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Internet of Everything for Smart City and Smart Healthcare Applications

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Health Care 4.0: Challenges for the Elderly with IoT

Henrique Gil and Maria Raquel Patrício

1 Digital Literacy: Reflections About the Concept and Implications for the Elderly

When trying to define the concept of digital literacy, we are often faced with different opinions and dimensions, given the polysemy that is associated with this expression. To try to make this question simpler, we decided to divide the expression into "digital" and "literacy." Regarding "digital," we can easily associate it with something that is related to the computer, information and communications technologies, and the media and, as Goodfellow [1] says, which is supported by a web-based environment. On the other hand, when in this context it intends to define "literacy," we are led to consider what is proposed by Lankshear and Knobel [2] when they state that it is more appropriate to refer to "literacies" in the plural form to express an expanded concept of literacy that emphasizes the diversity of social and cultural practices that are covered by the term.

Despite all the differences related to the definition of the concept, we must mention Gilster ([3], p. 1) because this author was the first to advance this definition many years ago: "the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers." This means

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that Gilster [3] seems to emphasize the differences between digital information media and other more conventional media (e.g., newspapers, radio, TV). So that we can have a more current view, we decided to focus on the definition presented by the European Commission within the framework of key competences for all the European citizens, in particular ([4], p. 6): "Digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure, and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, access, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet." From this point of view, digital literacy is in line with the opinions of Lanksheare and Knobel [5] who mention that in this perspective there is interaction with information and with its evaluation and validation, with its credibility and reliability.

In recent years, because of the increasing digitization of society, different definitions have emerged. As stated by Buckingham [6], this greater difficulty in defining the concept is a consequence of the increasing and gradual domestication of the Internet and the constant emergence of new technologies, the so-called emerging technologies that create new practices and new uses different from the first ones that were carried out when the technologies were appearing. For this purpose and with the aim of providing a broader view of different conceptions, only a few examples of these variants will be presented. Given this diversity of interpretations, we can say that we may be dealing with the concept of "multiliteracy" or "literacies." For example, Gourlay et al. [7] and Joosten et al. [8] have an opinion that can be more related to a functional perspective of technology use by highlighting the associated concepts of computer literacy or media literacy. From a different point of view that could be called "complementary," as Stordy [9] proposes, it will be the combination of technological skills with skills that promote more cognitive dimensions that lead to a set of practices of a more social nature in the use resources and digital platforms. In this regard we agree with Martin [10] who combines and advocates the need for citizens to have access and to be able to manage, evaluate, analyze, and integrate the already mentioned resources and digital platforms so that they can build new knowledge and share it with the others to enable constructive social action. In this sense, Lankshear and Knobel [5] state that digital literacy involves "mastering ideas," not "key-strokes." In this line of reasoning, this perspective is reinforced by Lankshear and Snyder [11] by the fact that users of digital technologies have practices that have a specific cultural and critical mark that can be considered as "ways of doing things" instead of being merely questions "operational" or "technical." In this sense, we agree with Pangrazio and Sefton-Green [12] that we must have a clear notion about the scope and depth in which the concept of digital literacy is referenced: "meaning digital citizenship conveys a different set of practices from simply casting a vote at a polling booth or participating in civil society to participating in online discussion."

What is more pertinent and important is that we must have a clear perception of digital literacy about the implications and direct consequences for the quality of life of citizens. The digital medium or resource or even the dimension to which it reports and on which the citizen is supported will not be decisive or fundamental. What matters to reflect and decide is to know and be able to choose this or that

resource or digital medium so that, in a conscious and safe way, it can bring about improvements in the daily routines and in the quality of life and health of citizens. To this end, we share the opinion of Lanksheare and Knobel [5] when placing the emphasis on this concept of digital literacy by including "only" two fundamental dimensions: creation and communication. However, as mentioned by Gilster [3], the use of digital technologies brings and redefines practices associated with writing and with reading in these new digital resources. At the level of creation, citizens are supposed to be able to access digital resources to select, criticize, reflect, and be able to decide which information can be used to be transformed and adapted to generate and create information that must be original and that is relevant and most appropriate. And at the same time, as Casey and Bruce [13] state, have the ability to communicate meaning.

On the other hand, in terms of communication, the citizen is supposed to have the knowledge and digital skills to be able to use digital resources to be able to share and disseminate correctly and appropriately using digital social networks or other resources (e.g., digital platforms, web pages). In this way, the citizen becomes active, moving from a passive consumer to an active producer increasing their levels of self-confidence and social belonging, which is reflected in greater levels of digital and social inclusion that will allow for a better exercise of citizenship. In this regard, it is important to refer and reflect on the social networks commonly referred to as social media. In this context, Tan [14] reflects in a way that proposes to promote an extension of the concept of digital literacy to what he designates as a "multimodal outlook" or even as a "new textual landscape" to which citizens have increasingly joined. Also in this regard, the European Commission [15], within the scope of the "Digital Agenda for Europe," reinforces the premise that there can only be an adequate and complete political and social participation if citizens are info-included because this new and present reality requires digital skills.

In a perspective of critical synthesis, it is important to remember the warning and need mentioned by the OECD [16] almost two decades ago that, to have sustainable development and good and adequate social cohesion, it is necessary for citizens to have all the skills that they need and allow them to be socially included and, for this purpose, digital skills are essential. This dimension is fundamental, and digital literacy must be seen as having causal efficacy to generate outcomes in society and in the world. This is where the importance of, as stated by Lanksheare and Knobel ([5], p. 12): "When one «has» digital literacy good things can happen; when one lacks digital literacy, one is vulnerable and undesirable things can happen." In this context, it is important to reinforce the fact that these consequences are for each citizen and, therefore, for society in general. We all lose out if the info-exclusion rate continues to be high among the elderly. Well, the elderly represents an estate and a rich history of life experiences and learning that we all want to be shared to achieve a better world. For these reasons, we support the opinion of Tamborg et al. [17], who feel that it is essential to reflect carefully on what is necessary for safe use in a technology-rich society in a wider context. Throughout this chapter, we have been referring, albeit in a more superficial way, to the info-exclusion issues of the elderly. We cannot forget and ignore that the elderly has a long history of personal and professional life full of experiences and experiences that took place,

mostly, in analogical contexts. And, fortunately, most were successful because of their more formal academic training and also of their lifelong training that included formal and non-formal contexts. The question that we now present for reflection has a direct connection with formal academic contexts: school. At school, the elderly was taught and trained for linear and pre-defined tasks and activities, with an emphasis on individual work and where memorization was the priority so that later they could reproduce this acquired knowledge, and the support was solely based on paper (books, documents, worksheets). Another characteristic had to do with the fact that this knowledge lasted for years, given that flexibility and updating were something marginal. On the contrary, as mentioned by Castilla et al. [18], the use of the Internet becomes very complex for the elderly as it relies on a new technology: hypertext. In this new type of digital document, users must be able, in addition to reading it, to select this information, which parts of the text to select, so that the "new reading" makes sense, given that the reading is no longer linear. At the same time, the elderly must deal with the fact that these documents have video, sound, and image links, which correspond to a new context for the elderly: multimedia. These new contexts make the reader active and participatory, instead of their initial training where everything was foreseen and where participation was passive. This new dimension also brings another type of metaphors and another type of terminology without a direct connection with the analogical dimension that the elderly dominates.

The European Union (EU) is fostering digital inclusion to ensure that everybody can contribute to and benefit from the digital world, such as Digital Competence Framework for Citizens (DigComp), the EU-wide framework for developing and measuring digital competence. However, EU has recognized multiple barriers to digital inclusion: "For some people, the digital world is not yet fully accessible. For others, it is not affordable, and others were not taught the skills to participate fully" [19]. In 2021, 25% of the EU-27 population aged 65–74 years had at least basic overall digital skills, with wide variation among countries, e.g., 57% in Iceland and 56% in Switzerland. In contrast, only 4% of people aged 65 to 74 in Romania had digital skills, followed by those in Bulgaria (6%) and Poland (10%). Portugal is in the seventh position of the European countries with the lowest index of digital skills of people between 65 and 74 years old, with only 17% [20]. In this context, this issue can become even more sensitive, since, as stated by Almeida et al. [21], "the progressive aging of the older population itself, as the relative important of the very old is growing at a faster pace than any other age segment."

Recently, on 22 March 2022, the Joint Research Centre of the European Commission published the latest update of the Digital Competence Framework for Citizens, DigComp 2.2, with updated examples of knowledge, skills, and attitudes. The update takes account of emerging technologies such as artificial intelligence, the Internet of Things, datafication of Internet services and apps, virtual and augmented reality, robotization, or misinformation and disinformation. DigComp 2.2 will contribute to achieving the EU objectives set out by the Skills Agenda, the Digital Education Action Plan, the Digital Decade, and the Pillar of Social Rights and its action plan, for instance, achieving a minimum of 80% of the population with basic digital skills [22].

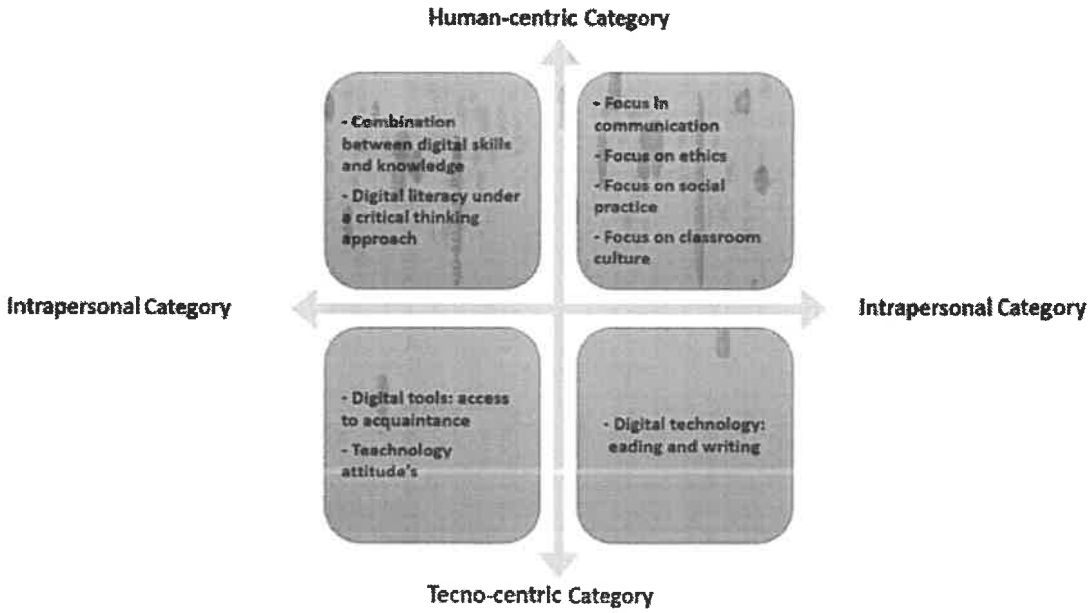

Fig. 1 Adapted/reformulated model proposed by Tamborg et al. [17] related to the different dimensions of the concept of digital literacy

Against this background, it is urgent to empower elderly people with digital literacy. Before doing so, however, it is important to continue presenting different conceptions of digital literacy to better put into perspective its implications for the elderly.

The research carried out by Tamborg et al. [17] presents a simple and objective way of giving a clear view of the different conceptions of digital literacy. To this end, Tamborg et al. [17] propose a model that includes eight categories distributed in four quadrants according to two axes: intrapersonal/interpersonal and human-centric/techno-centric (see Fig. 1).

At this stage, we will present a critical reflection based on the research of Tamborg et al. [17] with the aim of emphasizing the potential implications for the elderly. Starting this critical-reflexive analysis with the "human-centric and techno-centric" axis, it seems to emphasize the fact that digital technologies are related as means or resources for the production and consumption of information. However, as stated by Andrejevic [23], there is a tendency to assume that going digital only implies the automatic use of "mechanized" techniques, which can lead to an "automated" and "impersonal" dimension that should be caution and avoid. This assumption may also include concerns associated with the appropriate use of technologies that imply appropriate ethical behavior. In this context, we agree with the point of view of Shin and Seger ([24], p. 22) cited by Tamborg et al. [17] when interpreting digital literacy as "discursive practices that are shaped by one's social, cultural, and political access." Now making a critical-reflexive analysis in relation to the "intrapersonal and interpersonal" axis, we are led to conclude that the implementation of digital literacy will be determined by each citizen, individually. In this, when we think about elderly citizens, we feel a greater concern because it

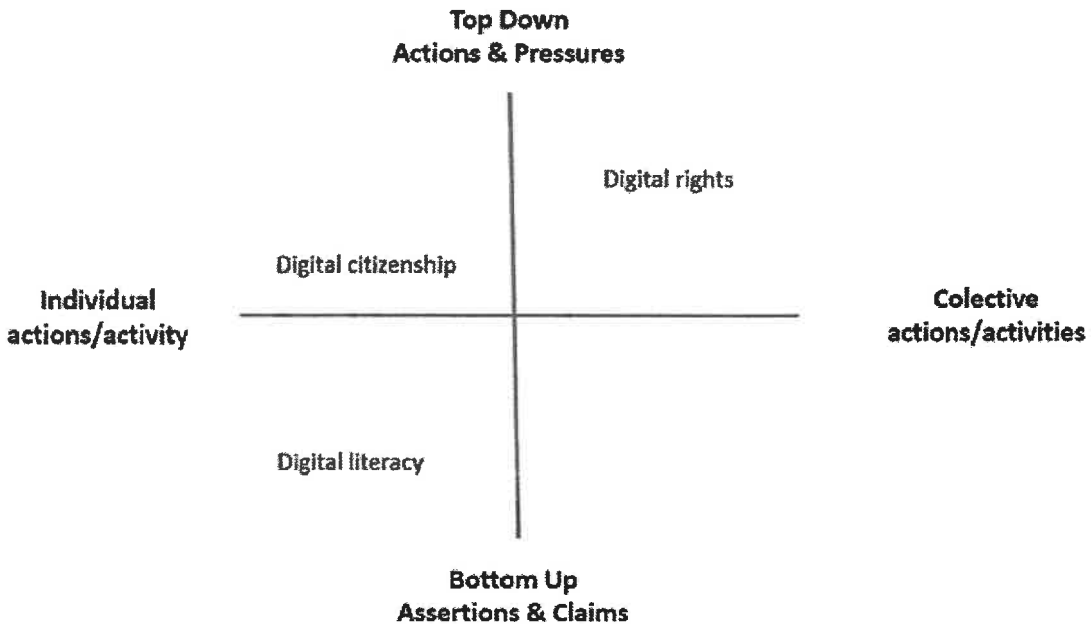

Fig. 2 Adapted/reformulated model proposed by Pangrazio and Sefton-Green [12] that includes the different dimensions of rights, citizenship, and digital literacy

will depend on their level or degree of info-inclusion. This conception is reinforced by the opinions of Thrane et al. [25] because at present the approaches are focusing on the issues of the digital divide and the strategies that must be implemented that will have to go beyond simple access, so that true inclusion becomes a priority and a reality. For this reason, as reported by international statistical data, the age group of the elderly is the one that is more info-excluded. In consequence, the levels of concern are higher because, in extreme situations, they can jeopardize their social inclusion. In their investigations and reflections, Pangrazio and Sefton Green [12], are of the opinion that there is a very close relationship between digital rights and digital citizenship and the concept of digital literacy to which they associate the concept of "agency" when citing Richardson [26]. However, it should be noted that "agency" has some philosophical complexity, which as mentioned by Pangrazio and Sefton-Green ([12], p. 23) is "the capacity of an individual to act freely in the world, the concept is entwined with assumptions about free will, the structural constraints which limit individuals' actions and the relationship between an individual and their society." In this conception and assumption, that there must be a given "agency" leads to the overarching "power" being needed to create value in an increasingly complex digital world. Figure 2 presents the model proposed by Pangrazio and Sefton-Green [12] which includes the different dimensions of rights, citizenship, and digital literacy.

In order to reach satisfactory levels of a good and adequate use of current digital resources, whose clues have been evidenced (Figs. 1 and 2), Lee et al. [27] identified the following factors that can be associated with the elderly: (1) intrapersonal factors, which include motivation and self-efficacy; (2) functional limitations, related to

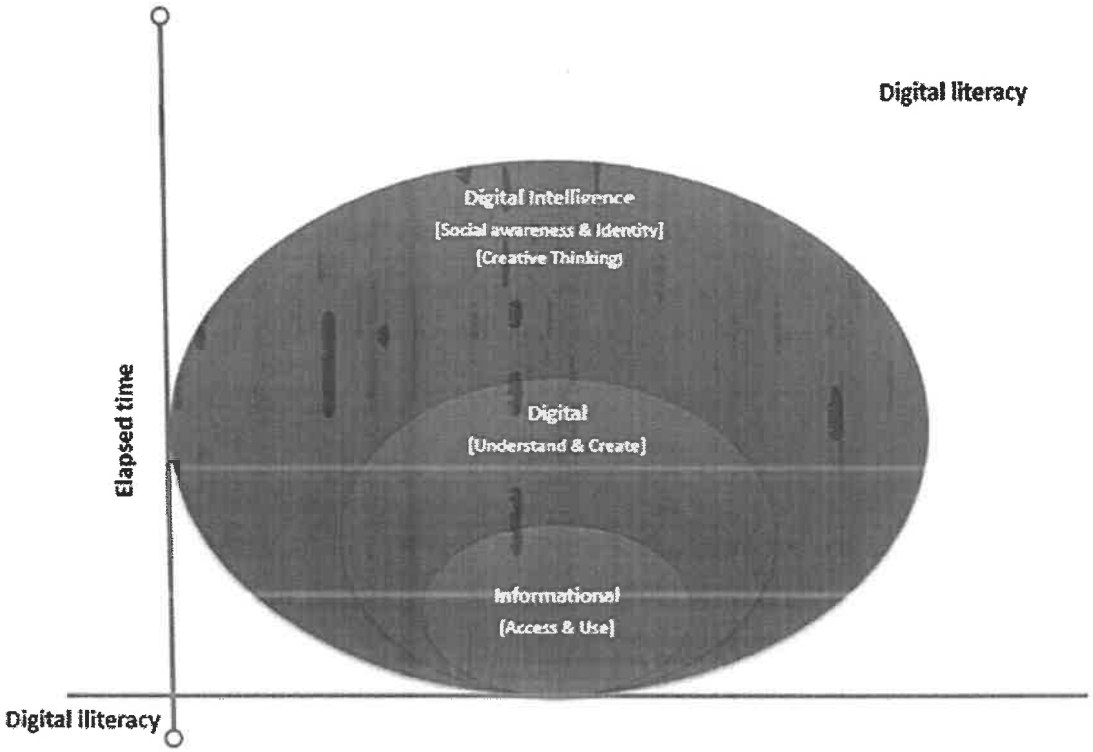

Fig. 3 Digital literacy process of the elderly. (Adapted/reformulated from [29])

cognitive decline or spatial orientation; (3) structural limitations that prevent normal and easy access to digital resources; and (4) interpersonal limitations, which may be closely related to lack of social support.

Continuing this critical reflection on digital literacy, we will rely on another proposal by Rahman et al. [28], cited by Martinez-Alcalá et al. [29], that refers to a new dimension: digital intelligence. In this context, digital intelligence corresponds to a set of several skills that include the social, emotional, and cognitive dimensions that will allow the elderly to be able to respond to the current challenges of society and better adapt to their needs as citizens. Figure 3 presents the model proposed by Martinez-Alcalá et al. [29]:

In Martinez-Alcalá et al.'s proposal [29], there are three levels that increase in quality and depth from the most basic level (informational) related to use and access, moving on to an intermediate level (digital) where you will already have there must be skills related to understanding and creation and, finally, the final level (digital intelligence) where the elderly will already have skills that will allow them to be creative, social awareness and a digital identity. It will be an ongoing process that must be supported by specialists and that must be updated given the constant evolution of technologies, including the Internet of Things (IoT) and emerging technologies (e.g., AR, VR, AI, etc.). To further explore this model, we rely on the opinions of Martinez-Alcalá et al. [29] regarding the four skill levels that are presented in Fig. 3: (1) instrumental, related to a practical use associated with hardware usage skills and software; (2) socio-affective, skills that allow creating

and establishing social bonds with other individuals through communication for socialization purposes; (3) axiological, understanding and putting into practice ethical and responsible attitudes in the use of the Internet; and (4) cognitive-behavioral, which represents a set of more reflexive and more critical skills in the sense of being able to recreate new information through a previous process of research, selection, analysis, and interpretation.

Digital skills training to improve digital literacy among the elderly is increasingly becoming a key priority in the digital society. This can empower the elderly to effectively, safely, and securely use and benefit from the opportunities offered by digital technologies and the Internet, thus achieving better health and quality of life [30].

The United Nations Economic Commission for Europe (UNECE) recently highlighted policy priorities for the digital inclusion and empowerment of the elderly in the digital era: ensure equal access to goods and services involving digital technology; enhance digital literacy to reduce the digital skills gaps; leverage the potential of digital technologies for active and healthy aging, well-being, and empowerment of the elderly; and ensure the protection of human rights of the elderly in the digital era [31]. Another area of EU policy is active and assisted living for fostering digital inclusion and aging well, through meaningful projects that promote innovative products, services, and systems based on information and communications technologies to help older people age well at home, in the community, and at work.

2 Ambient Assisted Living [AAL] and Internet of Things [IoT]: Implications and Consequences on Daily Routines

It is no longer a novelty that the world is gradually aging and there are already areas and/or countries where the aging rate is already very worrying. In addition to the great advantage of being able to prolong longevity, we have, on the other hand, a less pleasant panorama because the elderly is more prone to situations associated with the loss of motor, cognitive, and emotional faculties, which are caused by higher rates of loneliness and of isolation. As stated by Thomas [32], more than half of the elderly over 75 years old live alone, and the impact of this loneliness has emotional and psychological consequences that substantially worsen health and well-being. Consequently, these elderly people will have to be supported by their family or caregivers. As mentioned by the United Nations report in 2015, 7 caregivers are already allocated for each elderly person, on a global scale, but in the year 2030, the value of only 4.9 caregivers for each elderly person is projected [33]. In Europe, where the rate of aging is higher worldwide, Abdi et al. [34] report that in the year 2030, there will be only about 2.2 caregivers for each elderly person. As is easy to understand, the situation tends to become dramatic, and it is urgent to find solutions that reverse this trend.

Another very important aspect mentioned by Salovaara et al. [35] has to do with the fact that the elderly, in terms of comparison with other age groups, are those who mostly use the Internet to carry out research related to health. This data, in itself, implies that efforts are made so that more elderly people become info-included so that they can keep themselves better informed and, as a consequence, increase their quality-of-life levels. This reflection is corroborated by Heo et al. [36] when reviewing research results that show that greater use of the Internet by the elderly has provided better social support, reduced loneliness, better levels of satisfaction, and also a better psychological state.

Considering the reflections presented, it is necessary to find clues and resources that allow us to help the elderly to be able to live in their homes, as defended by the perspective of "aging in place," independently and with the highest possible indices of quality encouraging the elderly to remain recognized as vital to their community [37]. For, according to what is stated by Syed et al. [38], a survey carried out in the United States, and which can be extrapolated to other countries, about 90% of the elderly reported wanting to remain in their homes. For all the reasons, we agree with Mainetti et al. [39] in stating that treating and caring for the elderly is a great challenge, but it also represents a question that we must answer. However, we cannot forget that it is necessary for caregivers and medical experts to know and be able to motivate and accompany the elderly in their homes through digital resources [37].

To this end, the concept of ambient assisted living (AAL) is based on the objective of creating conditions for elderly people with limitations (motor, cognitive, or others) to be supported. This support aims to increase their levels of autonomy and security so that they can independently carry out their daily routines [40]. As reported by Dohr et al. [41], the applications associated with AAL are used for the elderly to have and/or maintain their levels of quality of life, well-being, and health, in a safe environment. As reinforced by Dohr et al. [41], the benefits of AAL are reflected in three different levels: (1) at the individual level (well-being and safety), (2) at the economic level (more effective and efficient management of resources that are already very limited), and (3) at the social level (improvement and increase in standards of living). In this regard, we have the same opinion as Mainetti et al. [39] in assuming that AAL can promote and create conditions of greater safety for the elderly with the detection of falls and immediate response mechanisms and through video surveillance systems.

In global terms, we can say in a way that seems to be consensual that the main needs of the elderly that must be supported in an AAL context will be the following: health (perhaps the most important and most pertinent), safety, relaxed environments (the elderly person is not subject to high levels of stress, so peace of mind will be a goal), autonomy, independence, and interpersonal relationships (privileging social contacts and relationships). To address these different levels, the AAL contexts, in the opinion of Kunze et al. [42], must be structured in three levels: (1) hardware (wireless network; sensing), (2) middleware (IT integration; data capture; data safety), and (3) services (application-oriented processes; biosignal processing; community services). In other words, they will have to be the conditions for the creation of an "ambient intelligence," as stated by Dohr et al. [41]. Therefore,

an ambient where technologies and digital resources coexist with citizens and with their context (house, equipment, and spaces where activities are carried out) where the inclusion of the Internet of Things (IoT) seems to be relevant [43]. Over the last few years, the European Commission has been paying attention to this issue and has recently made efforts to speed up the integration of IoT applications and resources to respond assertively not only to the elderly but to future generations [44]. As mentioned by Mainetti et al. [39], AAL can make use of different resources that make it possible to create safer environments and that allow the elderly to remain in their homes with greater indices of autonomy, where we can highlight GPS, radio-frequency identification, and Bluetooth. With these digital resources, the aim is for the elderly to remain active if possible, maintaining their social relationships and independence. From the point of view of Almeida et al. [21], AAL has been evolving toward a more global concept called the city-wide approach. This new approach intends to see the elderly not as people with disabilities or special needs, but as individuals who are part of a given community, with their networks of contacts and who are able to continue to be active either at the level of their homes or at the level of your city/community.

IoT is now recognized, and a large majority of the population knows what it means. Other expressions such as big data, artificial intelligence (AI), and 5G technology are also starting to form part of the conversations between info-included citizens. In recent years, there has been an evolution from the so-called ICT to emerging technologies because of this new digital context that we are experiencing. There seems to be, as proposed by Gigli and Koo [45], a tendency for digital technologies to become congruent and to attempt a certain unification of the different digital resources and technologies around the IoT. In other words, the conditions are created for the establishment and growth of IoT ecosystems that will create the basis for a new and upcoming "industrial revolution" with a strong focus on healthcare and with an innovative character.

Dohr et al. [41], state that IoT will generate new contexts, more innovative contexts according to three dimensions: (1) ubiquitous communication/connectivity in an "anywhere, anytime" perspective; (2) pervasive computing: giving "power" to things/objects, a way to make the environment like and each thing/object become a computer; and (3) ambient intelligence: each thing/object is considered to be "smart objects" because they have the ability to interact and to be able to promote changes in the surrounding physical environment. In short, with the IoT, the "smart objects" can communicate with each other and this time to be able to create networks of "things/objects" through their connection to the Internet. In this new paradigm, the concept of "anytime, anywhere" gains a new dimension evolving into "anyone" or, rather, evolving into "anything" [46]. In this context, the European Commission [44] states that the IoT, by its nature, creates new networks that are independent and that operate on their own infrastructures that provide new services and new forms of communication between citizens and things and between themselves. Accordingly, we can refer to the concept of "smart cities" because many elderly people live in urban areas and it is necessary to find proposals that narrow and

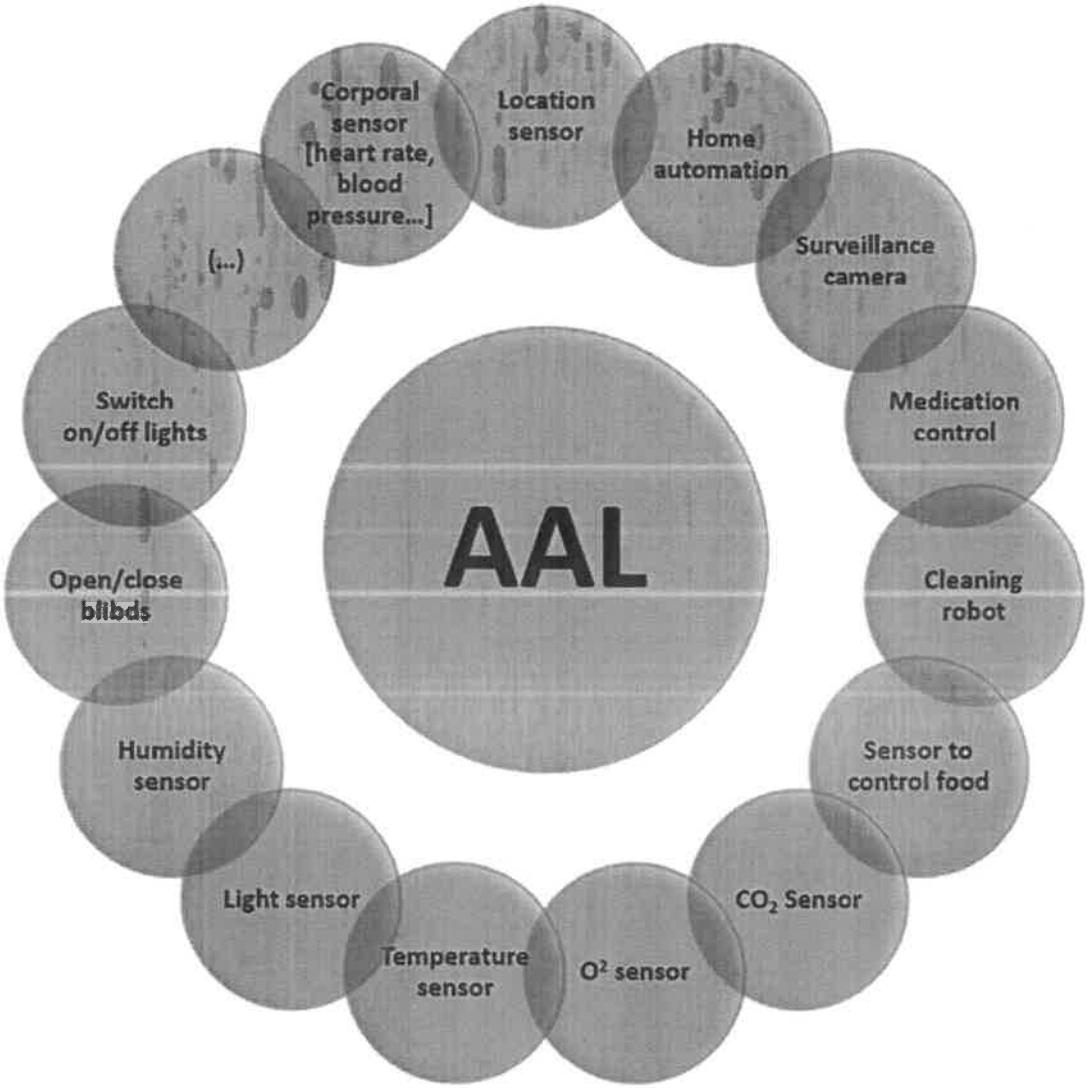

Fig. 4 An example of AAL elderly people's residence or house full of sensors

facilitate communication between citizens and the city, considering the real needs of the elderly [21].

Associating IoT with AAL is important and pertinent for a context that has better levels of quality for the elderly has to do with the fact that IoT establishes a bridge between the analog/physical world of "things" and technologies contextualized with the social environment. Therefore, as reported by Wu et al. [47], conditions are created for a human-computer interaction that integrates what these authors call smart allocation of resource and intelligent provision of several services. As also mentioned by Dohr et al. [41], what is intended is that IoT can provide relevant information in an active and passive way, actively through local decision-making and passively through data collected by sensors. Figure 4 presents an example of intelligent communication architecture for AAL that uses artificial intelligence for processing the information collected from several types of sensors, which could be

installed at different locations in the environment, depending on the parameters to be measured and the events to be monitored [48].

More recently, technologies have been using the cloud to make procedures more ubiquitous and in real time [49]. In this new technological and digital dimension, Syed et al. [38] introduce the concept of IoMT (Internet of Medical Things) which should be considered as something more focused on infrastructures that include software, medical devices, healthcare systems, and computing systems, capable of acting in daily routines and in risk and medical emergency situations. In summary, IoMT will interconnect wearable sensors, patients, healthcare providers, and other caregivers using different communication software.

In this new context, AI requires an active attitude where decision-making becomes fundamental and where IoT promotes a passage or a bridge between a physical world related to "things," the digital world, and the social component so that a more intimate, more fluid, and more natural relationship can be established: human-computer interaction. If these dimensions are articulated, it is possible to talk about ambient assisted living (AAL) where the conditions of well-being and better quality of life and health for the elderly will be increased, based on the more general concept of smart home [50]. As reported by Suciu et al. [51] with ambient assisted living cloud applications, monitoring is carried out inside and outside the homes of the elderly with a multiplicity of sensors whose main objective is to improve the quality of life and health through the information that is reported to family members, caregivers, and health staff. For instance, some of the sensors that can be installed inside the house associate the elderly person's gender, their location, relative to the environment, humidity, temperature, and lighting can be monitored, the steps, the use of the telephone, the incoming and outgoing messages, social media, noise level and sleep monitoring. More examples can still be presented, as proposed by Maskeliunas et al. [52] in the sense of having a positive influence to overcome or improve different dimensions that lead to higher levels of autonomy and independence: limitations in daily activities, risk of falling, chronic diseases, dementias, depression, social isolation, and medication management. Because some of this monitoring can become invasive, despite having good intentions and noble principles, it is essential to ensure that the elderly can gain more autonomy and independence, but with dignity, respect, and privacy. However, we agree with Choi et al. [30] when they state that the daily accumulation of data by digital devices and platforms will increase diagnostic accuracy, produce innumerable quality of data, and save time. In this sense, conditions are promoted to provide advantages to medical facilities and convenience in an individual and personalized way for each elderly person.

Although there is a very positive general feeling for these IoT and AAL proposals, as with everything, there are always limitations or obstacles that can make the objectives not be fully achieved. In this, security is one of the main concerns because it is very difficult to have digital platforms that can resist malicious attacks by hackers. For this reason, the elderly must be informed about this possibility, and they will have to decide whether to adopt the technologies. Another difficulty that is reported by Villari et al. [53] has to do with the interoperability between different

platforms and sensors and data collection systems. This lack of integration can generate conflicts in the collection of data that can lead to less adequate decision-making. To these limitations must also be added the fact that there may be some lack of precision and accuracy in the sensors, which will lead to an incorrect assessment of reality [54]. Regarding limitations, Syed et al. [38] also mention that there are aspects that digital technologies still cannot resolve: reliance on others, inadequacy of trained caregivers, healthcare costs, and increase in diseases with no cure (e.g., Alzheimer and Parkinson diseases).

Balancing the advantages and limitations, we agree with Ajami et al. [55] and with Rubi and Gondim [56] in arguing that this new solution proves to be very relevant because it incorporates AI methods with the possibility of becoming proactive through the entire process that includes observation, learning, adaptation, prediction, and decision-making within an intelligent environment. In this way, the IoT combined with AI creates new perspectives and new types of intelligent pervasive systems and platforms because this new type of intelligence is dynamic and interactive, making it more capable of adapting to the changes that take place. However, Syed et al. [38] are of the opinion that success depends on the degree of acceptance of the elderly. In this sense, it is important that the elderly know which spaces have sensors because, for them, aspects related to their privacy and confidentiality must be guaranteed. From a more extreme perspective, a "smart home" can lead to processes that increase the loneliness of the elderly because this new digital environment can meet practically all their needs. And, for this reason, the elderly will not need to collect these aids in a space outside their homes.

3 Reflections and Proposals for the Healthcare with Emergent Technologies

Not being, from the beginning, a novelty or a surprise, there is a general feeling that it is urgent and pertinent to create all the conditions for an increase in the levels of info-inclusion of the elderly. Various investigations have sought to find clues that may provide viable proposals to fulfill this objective. Perhaps the simplest, as suggested by Castilla et al. [18], is that the elderly feel the need, on their own, to access and use digital resources. However, as Castilla et al. [18] also mention, the elderly must feel self-confident, but previous training and the existence of a support team will be essential, not only for more technological purposes but fundamentally for emotional reasons. Therefore, Wang and Chen [57] are of the opinion that all variables should be taken care of so that these first experiences are positive and pleasant and that they also have a practical sense in the routines of the elderly to increase their levels of well-being and health.

In this sense, as stated by Zaid et al. [58], it is important to increase the opportunities and levels of exposure of the elderly to technologies because in the recent past, research has shown positive effects in reducing loneliness and more

depressive states. And, therefore, the elderly increases their levels of health and well-being. At the same time, the increase in their digital skills has also been promoting the participation of the elderly in lifelong learning programs within the scope of the so-called active aging [59]. For this reality to be even more expressive, Zaid et al. [58] are of the opinion that to increase the rates of adoption of technologies by the elderly, it is also very important and may even be very decisive for the elderly to feel the immediate benefits of these technologies for their daily routines. However, we must pay attention to a detail that can make all the difference: digital technologies are designed by young people and, for that reason, are designed and created to meet their needs, which, in general, are different from the needs of the elderly [60]. For this order of reasons, Martinez-Alcalá et al. [29] reinforce the need for these technologies to be more user-centered by involving the elderly in their design and development: "require useful, functional, user-friendly and meaningful technology." To this end, it is important to adopt a "user-centered approach" view, which we believe is a way to put into practice and which is supported by Merkel and Kucharski ([61], p. 18) "involving older people in the process of developing new gerontechnologies leads to a better acceptance and/or use of the innovative products." In this way, the elderly did not feel that they were being treated as guinea pigs, and they could feel uncomfortable because they felt that their home had become a laboratory and not the place where they "only" live with the safeguard of their dignity and privacy. For these goals to be achieved, it is necessary for the elderly to be aware that the expansion of health services with the integration of IoT/IoMT will allow health professionals to collect data that are treated and analyzed, while the elderly remain in the comfort of their own home [30]. And, given the large volume of data, it is possible to make predictions and diagnoses that are more correct and more adjusted to the needs of each elderly person.

As Maskeliunas et al. [52] mention and with which we agree, the motivation of the elderly is fundamental for carrying out activities if they require the least possible effort and the elderly feel that these activities have meaning and are of practical use for their daily routines. This motivation is based on a social perspective that includes their family members and their grandchildren, in what is usually called intergenerational relationships. In this regard, Sun et al. [62] report that family support and encouragement can significantly promote the use of the Internet by the elderly. Still from the perspective of Maskeliunas et al. [52], it is increasingly possible to customize digital resources, which makes the fear of using them for those who are info-excluded diminish. In the same vein, the latest digital capabilities tend to be more intuitive with low technical demands. In this way, it is also easier to adapt these digital resources for seniors who have some obvious disabilities.

According to recent studies and investigations, there is an increasingly evident trend toward the primordial role of digital technologies/platforms within the context of AAL, which Choi et al. ([30], p. 198) present as:

- IoT + architecture = smart home
- IoT + healthcare = daily healthcare devices
- IoT + healthcare + architecture = ALL healthcare platform

Also, as stated by Choi et al. [30], it is not enough to think and focus only on the digital-technological dimensions. On the contrary, what is fundamental and absolutely a priority is that AAL platforms will be based on the behaviors and desires of the elderly in their homes.

In general terms, it can be said that there is a low adjustment of the elderly toward digital technologies, which is often related to lack of incentives, economic problems, and digital skills associated with the lack of a policy that promotes the training of the elderly. From the point of view of Roupa et al. [63], training programs for the elderly should be designed according to their needs and priorities, and, for this purpose, we can rely on their families and grandchildren in an intergenerational perspective. Being aware that the elderly group is the most heterogeneous social group, especially because of their different life experiences (e.g., academic, professional, economic, social, religion, etc.), it becomes more difficult to find a model of training that can be understood as the most suitable for this elderly population. However, there are data from different investigations that allow giving clues to which elderly people will potentially be info-excluded. In this context, as stated by Sun et al. [62], attention should focus on the following variables: socioeconomic and demographic factors that include age, sex education, income status, health literacy, and urban and rural conditions. Consequently, several investigations have shown that older adults who are male, are younger, live in urban areas, and are of higher-income status and education use the Internet much more compared to the rest of the elderly [64].

According to Sun et al. [62], when the quality of life increased by a grade, Internet use increased 2.241 times, and, in this context, one cannot forget that the quality of life of a citizen is multidimensional, which includes not only physical health but also psychological health and social health. In this perspective, we also agree with Sun et al. [62] when stating that the greater social interaction among the elderly should also be encouraged to enable them to reap the benefits of the digital age.

Digital identity is another dimension that must be acquired during the construction of the digital identity because it is not enough just to know how to adhere and use digital resources, that is, knowing how and for what effect they use digital resources. As Blažic and Blažic [60] mention, this digital identity will allow the elderly to be more easily included and recognized in the digital context. In this way, conditions will be met for a fairer and more inclusive society.

The future of healthcare is exceptionally encouraging, seeing the rapid development in technology, IoT, AI, machine learning, and AAL systems. The elderly have new opportunities as well as challenges and significant changes that must be mastered. Digital literacy is fundamental for the enhancement of the overall user experience of Health Care 4.0. Even though many seniors are digitally vulnerable because they are info-excluded, we believe that with assertive measures of lifelong learning in knowledge-oriented digital skills and using new technologies, they will impact how seniors will deal with smart healthcare in AAL. Increasing the use of digital health among seniors requires understanding these technological barriers as well as the unique health needs of seniors to help them find the right ambient assisted living technologies and use them confidently and safely.

In this regard, helping seniors adopt technology involves more than just providing connected devices. It requires providing educational programs to increase digital health literacy, as well as a personalized approach to communication preferences with health professionals, and thus guiding individuals throughout their personal care experiences to healthier outcomes. Besides, when older people engage with technology, there are also potential benefits. The process of learning new skills can on the one hand contribute to increased well-being and independence; on the other hand, technology can help older adults overcome many issues that impact their physical and mental health, prevent some symptoms of health conditions, independent living support, social participation, and well-being.

To conclude, taking the above into consideration, we present some proposals in the field of training digital competence, based on the literature but mainly on our own experience in digital inclusion activities for the elderly: the elderly should be included from the earliest stages in a process of co-design not only of training program development but also of applications designed for them; identify each person's interests with regard to digital technology to respond to these interests; content, methods, and strategies should be varied, combining class time with self-study and blended peer learning with self-study, individual support, and also external visits; and training programs should be practical, flexible, and inclusive, with ongoing sharing of best practices, resources, and experiences among participants for the successful implementation of the training. Family support and motivation is moreover important.

The constant and rapid technological and scientific developments in healthcare, whether in the digitalization of health services or in healthcare assistive environments, require a continuous approach to the development of digital and health literacy competencies in a lifelong learning perspective. Therefore, empowering the elderly with literacy skills could enable them to benefit from the use of various digital health sources to improve their health quality and enable them to live independently for longer.

References

1. Goodfellow, R. (2011). Literacy, literacies and the digital in higher education. *Teacher in Higher Education, 16*(1), 131–144.
2. Lankshear, C., & Knobel, M. (2003). *New literacies: Changing knowledge in the classroom.* Open University Press.
3. Gilster, P. (1997). *Digital literacy*. John Wiley.
4. European Commission. (2006). *Recommendation on key competences for lifelong learning. Council of 18 December 2006 on key competences for lifelong learning, 2006/962/EC, L. 394/15*. Retrieved September 10, 2022, from: http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32006H0962&qid=1496720114366
5. Lankshear, C., & Knobel, M. (2015). Digital literacy and digital literacies: Policy, pedagogy and research considerations for education. *Nordic Journal of Digital Literacy, 2006-2016*, 8–20.
6. Buckingham, D. (2015). Defining digital literacy: What do young people need to know about digital media? *Nordic Journal of Digital Literacy, 4*, 21–34.

7. Gourlay, L., Hamilton, M., & Lea, M. (2013). Textual practices in the new digital literacies. *Research in Learning Technology, 21*, 21438.
8. Joonesten, T., Pasquini, L., & Harness, L. (2012). Guiding social media at our institutions. *Planning for Higher Education, 41*(1), 125–135.
9. Stordy, P. (2015). Taxonomy of literacies. *Journal of Documentation, 71*(3), 456–476.
10. Martin, A. (2006). A European framework for digital literacy. *Nordic Journal of Digital Literacy, 1*(2), 151–161.
11. Lankshear, C., & Snyder, I. (2001). *Teachers and technoliteracies*. Allen & Unwin.
12. Pangrazio, L., & Sefton-Green, J. (2021). Digital rights, digital citizenship and digital literacy: What's the difference? *Journal of New approaches in Educational Research, 10*(1), 15–27. Retrieved September 11, 2022, from: Digital Rights, Digital Citizenship and Digital Literacy: What's the Difference? | Pangrazio | Journal of New Approaches in Educational Research (ua.es)
13. Casey, L., & Bruce, B. (2011). The practice profile of inquiry: Connecting digital literacy and pedagogy. *E-Learning and Digital Media, 8*(1), 76–85.
14. Tan, E. (2013). Informal learning on Youtube: Exploring digital literacy in independent online learning. *Learning Media and Technology, 38*(4), 463–477.
15. European Commission. (2010). *A Digital Agenda for Europe*. Brussels. Retrieved September 10, 2022, from: http://ec.europa.eu/information_society/digital-agenda/index_en.html
16. OECD. (2005). *Definition and Selection Key Competencies – Executive Summary*. Retrieved September 10, 2022, from: https://www.oecd.org/pisa/35070367.pdf
17. Tamborg, A., Dreyøe, J., & Fougt, S. (2018). Digital literacy – A qualitative systematic review. *Læring & Medier, 19*, 1–29.
18. Castilla, D., Botella, C., Miralles, I., Bretón-López, J., Dragomir-Davis, A., Zaragoza, I., & Garcia-Palacios, A. (2018). Teaching digital literacy skills to the elderly using a social network with linear navigation: A case study in a rural area. *International Journal of Human-Computer Studies, 118*, 24–37.
19. European Commission. (2022). *Digital inclusion*. Retrieved October 3, 2022, from: https://digital-strategy.ec.europa.eu/policies/digital-inclusion
20. Eurostat. (2022). *Individuals' level of digital skills*. Retrieved October 3, 2022, from: https://ec.europa.eu/eurostat/databrowser/view/ISOC_SK_DSKL_I21__custom_3494070/default/table?lang=en
21. Almeida, A., Mulero, R., Rametta, P., Urosevic, V., Andric, M., & Patrono, L. (2019). A critical analysis of an IoT-aware AAL system for elderly monitoring. *Future Generation Computer Systems, 97*, 598–619.
22. Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2: The digital competence framework for citizens - with new examples of knowledge, skills and attitudes, EUR 31006 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-48882-8, https://doi.org/10.2760/115376, JRC128415.
23. Andrejevic, M. (2020). *Automated Media*. Routledge. Retrieved September 11, 2022, from: https://doi.org/10.4324/9780429242595
24. Shin, D., & Seger, W. (2016). Web 2.0 technologies and parent involvement of ELL students: An ecological perspective. *The Urban Review: Issues and Ideas in Public Education, 48*(2), 311–332.
25. Thrane, L., Shelley, M., Shulman, S., Beisser, S., & Larson, T. (2004). E-political empowerment: Age effects or attitudinal barriers. *Journal of E-Government, 1*(4), 21–37. Retrieved September 12, 2022, from: https://doi.org/10.1300/J399v01n04_03
26. Richardson, J. (2015). *Law and the Philosophy of Privacy*. Routledge. https://doi.org/10.4324/9780203516133
27. Lee, B., Chen, Y., & Hewitt, L. (2011). Age differences in constraints encountered by seniors in their use of computers and the internet. *Computers in Human Behavior, 27*, 1231–1237.
28. Rahman, T., Amalia, A., and Aziz, Z. (2021, January). From digital literacy to digital intelligence. In *4th international conference on Sustainable Innovation 2020–Social, Humanity, and Education (ICoSIHESS 2020)* (pp. 154–159). Atlantis Press. 13th-14th October 2020. Makarova.

29. Martinez-Alcalá, C., Rosales-Lagarde, A., Pérez-Pérez, Y., Lopez-Noguerola, J., Bautista-Diaz, M., & Agis-Juarez, R. (2021). The effects of Covid-19 on the digital literacy of the elderly: Norms for digital inclusion. *Frontiers in Education*. https://doi.org/10.3389/feduc.2021.716025
30. Choi, D., Choi, H., & Shon, D. (2019). Future changes to smart house based on AAL healthcare service. *Journal of Asian Architecture and building Engineering, 18*(3), 190–199.
31. UNECE. (2021). *Ageing in the digital era*. Policy Brief on Ageing No. 26. Retrieved October 3, 2022, from: https://unece.org/sites/default/files/2021-07/PB26-ECE-WG.1-38.pdf
32. Thomas, J. (2015). *Insights into loneliness, older people and well-being*. Retrieved September 30, 2022, from: https://backup.ons.gov.uk/wp-content/uploads/sites/3/2015/10/Insights-into-Loneliness-Older-People-and-Well-being-2015.pdf
33. UN. (2015). *World Population Prospects*. Retrieved September 30, 2022, from: https://population.un.org/wpp/Publications/Files/WPP2015_DataBooklet.pdf
34. Abdi, J., Al-Hindawi, A., Ng, T., & Vizcaychipi, M. P. (2018). Scoping review on the use of socially assistive robot technology in elderly care. *BMJ Open, 8*(2), 1–20. https://doi.org/10.1136/bmjopen-2017-018815
35. Salovaara, A., Lehmuskallo, A., & Hedman, L. (2010). Information technologies and transition in the lives 55-65 years old: The case colliding life interests. *International Journal of Human Compared Studies, 68*(1), 803–821.
36. Heo, J., Chun, S., & Lee, S. (2015). Internet use and well-being in older adults. *Education Psychology Cyberpsychology Behavior and Social Network, 18*(5), 268–272.
37. Rashidi, P., & Mihailidis, A. (2013). A survey on ambient assisted living tools for older adults. *Journal of Biomedical Health Informatics, 17*(3), 579–590.
38. Syed, L., Jabeen, S., Manimala, S., & Alsaeedi, A. (2019). Smart healthcare framework for ambient assisted living using IoMT and big data analytics techniques. *Future Generation Computer Systems, 101*, 136–151.
39. Mainetti, L., Patrono, L., Secco, A., & Sergi, I. (2016). *An IoT-aware AAL system for elderly people*. Retrieved October 4, 2022, from: https://ieeexplore.ieee.org/abstract/document/7555929
40. Sankar, S., Srinivasan, P., & Saravanahumar, R. (2018). Internet of things based ambient assisted living for elderly people health monitoring. *Research Journal Pharmacy and Technology, 11*(9). https://doi.org/10.5958/0974-360X.2018.00715.1
41. Dohr, A., Modre-Osprian, R., Drobics, M., Hayn, D., & Schreider, G. (2010). *The internet of things for ambient assisted living*. Retrieved October 1, 2022, from: https://www.academia.edu/6478405/The_Internet_of_Things_for_Ambient_Assisted_Living
42. Kunze, C., Holtman, C., Schmidt, A., & Stork, W. (2007). *Kontextsensitive Technologien und Intelligente Sensorik für Ambient-Assisted-Living-Anwendungen*. Retrieved October 1, 2022, from: https://www.researchgate.net/profile/Andreas-Schmidt 11/publication/229422957_Kontextsensitive_Technologien_und_intelligente_Sensorik_fur_Ambient-Assisted-Living Anwendungen/links/0912f50c7aa1d1130a000000/Kontextsensitive-Technologien-und-intelligente-Sensorik-fuer-Ambient-Assisted-Living-Anwendungen.pdf
43. Harum, N., Abidin, Z., Shah, W., & Hassan, A. (2018). Implementation of smart monitoring system with fall detector for elderly using IoT technology. *International Journal of Computing, 17*(4), 243–249.
44. European Commission. (2021). *Next-generation internet of things and edge computing*. Retrieved October 1, 2022, from: file:///C:/Users/Downloads/ng_iot_and_edge_computing_executive_report
45. Gigli, M., & Koo, S. (2011). Internet of things: Services and applications categorization. *Journal of Advanced Internet Things, 1*, 27–31.
46. International Telecommunication Union [ITU]. (2005). *ITU internet reports 2005: The internet of things - executive summary*. Retrieved October 28, 2022, from: https://www.itu.int/osg/spu/publications/internetofthings/InternetofThings_summary.pdf
47. Wu, Q., Ding, G., Xu, Y., Feng, J., & Long, K. (2014). *Cognitive Internet of Things: A new paradigm beyond connection*. Retrieved October 6, 2022, from: https://ieeexplore.ieee.org/document/6766209

48. Lloret, J., Canovas, A., Sendra, S., & Parra, L. (2015). A smart communication architecture for ambient assisted living. *IEEE Communications Magazine, 53*(1), 26–33. https://doi.org/10.1109/MCOM.2015.7010512
49. Suryadevara, N., & Mukhopadhyay, S. (2014). *Determining wellness through an ambient assisted living environment*. Retrieved October 7, 2022, from: https://ieeexplore.ieee.org/abstract/document/6813391
50. Maskeliunas, R., Damaševicius, R., & Segal, S. (2021). A review of internet of things technologies for ambient assisted living environments. *Future Internet, 11*, 259. https://doi.org/10.3390/fi11120259
51. Suciu, G., Vulpe, A., Craciunescu, R., Butca, C., & Suciu, V. (2015). *Big data fusion for eHealth and ambient assisted living cloud applications*. Retrieved October 7, 2022, from: https://ieeexplore.ieee.org/abstract/document/7185095
52. Maskeliunas, R., Damaševicius, R., & Segal, S. (2019). A review of internet of things technologies for ambient assisted living environments. *Future Internet, 11*, 259. https://doi.org/10.3390/fi11120259
53. Villari, M., Al-Anbuky, A., Celesti, A., & Moessner, K. (2016). Leveraging the internet of things: Integration of sensors and cloud computing systems. *International Journal of Distributed Sensors Network, 12*, 7. Retrieved October 7, 2022, from: https://journals.sagepub.com/doi/epub/10.1177/155014779764287
54. Duijnhoven, J., Aarts, M., Kort, H., & Rosemann, A. (2021). External validations of a non-obtrusive practical method to measure personal lighting conditions in offices. *Lighting Research & Technology, 53*(4), 285–310.
55. Ajami, H., Mcheick, H., & Mustapha, K. (2019). *A pervasive healthcare system for COPD patients*. Retrieved October 9, 2022, from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6963281/
56. Rubi, J., & Gondim, P. (2019). *IoMT platform for pervasive healthcare data aggregation, processing, and sharing based on OneM2M and OpenEHR*. Retrieved October 9, 2022, from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6806104/pdf/sensors-19-04283.pdf
57. Wang, C., & Chen, J. (2015). Overcoming technophobia in priory-educated elderly – The HELPS – Seniors service-learning program. *International Journal of Automation Smart Technology, 5*(3), 173–182.
58. Zaid, N., Rauf, M., Ahmad, N., Zainal, A., Hanis, F., & Shahdan, T. (2022). Learning elements for digital literacy among elderly: A scoping review. *Journal of Algebraic Statistics, 13*(3), 2850–2859.
59. Wang, C., & Wu, C. (2021). Bridging the digital divide: The smart TV as a platform for digital literacy among the elderly. *Behavior & Information Technology*, 1–14. https://doi.org/10.1080/0144929x.2021.1934732
60. Blažic, B., & Blažic, A. (2020). Overcome the digital divide with a modern approach to learning digital skills for the elderly adults. *Education Information Technology, 25*(1), 259–279.
61. Merkel, S., & Kucharski, A. (2019). Participatory design in gerontechnology: A systematic literature review. *Gerontologist, 59*(1), 16–25.
62. Sun, X., Yan, W., Zhou, H. *et al.* (2020). Internet use and need for digital health technology among the elderly: A cross-sectional survey in China. *BMC Public Health* **20**, 1386. https://doi.org/10.1186/s12889-020-09448-0
63. Roupa, Z., Nikas, M., Gerasimou, E., Zaferi, V., Giasyrani, L., Kazitori, E., & Sotiropoulou, P. (2010). The use of technology by the elderly. *Health Science Journal, 4*(2), 118–126.
64. Levy, H., Janke, A., & Langa, K. (2015). *Health literacy and the digital divide among older Americans*. Retrieved October 14, 2022, from: https://link.springer.com/content/pdf/10.1007/s11606-014-3069-5.pdf