is also the third generation of information and communication support systems for remote home care. This generation of systems includes the support of medical personnel. Doctors and other well-trained workers have occasional access to data recorded in users' homes and are transmitted and stored in the databases via broadband. Such access and monitoring of the health status of users enables the detection of different health patterns, which provides important information for the early detection of various diseases and deterioration of the state of health of an individual. This can help to adequately and effectively, and above all, adapt the treatment program and services to the user in due time. The data collected do not only allow monitoring the performance and health of the individual and improving the

efficiency of the carrier but also provide better and more informed insight into the condition and understanding of the patients' needs or/and "intelligently" monitor the effectiveness of the care and the wellbeing of the elderly [49].

Users that wish to monitor the results of their health efforts can access their aggregated data outfitted with appropriate recommendations and advices any time through the ICT of the fourth generation of such systems. Audio-visual technology allows virtual or remote consultation between the user and doctors, nurses, or other health care personnel, thereby reducing the need for home visits, hospital appointments, emergency room visits, or hospital admissions [50]. In this way, the elderly could feel significantly empowered in day-to-day life [49] and they can actively and effectively participate in promoting health, care, and remote protection [51]. Authors in Ref. [24] define the third and fourth generation of remote home care system as a "preventive mode" or "p-mode," as it "emphasis on prediction, prevention, and early detection so as to prolong active and healthy independent living" [49].

The use of information and communication technologies offers an opportunity for older people. They allow them to live in their homes, in their familiar living and social environment for as long as possible, and to be able to live as independently as possible in such an environment. Such a life enables them to have a good quality of living; thus, institutionalization is not necessary or postponed for a later period. According to Ref. [38], the findings of the studies confirm that remote care at home reinforces the mental and physical condition of older people, and that it has been proven that there have been fewer hospitalizations. If hospitalization occurs, its duration is shorter than it would have been in cases for those people who were not involved in remote care. Remote care is better, more efficient, and cheaper. That is a fact. Therefore, telecare is one of the possibilities for a significant reduction in costs for health care and social services, especially in socially aging societies. However, the question arises as to how to include telecare in existing national health care and social care systems.

#### **4. How to implement ICT systems for enabling remote home care for the elderly?**

Despite successful pilot and test projects, advanced forms of an innovative living environment for the elderly are not yet widely implemented. It is very important that the technologies are reliable. It is also important that the living environment of the elderly person is appropriately included. Only in this way, it is possible to effectively implement remote home care as an application of information and communication technologies. However, one thing cannot be bypassed, namely that in order to facilitate the aging of the home, technologies cannot in themselves provide for the successful implementation of home care in a regular health care system and social care for the elderly. According to Ref. [24], implementation within the existing health and social systems is very complex. It is a combination of technological design on the one hand and organizational planning on the other. At the same time, this also includes a large number of groups of different people and individuals. Each of them has different ideas about what are the risks and the different systems of values that need to be met. The implementation

of telecare also changes the existing relationships between the various stakeholders involved. Based on studies on integrating innovations into existing systems, some conditions or requirements for successfully implementing innovations can be defined, such as *ethical and legal acceptability, the suitability of the distribution of funds among the stakeholders, the technical reliability of an innovation, and the suitable arrangement of the living environment*. Beside these, some other conditions and requirements for successfully implementing innovations, such as implementing of remote home care into the regular health care and social care system, are important.

#### **4.1. "Local" social surroundings and support of innovation in it**

When introducing innovation into a "local" social environment (from a global social environment), the implementation of this innovation must be defined with the characteristics of the "local" environment. The acceptance of innovation in a local environment depends entirely on who is involved in introducing innovation, who is identified with innovation, and who takes the lead role as an initiator and mediator in the implementation process [39]. Implementation of innovation can be hampered by lack of support from the very beginning of the implementation process. This is mainly due to the lack of strategic support and decision-making by various (local) political and professional bodies. In those local environments where political will and decision-making are weak, information on innovation is insufficient. In such environments, the efforts to implement innovation must first focus on clearly determining the importance of introducing a specific innovation for the local environment. This includes the analysis of the existing state and the purpose, goals, and expected benefits of the new application. Efforts should be also focused on developing a collective "understanding of the innovation" through various forms of providing information and communicating [52]. The next step should focus on active involvement of politics. The author in Ref. [53] considers that this is the only true way and the only right way to determine the solid and clear legal frameworks that are indispensable to ensure that innovation is successfully implemented in a specific local environment. The political support needed to introduce a certain innovation into health and social systems is particularly important in the welfare countries. In such countries, systems are regulated in such a way that government policy regulates the social and health system on the basis of statutory acts. The governments of these countries also define policies and priorities, legal, and ethical rules of operation and are also the main provider of financial resources.

#### **4.2. Mutual cooperation**

As stated in Refs. [54, 55], successfully implementing more complex innovations requires coordinated, harmonized, and close cooperation between all groups of stakeholders; specifically, between and within individual groups (the vertical network of those involved) and with certain stakeholders also between the various levels of operation (the horizontal network of those involved). Mutual cooperation is essential for achieving high levels of awareness and recognizability, showing better cost effectiveness, increasing transparency while taking into account needs of a user, searching for solutions for adjusting legal frameworks, dividing risks in research and innovations, interoperability, and monitoring progress in general [3].

### **4.3. Readiness of organizations and the change of norms**

When implementing innovations, the common obstacles are the compliance of the innovations and the resistance of organizations with values and “cultural” norms of an organization. Therefore, according to Ref. [56], it is important for the organization to create an innovation that abolishes and replaces some of the existing routines. In this, we have in mind various organizational routines, behavior patterns, and mental patterns. The organization should devote itself to the appropriate preparation that is related to the planning of the introduction of innovation. This is about developing different plans (strategic and business), developing different models, and evaluating and analyzing what the needs are. It should also be dedicated to determine who the providers of different services (e.g., health and social) and also to bark to those who are in high positions (in politics, businesses, etc.) to gain advocates. The organization should also be dedicated in preparing an appropriate working environment for the purposes of implementing the innovation, which involves training and education of personnel. As part of the preparation of the working environment, it must also carry out the reorganization of the working process of the process and often change the management of the business. Referring to Ref. [57], this activity of the organization represents creativity in action and thinking. The author of the same reference also warns that such reorganization of work, management, thinking, etc. need to be carefully planned. The author also points out that such reorganization procedures need to be prepared for the needs of each individual organization, and that the universal approach does not exist. As stated in Ref. [58], we must therefore act according to the principle “one approach for all,” because this may lead to resistance, especially in organizations which are less flexible.

### **4.4. Evidence of the potential effectiveness of innovation**

A certain environment will receive certain innovations only if the potential effects (and benefits) of implementing the innovation are proven, and if they are such that all the groups involved are satisfied with the effects and benefits. It is important that interested groups have measurable evidence of the effects and benefits. The groups affected by the implementation of innovation usually have the following questions: what will be the benefits of implementing a particular innovation and what costs will be related, how the costs will be distributed, how innovation can improve the effectiveness of existing systems (such as care systems for the elderly), and the investment in innovation will revert to how soon the new innovation-based system will become (financially) more effective than the existing one. Evidence of the effects of innovation must be gathered before the implementation of innovation. Evidence is obtained through testing and pilot studies. The effects collected in this way should also be critically analyzed and evaluated [59]. As the author says in the refinement [60], the exact scope of the test environment needs to be accurately determined. Only in this way, we can reduce the risk for potential users and help to make the probability of success in implementing the innovation more likely. However, it should be emphasized that in the control environment, it is very difficult to precisely define all the possible effects that the actual implementation will have. Pilot tests provide useful information about any problems that may arise during the implementation. If the pilot tests are well done and the results are properly evaluated, we

can obtain fairly real evidence of the effectiveness of innovation. However, regardless of the credibility of the control tests, the obtained data must always be taken with reservations and critically. This is partly because it is difficult to implement large-scale projects that are truly representative and partly because we have many stakeholders in the actual implementation. These groups have different needs and different requirements, and these groups are those who ultimately make decisions about the usability and value of a particular innovation. It is also a fact that not all parameters of innovation can also be measured or displayed or converted into monetary values (e.g., better quality of life, people's well-being, less burden on informal caregivers, etc.). Many benefits and many effects are visible only over a long period of time [61]. Therefore, in Ref. [62], the authors emphasize that a more pragmatic approach is needed in demonstrating efficiency before the commercial product phase and innovation. In doing so, they have in mind, in particular, the implementation of innovations that are more complex (e.g., implementation in social care and health care systems, where high emphasis is placed on high standards). In this respect, pragmatism implies that the implementation of innovation must be carried out even if all evidence of the effectiveness of innovation is not yet available.

#### **4.5. Needs and requirements of users**

Technologies form the basis for the operation of smart-home systems, but any innovation can only be successfully implemented if the abilities offered by the new technology match users' needs and requirements. In order for an innovation to succeed, it is therefore necessary that the capacities offered by the new technology match the needs, requirements, and capacities of the users. Users are not interested in technological aspects of innovation. Users are only interested in their use. It is therefore very important how users take a particular innovation (e.g., how older people take a living environment in which information and communication technologies are implemented). From this, we can deduce the conclusion that the service and experience with the service (innovation) are those that are important to the user and which user is interested in, but not the devices and the system itself. The technical functioning is important, but it is not enough. The main question is thus what users like and what "works" for them [63]. As already mentioned by the author in Ref. [60], the lack of consideration for the needs of the users proved to be one of the major obstacles for implementing innovations in general as well as implementing medical technologies [64]. According to Ref. [20], we need to look for reasons for this in those who are suppliers and who carry out marketing according to the principle of "technological push strategy" rather than the "pull strategy" principle. In this way, they create a breakdown between users and their innovation requirements (e.g., requirements for innovative systems that help them carry out daily tasks) and products that are available for use. Author in Ref. [65] believes that ICT innovations in public services are also problematic because the suppliers are not always completely clear who the "leading users" are; specifically, the users, according to author in Ref. [66], have to find out what are the needs for new products and services ahead of others and in this way create demand for certain innovations. In order to ensure that innovation is successfully adopted, it is therefore most important that potential users are involved in the planning, development, and implementation process. This is especially true when it comes to innovations in the field

of information-communication technologies. These must be designed for users and should be designed with users [67]. As stated by numerous researchers [68–71], the failure to consider the needs and requirements of the users is the reason why innovations are not accepted in society after implementation.

We assume that the process of developing and implementing innovative ICT systems for enabling remote home care for the elderly takes place more or less because of the need to rationalize health care and social-care services, but far too little attention is paid to users and their wishes and needs, which is also one of the conditions and requirements for successfully implementing innovations into existing systems. According to Ref. [72], a number of products were created to help the elderly, but the creators, in their design, took little account of the esthetic, social, and emotional relationships that older people would establish with the product. In any case, this is wrong. Today's rapid advances in technology provide sophisticated and smart solutions, but when designing and implementing ICT applications for older adults, we need to make sure that no technological advancement is what determines what should be created, but this determines the actual needs of users of these products [15]. Studies dealing with the creation of innovative living environments and their implementation in society should therefore focus more on people who use the products. Users are those who need to assess the properties and the effects of living in such an innovative environment. It must be evaluated on the basis of how they perceive, feel, and understand it, namely as a desired or unwanted form of living.

## **5. Attitudes of the elderly towards ICT systems for enabling remote home care**

Technologists and developers of the smart environment would be very helpful if, on the basis of a sufficiently large number of pilot studies and on the basis of user experience, they could find out the user's attitude toward such environments and how they perceive them. This would probably increase the effectiveness of the implementation of such a living environment in practice. However, they should also enable users to be able to truly assess information and communication technologies and their use. We believe that, therefore, the main goal of the implementation process should be to provide users with meaning and increase understanding of the innovative living environment. User perceptions can be distorted for various reasons, which is especially relevant for innovations based on the most advanced forms of ICT and intended for the elderly. Studies [73–77] show that elderly people generally do not trust ICT. Authors in Ref. [78] report that among older people, one of the most common beliefs that discourages them is that life in a smart environment is too automated or that technology is perceived as a kind of substitute for personal contact with a person, who provides care and protection as well as communication, which could lead to a reduction of social contacts and loneliness or, as authors in Ref. [79] point out, a creation of a society of "high-tech hermits." According to Ref. [80], this means that the elderly suffer from "technophobia"; they are afraid of innovation and new technologies. Author in Ref. [81] believes this is because they do not know how to use these technologies, and authors in Ref. [82] believe this is because they do

not have confidence in and doubt their own abilities due to sensory and cognitive deficiencies. The authors consider [83], and this also somehow justifies the opinion that older people are more conservative. This means that the elderly do not want their current lives and their life habits and patterns to change too much. In particular, they do not want to do this because of “external”, less-known, or foreign factors that could affect their private life. In particular, as regards advanced technological systems of the living environment, older people, in the opinion of authors in Ref. [71, 84], fear to lose their privacy. In such smart environments, the elderly would appear to have an unpleasant sensation that they are constantly being watched and monitored (Big Brother syndrome). This is also proved by the studies carried out by the authors in Ref. [85–87].

In our own research, we proceeded from the assumption that elderly people have for the most negative attitude toward technologies, but also that (correctly) informing potential users, raising their awareness, and understanding of the usefulness and operation of remote home care are important for acceptance of this innovation among elderly and its implementation. We collected data for the analysis by directly interviewing people aged 50 years and more. We interviewed 114 of them in total. We divided the intrepid people into two groups. There were 57 people in each group. Prior to the interviews, both groups were informed about smart homes. However, the importance of information between groups was significant. In the first group, participants were generally informed about smart homes (what is their concept, how they operate, and what life is in them). In the second group of respondents, the concept of the living environment with information and communication technologies was explained in more detail and in a comprehensible and simple way. For this occasion, we prepared five short “scenarios” for the interviewees from everyday events from the lives of older people. On the basis of these scenarios, the interviewees wanted to make it as sensible as possible to present how the smart environment works, for what purposes it can be used, and what is the role of users. In this way, the interviewees could more easily and with more experience imagine how life in such a smart home is taking place. If they had any questions, interviewers could also ask the interviewer. The results of the survey revealed that there was a big difference between the groups in terms of what opinions and attitudes the interviewees had to smart homes. This reveals that it was very important how the interviewees were informed about smart homes. Interviewees in the first group had a very negative attitude toward innovative living environments and living in them. The other groups, on the contrary, had a very positive opinion about smart homes: nearly 80% of them responded that they would be willing to stay in an environment that is supported by information and communication technologies and which provides remote care. The reason that this group of elderly people has, in generally, expressed positive attitudes toward remote home care is the result of the fact that before the survey, the services were presented in detail in the most comprehensive manner to all respondents in this group. Most of those with very positive attitudes were “younger” elderly people (85.7%), aged 55–64 years. In the higher age groups, the share of the respondents with positive attitudes declined but was, nevertheless, still high (71.8%). We also made further analyzes. They have discovered that even those people who are properly and adequately informed about smart homes still have certain concerns about remote home care. The results show that half of the interviewees did not believe that the remote care system allows older people to stay in their homes for longer, and that institutionalization is postponed later. Furthermore,

about one third of the respondents (34.5%) stated that they fear that they will lose their privacy. A little more than a fifth (22.4%) said they did not believe that remote care can provide security and an independent life. The least (11.7%) of them believed that such service could reduce visits of relatives, friends, and acquaintances in their homes. According to our opinion, therefore, unsuccessful implementation of ICT systems for enabling remote home care in the societies is not only because of technical inefficiency and price disadvantage but also because of the fact that public awareness of this service for older people was very low and information campaigns about this service were very ineffective. For this reason, we believe that better and more effective information could be provided in order for better and more effective information to help to better understand the operation of these services. Understanding would improve if potential users had the opportunity to learn about the opinions and positive feedback from those older people who already use the distance service. This would also reduce the negative opinion and attitude of older people to this service. We therefore consider that it is crucial to raise awareness among potential users of this service for the reception of a telecare in society.

The importance of assigning meaning to and understanding the concept of an innovative living environment for successful implementation was confirmed by the similar findings of the studies in which elderly people were asked about their views on remote home care. The analysis showed that studies like these do exist. Three of them are presented here in greater detail. In one of these, which is described in Ref. [88], the authors carried it out in the cities of Plymouth, Barnsley, and South Bucks in the UK. In this study, almost two-thirds (64%) of older people said they wanted to have a remote supply in their home environments. Most of the elders expressed this desire in Barnsley, with a share of as much as 81%. Almost all of the respondents (98%) thought that remote care would provide them with extended stay in their homes. This service would also make the respondents feel safer in their home environments, as all users in Barnsley and almost all (96%) respondents in South Bucks were saying. There were a few more concerns about the surveillance, as only half (51%) answered that they would not interfere with their control in their homes. The control seems to be the biggest problem. In a survey conducted in the United States, older people had concerns about distance care [87]. What were the results? Almost two-thirds of respondents would not allow their homes to be watched by videos, but they strongly supported all other services provided by the remote control service. A large percentage of respondents (90%) supported the idea of transferring information to the control center about the health status of users. In this proportion, automatic alarms are also supported, which are disputed if necessary and offered by this service. It has also been suggested that users receive reminder for taking medicines through this service. More than 80% of respondents expressed support for monitoring unusual changes in older people's homes (e.g., fall detection). They also supported the possibility of monitoring the life cycle of users (e.g., measuring physiological functions) and recording daily patterns of behavior among older people and the possibility for users remotely to monitor collected information about their health and psychological status over the Internet, and that, according to the data collected, older people receive appropriate recommendations and advice. The authors in Ref. [89] also write about the very encouraging and positive views of the elderly about the Australian telecare system. Most of those elderly people who were included in the survey

stated that they would be willing to accept this service. In their opinion, this would be very useful. They also emphasized that they could help such a service help users in an independent and quality life in their living environment. In their opinion, such a service would also enable them to participate in the management of their own health. It would also provide them with better access to health services and prolonging the stay of users in their homes. They also emphasized the relationship between users and administrators (doctors, medical staff, and others). According to Australian elderly people, this attitude should not be based solely on the exchange of information that would only be virtual but emphasized that these relationships should maintain personal contacts (at least occasionally and in more important matters). According to the respondents, this could have very positive psychological effects both on the health of the elderly and on their well-being.

As we can see, our research had the same results (the positive attitude of the elderly to the remote control system) as research in the United Kingdom, the United States, and Australia. What is the reason for this? The reason is attributed to the fact that this service was detailed and as comprehensive as possible and presented to respondents in an easy and picturesque way before the interviews. In all three of these studies, interviewees did not know the home care system or just heard it, but they did not know what it meant. For this reason, interviewers (just as in our survey), prior to the gathering of information, described this service accurately to older people (interviewees). For example, in Australia, video films were used. In the UK, scenarios were used, just as we did in our research. From this, we can therefore conclude that the proper information of future users is of key importance for the adoption of this innovation. Users need to understand how this service works, they need to get all the relevant information and answers to the questions, and they need to understand how the system works. All this can make an important contribution to the successful implementation of this service in society. All this has been confirmed by the results of the pilot exercise of the telecare service in Scotland. In this country, from 2007 to 2010, on the basis of effective information, 25% of new users decided to adopt ICT in their home environments and thus to integrate their homes into the remote control network. It should be stressed that the Scottish Government has invested a lot of resources into the information (both time and money). Potential users were thoroughly informed about the characteristics of remote care at home and why such a service is important [47]. In the case of Scotland, it also turned out that users' experience had an important role to play in understanding and raising awareness among older people and hence for later adoption of this innovation among users. As reported by the authors in Ref. [90], the information provided by informers to potential users was obviously sufficiently informative that they motivated a sufficiently wide circle of addressees, as well as that the information was realistic. Among the users who took over this service, 60.5% of new users felt that their quality of life had improved with the adoption of this innovation. As many as 93.3% of users felt that their stay in their home environments became safer. Almost 70% of them believed that they were more independent with this service. Nearly 90% of new Scottish users said that because of the new service, their other family members are less likely to work with them. The Scottish example also confirms the study described in the case of the United States, namely that the most positive views on the new service had been the older people who had already had some experience with the technologies.

It should be noted, however, that informing and raising awareness about the new service should not be limited to older people. It is true that these people are the main users, but others are involved in the use of these services, for example, carers, especially those informal carers. They also need to be informed, as they are also the target audience for living environments that include information and communication technologies. The term informal caretaker refers to an unpaid relative, friend, or neighbor “who provides care to an individual who has an acute or chronic condition and needs assistance to manage a variety of tasks” [91]. Due to a rapid population aging, the share of the elderly who rely only on family caretakers has increased dramatically in the last decades. According to the results of Seniorwatch [92], more than 80% of the elderly are assisted in their daily activities and tasks by one of their family members as informal caretakers and care providers. As the informal care can be very demanding in terms of volume, intensity and duration, the most commonly adverse fact to ensure the care of the elderly is a burden. The burden of the care provider is defined as its negative response, namely the influence that the provision of care on the social, professional and personal roles of the caregiver has to provide. This burden is also the predecessor or predictors of future depressive symptoms among caregivers [91]. From this point of view, new technologies can help not only older persons but also their caretakers; authors in Ref. [90] reported that 74.3% of relatives felt less burdened thanks to their use. But new technologies can also assist to formal caretakers (i.e., nurses, care assistants), who supports old peoples’ independence through empowerment, developing flexible responses to their needs and supporting their formal carers [93]. The relationship between an older person and formal caretaker should base on trust, understanding, and compassion. However, as the number of elderly people increases, formal caregivers are also facing ever-increasing pressure. Authors in Ref. [94] report that health care workers are considered to be a particular risk of developing a negative age-related relationship because they are exposed to a disproportionate percentage of sick or dependent elderly people.

However, it is important to emphasize that for a realistic evaluation, the remote system at home should also be properly presented. They should be given the proper meaning of this system. The results of the studies show that the views of the caregivers can very often be misleading, due to various reasons. In the case of caregivers, fear and resistance to this service are often present in relation to distance provision. Sometimes, however, an exaggerated enthusiasm for such a service occurs among carers. Caregivers are against the service, because in their opinion, the care of the elderly by means of information-communication technologies is too impersonal. In Ref. [95], authors also state that caregivers fear that they will lose their role and mission (or partially or completely). So that technology will take over that role. Such an opinion should, in particular, be made by official carers, who feel that they are trained and qualified in the pursuit of this profession. Where does this fear of carers come from? According to scientists, fear was often caused by the fact that carers lack knowledge and understanding of the use of telecare-related technologies. Caregivers often treat training for new technologies as something that is an additional obligation that is unnecessary and perceived as very stressful. We can conclude that if the administrators knew and understood how information and communication technologies work and what they actually

do, if they knew about the advantages and benefits of remote control services, and if they learned how to use these technologies, the fear would disappear and carers would be ICT service as part of their work. In addition to the fears and fear of new technology carers, there are also carers who are overly excited about such technological services. This, of course, leads to the fact that carers would objectively evaluate the concept of a smart home and successfully adopt and implement it. Authors in Ref. [95] write that the too enthusiastic perception of telecare is the most common feature of informal caregivers (i.e., family members). The modern rhythm of life and patterns of living are increasingly limited by family members to take care of their elderly family members. "In the European Union, in the last few years, the family, as the main provider of care for the elderly (family members), seems to be no longer carrying out its basic task" [96]. As family carers are overwhelmed, they often expect illusory expectations that new technologies will compensate for their lack of time for elderly members of the family or that they will completely relieve them of the care of older family members. This is, of course, completely impossible. It can also be dangerous. It is dangerous for older people who, with full exposure to technologies, can really become socially isolated. It is also dangerous to successfully implement the innovation of this technology service. Why? Informal carers would soon realize that new technology cannot completely replace them. There would be disappointment, which would lead to the spread of a negative opinion on the new service and the resistance to this innovation. This means that carers (especially informal) must always be thoroughly informed about what technologies really can do, what is the actual life in smart homes, and what the caregivers should actually expect about the remote care service.

## 6. Conclusion

We can conclude that the use of information and communication technologies truly represents the right direction to realize the idea that we will move health care and social services into the living environment of older people. This will increase the rationalization of public finances due to the aging process of the population. In the future, it is expected that such smart/intelligent home environments will become part of everyday reality. Modern society is becoming increasingly informative, the content of our life is determined by various supporting technologies and information, and communication technologies have become an irreplaceable part of our everyday life. But beware! We cannot and should not expect that the aging of the population and the increase in financial expenditures associated with this process will be simply resolved with new technologies. In particular, we should not allow, in view of the increasing financial pressures on the existing health care and social care system, that information and communication technology be put into the implantation and the living home environment of the elderly be included spontaneously, without planning. This would not be beneficial to our company and the premiere of users, but it would be in the first place harmful. Equally unacceptable and harmful would be the implementation of new technologies in the lives of older people and for the needs of their care due to rapid technological development. Implementation of information and communication technology supply

services must, in the first place, be in line with the needs, habits, desires, and opinions of those who will use the new technologies and related services. Implementation of these innovations must therefore emerge from a model that actively involves users and identifies them as the main actors in this process. On the other hand, old people should come to the realization that innovative living environments can help old people to stay where their heart is long for. So that in their homes where their memories are, they can maintain their independence with the help of new technologies. Older carers also need to realize that new support technologies will never be replaced by their presence, that they will never be able to replace human contact and human proximity. They can, however, help them to relieve them from living with less burdens and more straightforward, as they know that those who nurture nothing are not missing and safe. This approach is called the participatory evaluation approach. Such an evaluation can actually lead to the realization of the set goals of all those who are directly or indirectly involved in the care of the elderly. Of course, the user aspect that we have presented (yet) cannot guarantee that the concept of using information and communication technologies to care for the elderly at home will automatically be accepted and become part of the system and society.

However, in promoting the idea of care with the help of information and communication technologies, it is necessary to know that the whole concept and process of implementation of this innovation is very demanding, that it should be carefully planned and that in addition to users, all other stakeholders should always be included in the implementation process (i.e., technologists, insurance companies, the state, municipalities, developers, broadband operators, etc.). Each of these stakeholders has its own function, its own way of thinking, and its perception of risks and a scale of values that need to be carefully studied and analyzed. All future research in this specific field must therefore take into account all these findings—that is, the different conditions and requirements of different stakeholders (not only the elderly)—and analyze and evaluate them. All this takes time. For this reason, we can conclude that rapid changes should not and cannot be expected in the implementation of care for the elderly through information and communication technologies. In order for the implementation to be as successful as possible and that an innovative service could indeed serve its purpose, it will be necessary to carefully examine everything that has gone wrong so far, that is all the shortcomings and mistakes, especially on the basis of case studies. We can expect, beforehand, that this innovative service for the elderly will become part of everyday life and part of our society, and we think that we could do something in that time without the need for such in-depth planning processes. It is about the fact that first, all spaces in which bivouac, in particular homes and homes in which elderly people reside, can be physically adapted according to the principles of design for all. This means that they would start to create a living space without obstacles. Therefore, where obstacles are (e.g., in the home environment of older people), these barriers would be removed and new buildings and spaces would be built without barriers. This would be a big step toward providing old people (and, last but not least, to us) to remain in their loving living environment for a long time. Such dormitories will be the basis for their further upgrading into smart homes, which provide care for elderly people remotely with the help of information and communication technologies.

## Acknowledgements

The study this chapter is based on was financed by the Slovenian Research Agency (Grant No. Z5-2062, title *A Telecare System for the Elderly*).

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