

Chapter 4

Contested homes in the age of the cloud

The changing socio-spatial dynamics of family living and care for older people in the 21st century

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Introduction: Changing homes, changing culture of living

The power of home lies in its enduring practices, conventions, everyday rituals, social interactions and communications, either within the household or with the outside world. Spatial configurations of homes are not, in this sense, limited to the physical characteristics of the domestic space; rather, people reconstruct domestic spheres based on sociocultural and temporal needs that transcend the limitations of the physical space (Mallet, 2004; Lawrence, 1987; Lefebvre, 1991). Homes are socially constructed and have consistently been changing in forms, uses and meanings (Smith, 1986; Smith, 1994; Saunders and Williams, 1988). While houses are built with the capacity to serve a wide range of family social engagements and needs that differ through generations, homes are constructed out of continuities of social activity, interaction, attitudes and conduct (Abdelmonem, 2011; Saunders, 1989). With online communications and social media interactions becoming essential part of everyday lives, homes are facing new affront, namely, the confrontation of uncontrolled access to private spaces, challenges to family attitudes and social-training, and above all, vanishing privacy. Homes are becoming increasingly contested between the controlled physical and the uncontrolled virtual, between the tangibility of one's presence and the intangibility of alien influences (such as social media, online friendship groups and shopping websites). From smart TV, smart phones, surveillance cameras, to social interaction and care, smart home systems do exchange much of our personal information with service providers, including information that defines personalities and personal consumption or needs profile (Smart Home, 2009).

Recent demographic analysis of western societies shows that the profile of older people is changing. In the United Kingdom (UK) there are 4 million people over the age of 75, which is projected to increase to 5.9 million by 2025 (Tinker, 1997, p. 274). In Europe it is predicted that in 2025 the total of number of people over 65 years will be 173 million, and will reach 27.6% of the total population. Population ageing brings with it a number of challenges to aspects of life in the home and the way the home is connected to society, most notably a rise in the proportion of the population in need of care. By 2010, 36 million people globally were recognised as having dementia and, by 2050, this number is expected to rise to 115 million (Mihailidis et al., 2012). The proportion of that population living alone at home is also increasing, and approximately one-third of older people living at home also live alone (Wild and Boise, 2012). Such

predictions highlight the importance of pursuing research on information and communication technologies (ICTs) and housing design for older people and those who care for them; to respond to the needs of aging at home, and of those who care for them (Mieczakowski and Clarkson, 2012; Pragnell et al., 2000). The impact ICT has on the lives of older individuals are still a topic of debate and discussion (Mordini and de Hert, 2010), although more issues such as privacy, security, social isolation and dependence are coming to the fore. Homes developed for the need of older people have fundamental difference from those used by young families or those with multiple generations. The responsive capacity and connectedness of those homes are critical to the support, care and social engagement of older adults.

Much of the attention over the past few decades has focused on the ‘work–family conflict’ being a key operational hurdle with suspicion of negative impact on work rate and efficiency (MacDermid, 2005; Edwards and Rothbard, 2000). The result is a home–work interface that is a “socially constructed” boundary between the life domains of work and home, which remain at the core of human history (Holliss, 2012). The development of Skype, Zoom and virtual meeting rooms and workspaces, and e-shopping have made it much easier to overlap private and public domains, compared to time, cost and health risks of commuting on busy transport, as we learnt during the 2020 pandemic. Yet, the home holds more significance for older people. Recent data suggest that elders spend on average 80% of their daytime at home (Rowles and Chadhury, 2005, p. 25) and 89% of older people live in a mainstream family home (Hanson, 2001, p. 14). Within the Futurage Road Map, the home’s centrality to everyday life is important with increasing age, and particularly in very old age, people spend most of their time in the home with incremental need for monitoring, support and care (Futurage, 2007).

In the UK, the global coronavirus (COVID-19) pandemic has impacted all sections of society and resulted in close to 124,419 victims between March 2020 and March 2021, with older adults being most vulnerable, forming over 80% of fatalities. The government’s preventive measures such as “social distancing” and household quarantine and closure of schools and universities have been critical in reducing the total number of deaths by at least 78%, with the capacity to reduce the viral infection reproduction rate to below one (Ferguson et al., 2020; Long, 2020). On 16 March 2020 the British Prime Minister announced that it was “time for everyone to stop non-essential contact with others”, instructing people to work from home and avoid “social venues” such as pubs, clubs and theatres (Long, 2020). Such measures led to aspects of technology-driven and e-communications (e-shopping, e-medicine and e-learning) become overnight mandatory practices by Monday 24 March 2020, when the British government enacted a national lockdown, altering the way we work, communicate, educate and care. TV and playrooms have become workplaces, classrooms, meeting rooms or a virtual-coffee room to socialise with colleagues or elder relatives. iPads and computers with cameras have enabled work devices and facilitated such instant transition, allowing more flexible working hours, and open access to workplaces round the clock.

The critical importance of technology for older people makes technology an essential factor at home, which would come to be critical during the COVID-19 preventive measures and during the stay-at-home. With growing ageing population and associated vulnerability to such external factor as the coronavirus, the growing influence of technology on domestic environments, mixing work with life could mark the beginning of a new pattern of living. The effectiveness of e-shopping and e-medicine was therefore involuntarily tested during March 2020 – March 2021 to a great success, with millions of older people being self-isolated, ordering supplies online and receiving care and medication via e-medicine and e-care support without any physical contact.

Researchers argue that technology is favourable in increasing the level of control an older person can feel within his or her home. Barlow and Venables (2004, p. 1) argue that technology can increase control grasped in the home as the level of security felt is improved, in reference to technology that can “deliver more control over the domestic environment and provide an ‘electronic blanket’ for those being cared for and for carers”. By contrast, control could be lost if technology is taken in unwillingly, and tensions can arise. ICTs have become structurally integrated with the home environment. Our understanding, design and architecture of home need to equally change to suit such conditions and active communication arenas. This chapter, hence, looks at the challenges, risks and opportunities that modern technology poses for the domestic sphere, specially testing the effectiveness of existing ICT systems and assisted living to support older people ageing at home.

The architecture of home in the digital era: Space and identity of domestic atmosphere

Louis Kahn once argued that architecture “is the thoughtful making of spaces”. The continual renewal of architecture comes from those changing concepts of space (Norberg-Schultz, 1971). While architecture is able to provide the multi-dimensional experiences of space and time, home corresponds those experiences to the human actors in a structured and synchronised organisation (Abdelmonem, 2016). The idea of home lies in its organisation of space over time, in its capacity for memory or anticipation (Douglas, 1991). The home is capable of anticipating future events through coordinating actions and planning consumption, not only through efficient response to memory and the regularity of experiences, but also regarding swift changes and adaptation to unpredictable events, such as the COVID-19 worldwide pandemic.

In this context, homes have been one of the most rewarding experimental missions of humans in their negotiation with nature and technology. Philosophers have related the process of building a shelter, dwelling or a home to the state of being in the world. Norberg-Schultz argue that “architectural space may be understood as a concretization of environmental schemata or images, which form a necessary part of man’s general orientation or ‘being in the world’” (Norberg-Schultz, 1971). From Nietzsche to Martin Heidegger and Hannah Arendt, the act of building and inhabiting space is a process of mediation with nature, culture and technology and contextualised to meet the always changing human needs (Abdelmonem, 2012). The change of those aspects forces a change in form, spatial configuration and social processes. Humans have always created

spaces as a medium of their understanding of the world. The architectural space, its inhabitation and use have changed over time (Junestrand and Tollmar, 1998).

The underlying meaning of modern living, however, suggests a temporal condition that is largely time-flexible, thereby situating the understanding of modern homes peculiar to their contemporary relevance, and more increasingly technology (Kern, 2003; Bauman, 2000). The use and management of domestic space to accommodate modern and technologically led lifestyles have become symptoms of mobile communication as a driving force for social engagement; physical space became less critical; emotional engagement became more volatile. The necessity of attachment, confrontation and mutual co-habitation are increasingly vulnerable to forces of efficiency, detachment and redundancy as epitomised by the stark scenes of high-rise concrete forests of apartment blocks in the downtowns of contemporary cities.

Yet, the intervention of smart, digital and virtual technologies has largely altered these patterns within the domestic space. The face-to-face contact in protected environment has largely been challenged by multiple online influences on children and young generation into an increasingly boundary-less environment. Access to social media, reliance on smart devices and online resources by schools have created generational gap in communication skills and accessibility at home. But, equally, same devices have enabled critical access to older people by family, neighbours and carers from remote locations. In addition, devices that may pose risks to some family members at certain age become very important to reduce those risks to different age groups. The dichotomy of risk and opportunity has largely been debated in technology-centred intellectual debate. Here, I will try to explore how ICT devices at home are increasingly essential and integrated components of domestic operations and family life.

Smart homes: Technologies, systems and infrastructure

Despite their predominance in everyday homes, research lacked critical evidence on how technology in domestic environments has an impact on people's everyday life (Demiris and Hensel, 2008), at least until the 2020 pandemic. Research demonstrates the viability of technological solutions of essential social and medical needs either in a laboratory or limited community-based settings (Demiris and Hensel, 2008, p. 40). The co-design of technology with the input of the end user balances technological challenges with the cultural context of practice and needs in domestic environments. (Weiner et al. 2003, p. 430). While these are driven by technology companies, they remain universal in their applications and context neutral for commercial purposes. The input of users or the impact of technology on different user groups is very small, leaving our understanding on this evolving integrative environment quite limited.

The concept of a "smart home" has existed for many years. Referred to as intelligent homes or home networking, it involves the introduction of networked devices into the house, or "the integration of technology and services through home networking for a better quality of living" (Bierhoff et al., 2005). There are two elements that require further discussion. First, the capabilities of the technology are always expanding through increasing networks speeds. Second, the introduction of entirely new devices, the rapid pace of development means that the smart home paradigm must be

periodically assessed and adjusted to reflect new capabilities, opportunities and challenges. Smart homes can also be classified from a functional perspective, as illustrated by Aldrich's (2003) five hierarchical classes:

- 1)Homes which contain intelligent objects: homes contain single, stand-alone applications and objects which function in an intelligent manner.
- 2)Homes which contain intelligent, communicating objects: homes contain appliances and objects which function intelligently in their own right and which also exchange information between each other to increase functionality.
- 3)Connected homes: homes have internal and external networks, allowing interactive and remote control of systems, as well as access to services and information, both within and beyond the home.
- 4)Learning homes: patterns of activity in the homes are recorded and the accumulated data are used to anticipate users' needs and to control the technology accordingly.
- 5)Attentive homes: the activity and location of people and objects within the homes are constantly registered, and this information is used to control technology in anticipation of the occupants' needs.

Each stage of the hierarchy requires increasingly complex technology, both in terms of hardware and software, as well as increased need for efficient networking and data collection, particularly with respect to tiers 4 and 5, where the needs and preferences of users are anticipated.

Smart home technologies (SHT) can perform a wide variety of functions and incorporate many different devices as listed in [Figure 4.1](#):

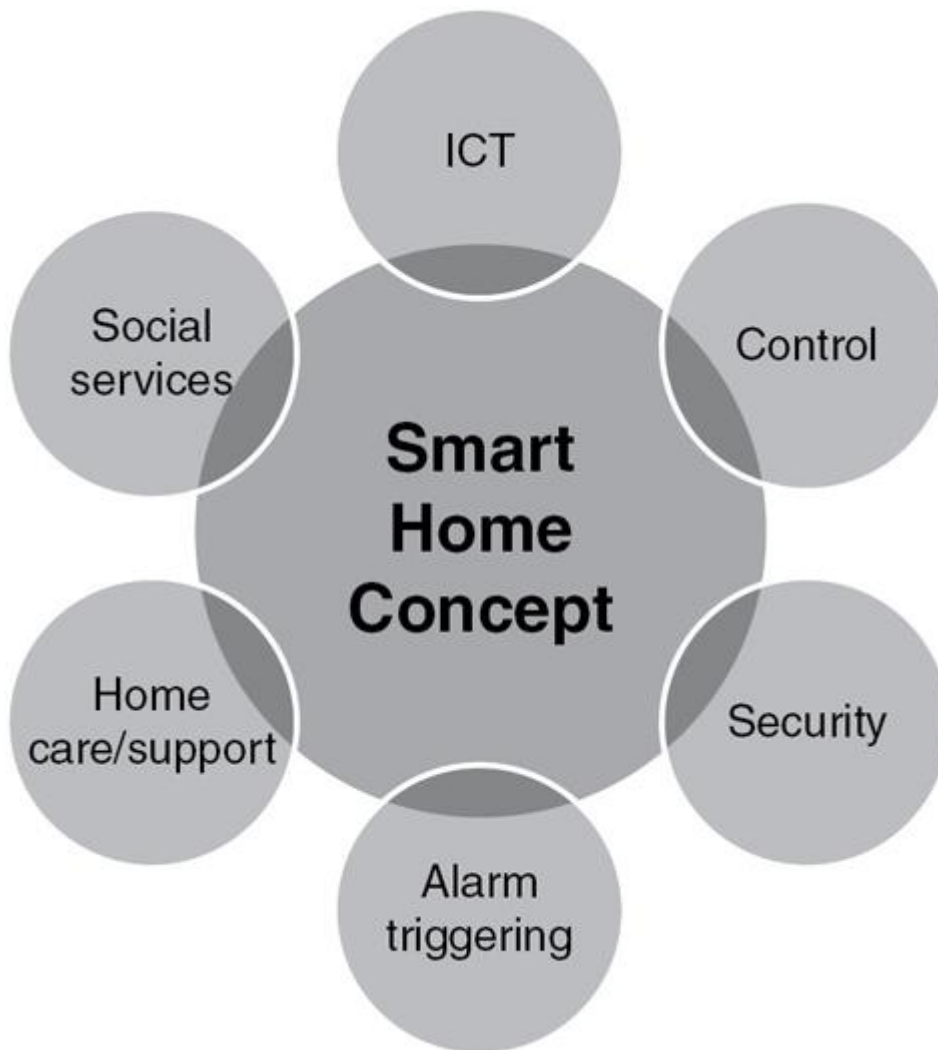


Figure 4.1 Home technologies: Functions.

- **ICT:** Although many elements in the smart home are networked, ICT in the context of smart homes refers to those that allow for direct, controlled access to the outside world and includes devices such as the telephone, TV, and services provided by an Internet connection.
- **Control:** Control refers to the ability of the resident to manipulate the environment through the use of switches and panels for lights or heating. The degree and comfort with which a resident is able to control or operate the different parts of the smart home is an important factor for the devices being deemed acceptable or desirable to the wider public and older people. Control also includes smart meters, and remote control of security cameras, energy consumption and lights, among others.
- **Security:** Security refers to security from intrusion and from potential hazard. It may involve the use of “smart” locks, which can be operated via smart phone or alarms that indicate the presence of a water leak or fire, among other information.
- **Alarm Triggering:** Although the six categories listed here describe various aspects of the smart home, it is important to note that these distinctions are not impermeable, as evidenced by the links between security and alarm triggering, which both feature alarms for a variety of purposes. Alarm

triggering however also includes devices such as wearable alarms and sensors that detect where in the house a person may be. The alarm may trigger for the resident or, in the case of smart homes for elderly or vulnerable people, for caregivers and family members. Alarms may also be tailored to the needs of the resident, such as flashing lights or a wearable alarm that vibrates in lieu of loud alarms for those who are hard of hearing.

- **Home Care/Support:** Devices and services for home care and support are designed with elderly or vulnerable people in mind. The goal of the elements in this category is to increase the independence of the resident through the use of measures that make it easier for the resident to perform activities of daily living (ADL). Not all of the solutions in a smart home need to be based on ICT. In some cases, the “smart” solution is a redesign of traditional elements of the house to reflect the needs of the resident. This could include adjustable work surfaces in the kitchen, seats in the shower or ramps in the place of steps at the outside entrances.
- **Social Services:** Regardless of the possibilities of technology, it should enhance not replace potential for human interaction. With this in mind, the social services aspect of the smart home concept focuses on the services which can encourage independence and enable ageing in place. Although advances in technology may assist in this aspect (such as easier access to reliable information on buses or other services), it is primarily focused with the infrastructure that surrounds the smart home, emphasising that the concept is not merely about the physical structure of the house, but in providing an environment that is supportive of the resident, especially in the context of the older people. This aspect of technology was paramount in older people’s ability to engage with their families, friends and social networks during the strict lock down in 2020, as was recommended by many health and ageing groups as frequently appeared on ABC News, and the BBC. Such engagement was critical for mental health and well-being of older adults during several weeks of self-isolation (Gill and Munbodh [2020](#)), as grandparents were able to see grandchildren and socially engage with siblings and family.

To be truly effective, smart homes must be responsive to the needs of the user, increasing their comfort, independence, security and quality of life. This is equally true of smart homes for older people. Smart homes are designed to address needs based on three main areas: comfort, leisure and healthcare (Chan et al., [2008](#)). The potential of smart homes to address the healthcare needs is however of greatest relevance. The smart home itself is not a technology per se, but rather a concept incorporating many different devices and services. While some of those aspects are digital and virtual, critical elements of smart home design remained physical and spatial (Value Ageing, [2010–2014](#)). Beyond a network connection through which technology can communicate both to each other and to the outside world, there is no rigid formula for making a home smart. They need to be curated and designed for the use of specific individual needs and require expertise in architecture and construction, ICT, hardware design, psychology, healthcare, medicine and robotics.

Smart, responsible and intelligent homes can be classified under the umbrella of “Ambient Intelligence” (ETICA D5.7.c, [2010](#)). The ETICA Project identified and defined seven features of artificial intelligence (AI) environments:

- **Embedded:** The technology is not conspicuous in its presence, but is rather in the background as a network of sensors and devices.
- **Interconnected:** The different devices and sensors are wirelessly connected to each other, forming a single system.
- **Adaptive:** The system can operate (with varying degrees of efficiency) even with incomplete data. This is important for users who wish to restrict the collection or use of personal data.
- **Personalised:** The system can be tailored to the needs and wishes of the user (user centred).
- **Context-Aware:** The system can recognise and react in an appropriate manner to the circumstance, such as switching on a light (in the evening or at night) when a person enters the room.
- **Anticipatory:** Through the collection and analysis of user data, the system can anticipate user preferences and act accordingly, such as automatically adjusting the room temperature based on prior behaviour and settings.
- **Novel human-technology interaction paradigms:** How users interact with AI environments is always changing or developing in directions. What began as interactions with a computer through the use of a keyboard and mouse has moved to touchscreens, voice and motion control.

Smart homes can also incorporate “e-health” technologies as emerging applications in the intersection of medical informatics, public health and business, which provide health services with flow of information enhanced through the Internet and related technologies. These are series of applications of telehealth technologies and services, both for the user and for society, from National Health Service (NHS) individual account of checking personal records, appointments or tests, with record of medications and reviews, to the Trace and Track applications in the case of monitoring infection diseases and their spread within society, like 2003’s Severe Acute Respiratory Syndrome (SARS) or the new 2020’s COVID-19 (Robinson et al., [2020](#)). The former reduces the need for patients to leave their houses and travel to the hospital for check-ups, while the latter detects the spread of virus through big-data monitoring system of contacts, advising people to stay away from contagious areas (Firth et.al., [2020](#)). As such, for e-health applications the cost on the patient is lowered and the burden on hospital facilities is reduced (European Commission, [2010](#)). Telehealth is not only remote monitoring and communication with doctors, it is more of an increase in information available for the patient as well as the doctors, with some new application providing live data on patients’ biological conditions. Weighing scales are, for example, capable of monitoring and recording heart rate data, as well as calculating body mass index (BMI) and providing environmental information.

Most arguments against ICT within the home are concerned with the acceptability of technology, ethics and the negative connotations of “substituting ‘warm’ hands with ‘cold’ technology” (Aanesen et al., [2011](#)). The aim of SHT is defined by Demiris and Hensel ([2008](#), p. 35) in their paper, “Technologies for an Ageing Society”, as

[a] smart home aims to enable non-obtrusive monitoring of residents and involves different levels of technological sophistication, ranging from stand-alone intelligent devices to home that continuously monitor residents' activities and physical status and adapt to residents' needs, often providing proactive measures.

The degree to which an older person living at home accepts technology depends on numerous factors. A major influence in the use of technology is the motivation of the older person, desire for control, sense of privacy and understanding of its potential connectivity. Below, I will try to shed more focus on the impact of smart technologies on the lives of older people in everyday life by analysing the findings of two research projects: the first one is Value Ageing (2010–2014) that looked on the impact of artificial and assistive technologies on enhancing the design and quality of life for older people at home. The second project (2012–2017) focused on the analysis of older peoples' reaction to the use of smart technologies at home for care purposes.

As demonstrated above, while this work has been conducted much earlier than the disruptive occurrence of COVID-19 pandemic between March 2020 and March 2021, much of the research and analysis in those projects pave the road for in-depth understanding on how ICTs were already available and in good operation for some time. Hence, once coronavirus spread and lockdown enacted by the British government, households across the UK and abroad have swiftly used the very present technologies and infrastructures to operate as smoothly and as efficiently as possible, helping millions of families across the globe to stay safe at home, while e-care and work from home continued at large.

Investigating smart homes of older people: Methodology, data and findings¹

The understanding of smart homes from older people's perspective is centred around how they accept, react and co-inhabit a domestic environment dominated by electronic systems, communication devices and flow of personal information within their homes, and the impact of such interactivity on their sense of security, privacy and well-being. To gather the data for this research, two methods were deployed: first, gathering information on technologies and systems that shape our active and responsive homes, and, second, in-depth face-to-face semi-structured interviews with user groups (with and without access to technologies) to enable the collection of rich data on the meaning and perception of smart homes to older people. Technology in those homes comprises motion sensors, lux sensors, door and window sensors, Internet-connected TV, temperature sensors, electricity water and heating usage sensors and emergency alarm devices including pull cord alarms in the bathroom and bedroom and a push alarm in the hall entrance, all connected to an outside security call centre. The participants without technology were sampled considering the number of years they had been living in their homes. No self-identifying data has been included in any material presented in this research and confidentiality of all participants was maintained throughout.

There are a number of themes that emerged from the research and analysis that predominate the impact and feeling towards the use of smart technologies at

home. While some of these themes embrace the use of technologies, others underline the need for co-design of smart technologies. These include security from intruders, security for assistance, control, independence and privacy.

a. Safety (security from intruders): Safety was the most frequent topic when discussing the meaning of home and what they consider important. Participants discussed the importance of locking their doors, not only at night but also during the day. The front door was seen as a link to outside but more importantly a link for intruders to enter. Fear was mentioned along with security, emphasising the fact that many older people were vulnerable. Participants recognised their limited involvements in the operation of smart technology used for their security or its use. The findings revealed that feeling secure is the greatest benefit and acceptability factor of having technology, and the major motivation. When asked if they feel secure in their home, one participant stressed it as the greatest benefit of assistive technologies: “[t]hat is the biggest, the security ... you see the security that gives you the peace and tranquility” (RW3).

Another participant lived with such technology referred to being burgled once and had been unable to sleep in her room ever since. Instead she sleeps on a sofa in complete fear. Having moved to a new home with assistive technologies, she asserted: “I have security everywhere, nobody is going to get me” (RW3). One symptom of such appreciation of technologies is the psychology of vulnerability and fear, as older adults become more frail, especially when living alone. Safety in this sense affects the motivation of use and acceptability of technology, helping older people live more peacefully as security is becoming more prominent in their lives.

b. Security for assistance: Security is fundamental and the most influencing factor for accepting SHT. Older people mostly live alone and some feel fragile – therefore, feeling more secure can help them dwell more peacefully. Participants agreed that they would and do feel more secure if they knew that at the pull of an alarm cord or the push of a button they would receive help quickly. The presence of such simple devices offers assurances and sense of external help should it be needed: “Well I suppose the one good thing..., you only have to press a button if something happens to you and I’m sure that’s the greatest benefit of all” (RW2).

Yet technology can also disappoint and fail to enhance security for some. One participant was sceptical about the effectiveness of technology in this regard. He referred to incidents when he fell, lying for hours as the motion sensor could not pick up a movement of an arm while he lay on the floor:

If you move your leg, it couldn’t distinguish - I’m sure it can’t distinguish a movement of your leg, lying on the floor or standing... It breaks the infrared or whatever it is. It breaks the signals that’s all it can do. It doesn’t show you anything, if I move my hand like that, it thinks you’re moving normally.

(RW1)

When asked whether the technology made him feel secure in the home, one participant asserted: “I don’t know, I suppose the windows can still be broken”

(RW1).² Scepticism, however, prevails on the back of loss of control of your own security. Some participants stressed that having technology could make them feel less secure as control would be taken away from them; it could be given to wrong or less caring people, without control from the resident's side.

c. Control, independence and privacy are key elements that separate our private sphere from that of institutional and public domain. Territoriality and control within the home are intrinsically linked and this was made clear through ownership of items and autonomy over the home. Adoption of technology is uncontrollable in some instances as participants expressed their desire to control all devices in the home with nobody to answer to: "Very important, it's my home and I like to think I'm in charge (laughs)" (RW02).³ Autonomy is also significant as freedom and control to act is key to their independence and living at home, not in the over-controlled care homes. Autonomy is evidently a motivational factor in using technology when compared to the other alternative:

I think it's just you can do what you like, move around, you're independent, answering to nobody, there's nobody saying right be down for your tea at 4 or 5 o'clock. I can have my tea at 7 o'clock if I like. I think it's just the independence in the place of your own.

(RW03)

Technology could both hinder and enhance the control over home. The device which directly enhanced control for all SHT participants was the videophone which gives authority and control to the resident. Indirectly, sensors that detect intruders improved the feeling of safety and control and assured some older adults of the continued monitoring of healthcare provision, and hence instil more confidence and freedom to move about and activate their life knowing that a backup and responsive system is in place should it be needed. One participant stressed that some compromise and two end controls will enhance the sense of ownership by older people, which could be achieved if there was an "off" and "on" button, and one participant felt that this would replenish control: "Maybe that I could control the technology, in other words, it's nice knowing you can switch it off as well" (RW1).

d. Independence: Independence is another motivational factor especially as the thought of altering the home and embedding assistive technologies would aid those who are fragile. In way, there was a predominant feeling that altering the house physically to accommodate assistive technology would make residents feel more dependent and fragile who needs continuous monitoring, in comparison to the average person in their home, and hence, letting go of their independence. According to one resident living without assistive technology:

[T]hey're more or less cries for help anything that I've seen there, which I don't think, you know, up to now that I need... It needs a whole lot I suppose but I refuse to turn it into a disabled person's home... I can manage it at the moment.

(RW01)

Participants recognised that technology helped them age in place, through increased security and peace of mind with a trade-off of part of their independence. One

participant stressed that having responsive technology actually made them feel more independent as it helped to look after herself. Future capacities such as self-monitoring blood pressure and heart rate ensure that such autonomous feeling is well placed: “And it’s going to stop me from [going to] hospitals, from [seeing] doctors; you know it’s given me a greater quality of life” (RW3).

e. Privacy: The idea of remote monitoring of people’s safe movement without actual presence and seeing them in person breaks down the barriers of what home means. Technology which is simply placed in the home for your benefit, which does not involve someone else keeping an eye on your actions and movements, was seen as viable, such as light sensors or alarms. However, in direct monitoring by a stranger through motion sensors, queries arise. Participants viewed it as an invasion of privacy: “Actually, I wouldn’t like it at all because to me it’s a bit like big brother is watching you. The more I think about it” (RWO1). Another asserted the same point: “I don’t think I would like that ... Yeah, no, no not really, that would be sort of intruding on your privacy, do you know what I mean. It doesn’t appeal to me at all” (RWO2).

Participants have different opinions due to their personal experiences and health problems. One with healthy conditions and no prior incidents values privacy over being monitored by someone else. By contrast, those with previous history of falls and need of assistance support it. One supporting participant had suffered two falls within her home and this left her feeling afraid of it happening again. Participants RW2 and RW3 took to the technology immediately and put that down to the fact that they feel it is beneficial and also the fact that it appears physically did not disturb how rooms felt: “Not at all, no, I wouldn’t pass any remarks, you just go around and as you walk they’ll light up but you pass no remarks” (RW2). “Well for me, other people might see them intrusive, I don’t. I honestly don’t” (RW3).

The consideration of the future development of such technology was also an acceptability factor, as SHT participant RW1, who felt that monitoring could become recorded in the future, having devastating effects on privacy and the meaning of home. Well I don’t think it’s doing any damage at the moment but it has the potential to do it... It can change the meaning of home, from a place where you should be able to sit back, relax, feel your own comforts in, to you know, jail. It’s not a jail, they [are] not putting people into jail and I say I know people can feel that, go to some of the homes and older people are in prison, they can’t get out.

(RW1)

Impact of smart technologies in improving older people homes

Research indicates there are two stages of user motivation: “felt-need” and “perceived benefits” (Mahmood et al., [2008](#), p. 108). The degree to which an individual feels they need technology will affect their acceptability of it (McCreadie and Tinker, [2005](#)); they state that, “the assessment of objective need has to be balanced by reference to the individual’s perception of his or her own needs” (p. 105). “Independence is also a factor for motivation, if an older adult is strongly determined to live independently despite

his/her physical or mobility limitations; motivation is likely to be high to find ways to achieve that goal” (Mahmood et al., [2008](#), p. 108).

While considering the impact of ICT on an older person’s living conditions and environment, it is necessary to consider such impact on different functions and aspects of a person’s life that takes place in these conditions. Three different spheres of influence can be distinguished: cognitive function, physical function and social, cultural and emotional life. Different ICT solutions will vary in terms of their impact, benefits and risks for different spheres of a person’s life, usually influencing more than one sphere. They may also affect differently the space older people’s lives take place in – only home or home and a wider community. ICT solutions can also play different roles for various phases of the ageing process: they can help to delay the effects of ageing, such as cognitive decline, assist in managing specific conditions, such as physical disability or dementia, or open up social, cultural and economic opportunities for older adults. The basic cognitive functions that are most affected by ageing are attention and memory. Among other cognitive functions that may decline with age are the following: perception, mainly due to deteriorating sensory capacities, language processing and decision-making. Maintaining cognitive health allows older people to live independently longer, postponing or in some cases reducing the need for carers or being moved to residential care.

Although in most cases the impact of ICT on cognitive functions is positive, there are some ICT solutions that reduce cognitive functions if designed or applied inappropriately. One of the key risks associated with SHT is removing the user’s need for thinking and decision-making (ActiveAge, [2010](#)). Safer walking technologies, including alarms and tracking devices, are used to inform the carer that the user is outside the set boundary or to track the movements of older people with memory problems and particularly with “wandering” tendencies. Although such technologies are potentially beneficial for both the user and the carer, the use of such solutions is feared to lead to the loss of civil liberties and privacy, as well as stigmatisation as such devices often have negative connotations. Issue of the user consent is also important in this context (Alzheimer’s Society, [2013](#)).

Similarly, like in the case of cognitive functions, ICT developments have a significant role to play in maintaining and improving the physical abilities of older people. ICT solutions, such as Vital Mind, support participation in physical exercises by allowing users to choose from a range of different exercises (from repetitive to fun), carry them out at home and with friends if desired, and while doing so to receive feedback and monitor their physical performance. Although Vital Mind is a purposefully built system, other systems available on the mass market, for example, game console Wii or XBox Kinect may be used for exercises.

Challenges and opportunities of technology at home

This research into older people’s perception of assistive technology has been shaped by availability and access to assistive technologies, which change over time and vary from one country to another. While assistive technology changes with the

evolution of systems, applications and infrastructure, the sudden impact of COVID-19 has meant that self-isolation has significantly pushed and tested the boundaries and use of simple and more commercial technologies that activated the responsive functions of homes, making simple interaction like Skype/Facetime video calls, regular medical appointments over the phone (e-medicine), and shopping orders (e-shopping), among others, a normal everyday practice. In fact, such activation of SHT emerged from essential need and context of which all age groups, families and society had to change their lifestyle into more technologically adept (Gill and Mundobh, [2020](#)). Older people's swift acceptance of technology in this sense was informed by overarching societal change in response to an existential and universal health crisis. In other words, while those technologies were available for long time, they became commonly used, when normal family and societal context used them equally.

In the long term, once the dust of this crisis settles, we do not expect to go back to our way of living pre-pandemic, instead effective technologies will remain in active use. But, while families go back to work and children go back to school, older people will be left with similar challenges of being alone. Hence, some of these concerns remain valid and important to address in the transformative culture of living in post-pandemic homes. These are discussed under a number of topics:

a. Social isolation: Social isolation can manifest itself as loneliness in the individual, and is reflective of dissatisfaction with the frequency or closeness of social relationships they have, when compared against what they would like to have (Steptoe et al., [2013](#)). It has social, psychological and even physical implications for those who experience it, particularly those in need of care and assistance. A person is or is not deemed to be isolated based on contact with other people, while the feeling of loneliness is one of the psychological implications of the isolation and it has been associated with higher mortality in older men and women (Steptoe et al., [2013](#)). Loneliness does not have a measurable, direct impact on the mortality of older people (isolation had an impact regardless of the individual's own perceived satisfaction), it stressed that they were both important for quality of life and well-being (Steptoe et al., [2013](#)). In 2010, a Eurostat study "Social Participation and Social Isolation" noted that the likelihood of social isolation tended to increase with age. Within half of the countries in the European union (EU), 10% of respondents over the age of 65 years had no contact with friends for weeks, either in person or remotely. In the cases of Hungary and Lithuania, this increased to 25%.

Addressing social isolation is one of the core areas of implementing "successful" ageing in place and one aspect where ICT and SHT show a lot of promise. The connectedness of smart homes allows users access to new forms of communication, which may assist in mitigating some of the impact of social isolation, particularly the feeling of loneliness. ICT serves a social need by connecting family and friends, but to do so it must be available and accessible to all, as we saw between March 2020 and March 2021 in the UK and around the globe. It also should be viewed as a tool to augment, not replace, human contact.

This was highlighted in the “Report on Best Practices and Roadmap towards the Roadmap” published as part of SENIOR (2009), which warns that “new communication tools may become a substitute for face-to-face contact and make social isolation worse” (SENIOR D4.1, 2009).

b. Sense of identity: The home is reflective of the individual’s experiences and personality, and the environment can possess a strong sense of identity for residents. This identity is drawn from tradition, social cohesion and history, and it is important that any modifications have a minimal impact on this aspect of the home. This sense of identity has numerous positive implications on older people, particularly those with cognitive or physical impairments. Familiarity with the place, home and its features enables those who are frail to navigate spaces that would normally require greater effort and even those with dementia are documented to be able to perform tasks otherwise outside their capabilities when performed at home (Mihailidis et al., 2012).

AAL technology may be of benefit in this respect, as the sensors employed are often embedded and unobtrusive. However, AAL technology can interfere with individual’s space, particularly affecting the relationship between public and private space, where the distinction between the two becomes blurred. As Jennings describes it, “someone outside your home knows what’s happening, totally breaking down the privacy of the home. That can be troublesome for some older adults” (Abdelmonem and Krawczyk, 2013). It is important that SHT and home modifications do not erode the sense of identity of the home environment with over-dependence on technology. However, they must also find a balance between providing the distinction of the public and private space, while not making the residents feel like they are closed off from society.

c. Privacy: For those that are physically or cognitively impaired, ageing well at home is made significantly more achievable through the use of ICT and communications technology. However, technology must be deployed in a manner that both feels comfortable to the user and is effective in conducting its assigned task. Even though monitoring is a function of the ambient assisted living (AAL) and a potential benefit for assisting ageing in place, we must be careful to ensure that the privacy and autonomy of the resident is respected. Privacy also involves the shielding of people from unnecessary or excessive categorisation, which can have a negative impact on the lives and quality of life of older people (de Hert and Mantovani, 2010). While social networks can have a positive impact on the well-being of older people, they must also shield the user from unwanted contact (such as spam) and take all necessary measures to ensure that the data provided by the user are protected. Failure to properly respect the privacy and private lives of older people can have serious negative consequences to their quality of life (ibid.). It remains important to consider while older people adapt to new technology effectively, they remain more vulnerable and easier target to digital piracy and their data could be stolen at much more frequent basis than other age groups.

d. Control: Smart homes can act independently of active user input, triggering an alarm in the event of a fall, for example. Their systems, such as sensors for monitoring motion, heat, electricity usage, etc., are designed to operate in the background, at all hours of the day. However, while this may enhance the effectiveness of the technology, it can also have a significant psychological impact on the resident. Smart home technology can be divided into two groups: active and passive. The issue of control and the level of control provided to the resident is one of the most important factors influencing user acceptability of smart home technology. According to Lisa Jennings:

Active technology seems to be much more acceptable, because it is technology that they are used to, and they can turn on or they can turn off. They can use the phone if they want to, they can turn on their house alarm if they want to, or they can push the button on the wearable alarm around their neck.

(Abdelmonem and Krawczyk, [2013](#), Annex A)

The issue of control is strongly connected to that of privacy and personal space. The need to maintain an awareness of user preference in finding the balance, and the ability to manage it in a way that is dynamic and responsive to changing user needs and attitudes, is vital. According to Capurro ([2013](#)):

Freedom is not a fixed parameter but depends on the personal degree of openness to others and the shared world. This balance, particularly in the context of smart homes, should be thoroughly reflected, evaluated and dynamically adapted to persons and their respective worlds, including physical and digital places, within a relation of mutual care and respect.

(Abdelmonem and Krawczyk, [2013](#), Annex A)

e. Frustration and abandonment: Although the number and capabilities of assistive technologies is increasing, older people may still be reluctant to adopt them. Even when they begin to use them, however, there is the potential for them to abandon the technology, resulting in benefit to the user's quality of life. One of the greatest reasons for user abandonment is frustration (Abdelmonem and Krawczyk, 2013). Frustration occurs when the device or service is a "poor fit" for the user. This poor fit is of particular concern with emerging technologies, where the user may have no prior experience with a device and no initial comfort can be assumed. The inability of the user to adapt the device to their specific needs, either as a result of inflexible design or poor training, increases the risk of the user growing frustrated with the technology and either actively choosing not to engage with it, or using it with less frequency. Frustration with a device may also occur if it is not comfortable to use, for example, if a wearable sensor weighs too much, or an installed ramp is too steep.

Conclusions: Implications of smart homes and housing design for the elderly

Smart homes are designed to improve the quality of life of older people, family or households. Measuring, evaluating and improving the home of an individual or a group is a complex process. There is no standard or universally accepted definition of quality of life at home, nor is there universal consensus on what elements should be considered

under its umbrella. This is particularly problematic in the context of smart homes for older people. Traditionally, assessing older people's quality of life has focused on diminishing capabilities and the subsequent loss of independence. Functional capacity, care, health status, psychological well-being, social support, morale, dependence, coping and adjustment are all examples of indicators used as "proxies" for quality of life at home (Fernandez-Ballesteros et al., [2010](#)). However, there are attempts to develop definitions and concepts of ageing well at home for older people as to "facilitate older people in living independently longer and support their active involvement and contribution to society. Such conditions also have the potential to reduce health risks and consequently lead to lower costs of healthcare for elderly" (Abdelmonem and Krawczyk, [2013](#), p. 1).

As we emerge from the COVID-19 pandemic, most of these functions were facilitated by technology using mobile technologies, online applications and e-services from all types of trades: banking, grocery, care and shopping. Hence, quality of life for the near future will be reviewed and assessed differently and with technology and smart system at the centre. Yet, human aspects and sense of identity, privacy and control will remain paramount. For the majority of people, the house they reside in is their "home", an environmental space, threaded with memories and meaning, informing and informed by the identity of the resident. This is especially true for older people, where the home is a symbol of their independence. The proportion of time spent in the home also increases as a person ages, reinforcing its importance as a place of comfort and security to the resident. The links between the home and smart technologies are well established in contemporary everyday life. Such is the importance of the environment, that there are a variety of quality assessments solely focused on the relationship between it and the individual.

There are multiple and contrasting feelings about the predominance of smart technologies at home. These require consideration of many other elements and we must understand the psychological and social implications of the measures adopted, whether they are based on design or technology. There are some important psychological and social implications of housing design and smart homes for supporting ageing in place. However, these issues are not discrete. For example, there is no formal ethical framework for assistive technologies (Tiwari et al., [2010](#)), but there are guidelines and conditions for the successful and ethical development of smart home models. Some studies highlighted the need for user freedom of choice to be respected, as well as their autonomy and privacy. Self-awareness and self-perception of the user's own needs have been shown to affect the way they feel towards assistive technology, increasing the likelihood that they will use technology once they recognise the utility and effectiveness of the proposed device. Older people may recognise the utility of a technology, but may not feel that it could assist them specifically.

Identifying the needs of older people is vital to the successful development of smart homes. However, it is also vital to remember that these needs can vary greatly for each individual. Whether as a result of their physical or cognitive capabilities, their living situation or their personal preferences, each person's needs, and the hierarchy of needs, will vary greatly. For solutions in housing design and ICT to address the "constellation

of needs” of older people, they must be flexible and capable of adapting to their preferences and unique situations. If the solution is not able to adapt to the preferences of the user, it risks being abandoned due to frustration, rather than increasing the quality of life of the user. Flexible spaces, homes with moveable interior walls that can be altered to adapt to the needs of the resident, are also in development. Likewise, when developing spaces to support ageing at home, we must recognise that the needs of specific users will likely change over time. Our interviewees embraced the principle of designing for all, with the recognition that we are all ageing, where the space or the device can change, alongside the individual.

Both ICT and smart home systems have advantages and drawbacks that must be fully understood when attempting to support ageing in place. ICT should not be deployed purely as a wish to find a technological solution, but instead considered alongside other potential solutions to the needs of the older person. People project themselves into their home. Items on the mantelpiece, pictures on the wall, and even the colour of the walls in many cases are representative of the residents’ identity and artefacts of their history. The house is not a new technology, and the goal should not be to present a radical, entirely new concept of a house, but to address individual user needs in a manner that is respectful of tradition and cultural understanding of the home.

Although the design and development of smart homes present numerous engineering challenges, smart houses are more flexible than a device, a technology or a service. Comfort is also an important need to address in the successful development of SHT. Comfort can be provided in numerous ways. In part it is achieved through the successful provision of other needs – the actual security, safety and control benefits – perceived by the users so that they feel the technology is of real benefit to them, simultaneously increasing its acceptability. Understanding how the technology functions or what data the sensors are collecting is important for users to feel comfortable in their homes. Feeling at home is a key ethical issue with regard to smart homes and, hence, devices and services should be conceived and adapted to the specific forms in which a person, a family or a whole society conceives the freedom to reveal and conceal themselves so that they can decide who they are or want to be. As SHT are ever increasingly present in our daily lives, their impact, positive and negative, will continue to evolve. While we need to embrace the positive opportunities and increased capacity technology offers to our quality of life and our abilities to attend to more needs with lesser resources, it is also critical to acknowledge that in the process, technology changes and alters our behavioural patterns and attitudes.

Notes

[1](#)Some of the interviews were recorded as part of an unpublished research work at Queen’s University Belfast, by Lisa Jennings and Ela Krawczyk, who conducted first-hand interviews and coding, under the author’s supervision in two research projects between 2012 and 2014. Those were gathered at different timescales and as part of different research projects. The collation and analysis of data and generated findings, however, remain the sole work of the author.[2](#)For all interviews used in this research,

participants have been anonymised, and all interviews have been coded: RW refers to the interview of a participant living with assistive technology; RWO refers to the interview of a participant living without assistive technology. The number refers to the interview code: RW1 here refers to the Interview of participant No.1 who was living with assistive technology.3RW02 (refers to interview individual No. 2 who does not live with assisted technology).

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