TOWARDS DIGITAL INCLUSION IN EUROPE: DESIGNING A COURSE ON SMART HOME TECHNOLOGY FOR OLDER ADULTS

Dr Alfredo Salomão Filho (corresponding author)
alfredo.salomaofilho3@mail.dcu.ie
Institute of Education, Dublin City University, 9, Drumcondra, Dublin, Ireland

Dr Trudy Corrigan
trudy.corrigan@dcu.ie
Institute of Education, Dublin City University, 9, Drumcondra, Dublin, Ireland

Dr Tanja Tillmanns
tillmanns.tanja@fh-swf.de
Department of Electrical Engineering, South Westphalia University of Applied Sciences, Lübecker Ring 2, 59494 Soest, Germany

ABSTRACT
An ageing population and an increasing life expectancy in the European continent – together with the current technological turn, favours the exploration of smart home technology and its potential to promote digital inclusion of older adults. The research draws on a European Union (EU) Erasmus + project conducted by five partner organisations from Germany, Ireland, Spain, Italy, and Romania. The study is threefold. It starts by investigating the perspectives of older adults on smart home technology and continues by assessing participants' learning preferences in relation to smart home technology. Given the Erasmus + project's overall aim to design a course on smart home technology for older adults, the study then discusses design elements to be considered when assembling a course with this purpose. The analytical framework consisted of multiple descriptive case studies generated by a survey and a focus group held in each one of the partner countries, summing 215 participants. Results indicate openness of participants towards smart home technology, despite their small familiarity with it. Data security and home security appeared as the main concern and benefit, respectively. Older adults require tailored, supportive learning experiences that address their needs and provide a space to experiment with technology.
Keywords: digital inclusion, digital skills, lifelong learning, digitalisation, smart home technology

1. Introduction

 Population ageing is coming into being as a substantial societal change (UN, 2017; WHO, 2018), especially within the European context. An increasing interest in the development of innovations through Internet of Things (IoT) systems, such as advancements in health care and engineering, have directly contributed not only to the extension of one's life expectancy, but also to a greater quality of life in these newly *added* years. While digital technologies, in a broad spectrum, offer an immense potential for increased quality of life in older age, the reality in Europe is that currently the majority of older adults are not digitally literate and/or are neither motivated nor interested in participating in the digital revolution (Friemel, 2016; Wilson, Hargreaves & Hauxwell-Baldin, 2015; 2017). Besides several e-inclusion policies, such as the digital inclusion for a better European society policy (Sovacool & Fursyzfer Del Rio, 2020), efforts from educational initiatives are required to empower citizens, especially older adults, through their embracement of technological developments.

This research is born out of a concern with the in/exclusion and (dis)empowerment and (in)equality that emerge from the rapid advancement of the digitisation of societies (Fuchs, 2015). We understand digitalisation, as defined by Kania-Lundholm & Torres (2018), as a process, not only of transition from analogue to digital, but of social transformations that this transition is bringing about. In the case of smart homes, the very concept of home is put into perspective (Sovacool & Fursyzfer Del Rio, 2020). It is our understanding that smart home technology acts a promising link between older adults and technology – where digital inclusion is seen as an effect of such link, as older adults see potential benefits in learning about, and using, smart home technology.

We draw on data generated by a European Union (EU) Erasmus + project entitled "SmartYourHome: how to make seniors' homes smarter" on digital, and lifelong, learning. Each one of the five partner organisations from the five participating countries (Germany, Ireland, Spain, Italy, and Romania) held a survey and a focus group with a sample of 215 participants in total. Description as a frame of analysis guided the design of one case study of each national context. The exploratory study is guided by three objectives. Firstly, we explore the current perspectives of older adults on smart home technology in Europe, mapping potential benefits and concerns in interacting with smart home technology in each national context. Secondly, we investigate how older adults would like to learn about smart home technology. Thirdly, we discuss – based on the elucidation of the previous objectives, some design elements of a course on smart home technology, dialoguing with the possibilities of these *new* technologies to act as promoters of 21st abilities and digital inclusion of older adults in Europe.

The article commences with the presentation of the concept of smart home technology, followed by a brief discussion on the benefits and challenges of smart home technology use by older adults – as well as their engagement in learning about technology. Furthermore, the employed methodology, methods, and analytical framework are explained. The article follows by presenting the five descriptive case studies and an analytical piece illuminating what elements can be considered to design a course on smart home technology for older adults. Lastly, the conclusion is drawn from this exploratory study.

2. Smart home: definition, benefits, challenges, and engaging older adults in learning about technology

Population ageing is a phenomenon with full capillarity: it affects us all, changing the way we perform our daily lives and moving us towards new, or newly reshaped spaces, such as the consideration of digital technologies in healthcare, retirement, housing, and mobility (Tse, Choi & Leung, 2008). It is within some of these spaces that smart home technologies and their "eldercare capabilities" (Kelly, McLoone & Dishongh, 2009) are acquiring more relevance, consolidating as an object of study, and bringing professionals of the most diverse areas of knowledge together to think of, and about, innovative technological solutions to smart living. Analysing the infrastructure requirements for the installation of smart homes, Kelly et al. (2009) contemplate that these technologies will soon be integrated into the design of future houses: "it is a question of "when" rather than "if"" (p.221). In this study, our primary concern focuses on the potential brought by smart homes to engage older adults in technology (and learning about technology), hence fostering digital inclusion.

2.1 What is a smart home?

Drawing on Chan, Esteve, Escriba, & Campo (2008), Balta-Ozkan, Davidson, Bicket & Whitmarsh (2013, p.364) define smart home as "a residence equipped with a high-tech network, linking sensors and domestic devices, appliances, and features that can be remotely monitored, accessed or controlled, providing services that respond to the needs of its inhabitants". Smart home technology is usually applied to security (cameras, locks), entertainment (television, voice assistants), energy efficiency (through optimal electricity consumption), comfort (windows and blinds managed automatically) and health support (devices that monitor the health conditions of the user, allowing information to be shared with doctors and/or family members). The distinction of smart home "device" and "service" is beneficial under the smart home thematic. Balta-Ozkan et al. (2013) classify "smart home services" as the benefits "smart home devices" offer to users. What differentiates smart home from "simply high tech-equipped residence (…) is the network, through which each of the technological components and information about them is connected and coordinated" (ibid p.364). IoT is an emerging paradigm, connecting objects or *things*, such as smart home devices, to each other, to the internet, and to users (Ali & Awad, 2018). Sovacool & Fursyzfer Del Rio (2020) concluded that moving beyond analogue home requires engagement with multiple levels of "smartness". They defined the various levels of smartness within smart home technologies, as summarised in Table 1 below.

Level title	Level description
Level 0 – Basic	The basic analogue home without any smart home technology
Level 1 – Isolated	A home with some isolated smart technologies (e.g. baby monitor or TV)
Level 2 – Bundled	Smart technologies become bundled and programmable (e.g. heat and appliances)
Level 3 – Automated	Smart home technologies become programmable, more automated and anticipatory
Level 4 – Intuitive	Systems integrate to learn, modify, and adapt provision of many services
Level 5 – Sentient	Systems fully integrate and automate to meet all predicted needs
Level 6 – Aggregation	Intuitive or Sentient smart homes become interconnected into

neighbourhoods, cities, and states

Table 1. Levels of smartness with smart home technologies (adapted from Sovacool & Fursyzfer Del Rio, 2020, p. 7).

2.2 The benefits and challenges of smart home technology use

The engagement with smart homes is prioritised in EU policies towards a digitally inclusive society as well as in relation to strategic energy planning, climate change, sustainable architecture, and building construction management (Sovacool & Furszyfer Del Rio, 2020; EC, 2015; Wilson et al. 2017). In the context of older adults, smart home technology offers a possibility to enhance home care. It enables users to become more independent, positively contributing to their health and well-being. Smart environments may also prevent social isolation, as residences can share the user's data with others, such as in a health emergency. There is a consensus on the relationship between smart home technology use and quality of life improvement (Chan, Campo, Estève & Fourniols, 2009; Flores-Martin, Pérez-Vereda, Berrocal, Canal, & Murillo, 2019; Kelly et al. 2009; Laver, George, Ratcliffe & Crotty, 2011).

Yet, through the analysis of expert views and public attitudes, Balta-Ozkan et al. (2013) explored social barriers to the adoption of smart homes. They concluded that the main barriers are control (over systems and devices), security (data and home), and cost (acquisition and maintenance). Older adults lack engagement with technological advancements and tend to have data security and privacy concerns (Sovacool & Furszyfer Del Rio, 2020; Wilson et al. 2015). As progressively more data is collected by, and exchanged among, IoT objects, issues of confidentiality, authenticity, and integrity preoccupy users (Ali & Awad, 2018).

2.3 Engaging older adults in learning about technology

Wilson et al. (2017) conducted a content analysis of smart home technology marketing material and concluded that the industry is not investing in building consumer confidence. Marketing experts perceive education as vital in helping consumers to be ready for interconnected homes (Twice, 2019). Similarly, González-Oñate, Fanjul-Peyró, & Cabezuelo-Lorenzo (2015) examined the preparedness and interest of the European ageing society to deal with new technologies. Using a survey in UK, Spain, and France, the study concluded that older adults can adapt to new technologies through Information and Communications Technology (ICT) education and training. This implies the responsibility education has to equip older adults with digital skills, therefore enabling digital inclusion.

Mooij, Steffens & Andrade (2014) exemplifies three different models of ICT–based learning, ranging from "traditional" via "more flexible" to "optimal" learning. Chaffin & Harlow (2005) also conceptualised a model demonstrating the learning process of older adults to acquire computer skills. They emphasise that the key interests of the learner should be identified, followed by thoughtful preparation of the material by the educator, which in turn would result in student motivation (Chaffin & Harlow, 2005). Advancing on Davis' (1985; 1989; 1993) Technology Acceptance Model (TAM), Dogruel, Joeckel & Bowman (2015) developed an "expanded Technological Acceptance Model" (eTAM) for older adults that considers other variables apart from the perceived ease of use (PEOU) and perceived usefulness (PU) as the original TAM framework suggests. Additional predictor variables for older adults are: system use (such as technophobia) self-efficacy, previous experience, and expertise with media technology. Their conclusions suggest that older adults can learn to use and enjoy technology only if they feel they can handle it. The next section discusses the methodological steps of the study.

3. The Study

3.1 Context and Purpose

This exploratory study draws on an EU Erasmus + project entitled "SmartYourHome: how to make seniors' homes smarter" – executed by a research consortium formed by five partner organisations from five countries: Germany, Ireland, Spain, Italy, and Romania. The focus of the investigation is threefold. *First*, we explore the current perspectives of older adults on smart home technology, mapping potential benefits from, and challenges in, interacting with smart home technology in each national context. *Second*, we investigate how older adults would like to learn about smart home technology. *Third*, based on the previous investigative efforts, we discuss the design elements of a timely course on smart home technology, a task envisaged to be conducted posteriorly by the *SmartYourHome* research consortium. In what follows, we discuss *case study* as the selected methodology, followed by the appraisal of the research methods used: *survey* and *focus group*.

3.2 Methodological & Analytical Framework: Multiple, Descriptive Case Studies

Case studies are largely used in qualitative inquiry, being defined in multiple ways (Blatter, 2008). They allow the researcher to focus on a case of interest, its context, and its complexity (Mabry, 2008). Whether a bounded system (Stake, 2005), a research strategy (Hartley, 2004), or an empirical investigation (Mabry 2008), case studies are usually rich in data (ibid). The methodology employed in this study consists of multiple qualitative case studies (Yin, 2018). The data generated by the surveys and focus groups informed the writing up of a descriptive case study of each of the five participating countries in the project. Axiologically, a more objective perspective was applied to report and explanate the meanings, experiences, and the reality of research participants.

A multiple case study methodology may consist of multiple individual cases, that once assembled, provide an overview of a broader context. The data generated for the study was analysed in light of Wolcott's (1994) elaboration of *progressive focusing:* a tool to "reveal" a descriptive account. Progressive focusing refers to the act of "zooming": *in* and *out*. We zoom *in* five different national contexts in all their particularities, as well as zooming *out* to elucidate our object of study more broadly. Considering the explorative nature of the research and following Wolcott's (1994) elaborations, the focus on description as a way to transform qualitative data is warranted by the treatment of descriptive data as facts that "speak for themselves" (Wolcott, 1994, p.10), which is facilitated by the establishment of pre-determined themes prior to data generation. As description and analysis are not mutually exclusive, we debate on the possibilities to design a course on smart home technology for older adults having the content previously displayed of the descriptive data (case studies) as an analytical guide. Figure 1 below shows the analytical framework of the study.
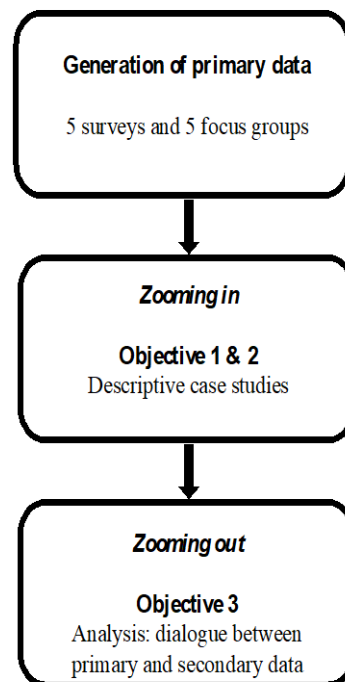

Figure 1. Analytical Framework of the study (designed by the authors).

The descriptive case studies followed a structure based on pre-determined themes, as follows:

Objective 1: investigate the perspectives of older adults on smart home technology

- Country's Context (demographics and internet use)
- Self-assessment on digital skills
- Current knowledge of smart home technology
- Imagined benefits emerging from the use of smart home technology
- Concerns associated with the use of smart home technology

Objective 2: investigate the perspectives of older adults on learning about smart home technology

- Learning preferences on smart home technology
- Amount of weekly time one would invest in smart home technology learning
- Interest to become an e-tutor of a course on smart home technology

Posteriorly to the case studies (zooming in), we focus on answering *Objective 3* of the study (zooming out): establishing a dialogue on the possibilities of designing a course on smart home technology for older adults.

3.3 Methods & Sample

This study made use of surveys and focus groups that inform each of the five descriptive case studies. A set of triangulation strategies, such as utilising different data sources and methods, were implemented in order to enhance the study's robustness and trustworthiness (Flick, 2002). We, the authors, remained objective and transparent during the conduction of the research, albeit aware that both researchers and participants are inevitably influenced by the subjective, multi-faceted qualitative research process itself.

First, each partner country conducted a *survey* – a total of 5 surveys with 176 participants: Ireland (n=20), Germany (n=24), Italy (n=29), Spain (n=80), and Romania (n=23), noting that Spanish participants constituted almost half of the survey sample. Posteriorly, each partner country held a *focus group*: a total of 5 focus groups with 39 participants: Ireland (n=11), Germany (n=7) Italy (n=9), Spain (n=8), Romania (n=4). Considering both research methods employed, a total of 215 older adults participated in the study. This research obtained approval from Dublin City University's ethics committee, being conducted in light of its ethical research guidelines in force. In what follows, we describe the specificities of the research process within the scope of each of the research methods employed.

Following the World's Health Organization fluid understanding of ageing, where "decrease in physical and mental capacity" would not necessarily imply linearity (WHO, 2018), we considered people over the age of 40 (regardless of their level of digital skills) as suitable survey participants. 67% of survey participants were over 60 years old. Table 2 shows the age range of the survey participants from each country.

Age range	Germany	Romania	Spain	Italy	Ireland	Total
40–50	1	1	4	1	4	11
51–60	13	13	6	3	10	45
61–70	8	7	37	11	3	66
71– 80	1	2	30	13	3	49
81–90			3			3
Undisclosed	1			1		2
Total of Participants	24	23	80	29	20	176

Table 2. Age Range of Survey Participants.

We recruited participants via convenience sampling, which allowed us to explore the potential of our networks of acquaintances. Members of the education and training community, including former university students as well as members of social organisations for older adults were invited via email to take part in the study. The application of snowballing sampling techniques complemented the recruitment phase (Waters, 2015).

The survey was carried through SurveyMonkey. The survey questionnaire covered the following areas: demographics, level of digital skills, current knowledge on smart home technology, expected benefits of the technology, and concerns in relation to the use of the technology. The questionnaire also assessed the preferred method of learning about smart homes, the amount of weekly time one would invest in learning, and the interest to act as an e-tutor for the course on smart home technology to be designed by the *SmartYourHome* research consortium in the near future.

Subsequently to the survey, all 5 partner countries held a focus group of approximately 1–hour duration. Similar to the survey procedures, focus group participants were recruited by convenience and snowballing sampling. Table 3 displays the information about the age range of focus group participants in each partner country.

	Germany	Romania	Spain	Italy	Ireland	Total
Number of Participants	7	4	8	9	11	39
Participants' Age Range	60–80	50–60	60–80	51–75	60–80	

Table 3. Age range of focus group participants.

A semi-structured guide was applied to the focus groups, where the focal point of the investigation did not differ to the survey. However, given the discursive nature of focus groups – or "collective conversations" (Kamberelis & Dimitriadis, 2005, p.887) – participants had the opportunity to elaborate further in emerging themes, voicing their opinions and concerns on smart home technology more comprehensively.

Although the research consciously adopted an exploratory stance, aiming at executing a two-phased mapping of a thus far incipiently explored terrain, the number of recruited participants appears as a limitation of the study if one considers issues of representativeness and generalisability. We display the five case studies in the next section.

4. Zooming in: descriptive case studies

This section presents the descriptive case studies on smart home technology in Germany, Ireland, Spain, Italy, and Romania, as follows.

4.1 Germany

With a population over 80 million people, 38.73 % of Germans are over 55 years old with a life expectancy of 81,1 years (CIA, 2020). 48% of 55-74 years-old individuals have basic or above basic overall digital skills (Eurostat, 2020).

Overall, German participants of this study were familiar with basic technology. 75% of survey participants (n=24) consider themselves as an advanced or expert user, while all focus group participants (n=7) use computers and smartphones on a daily basis with no help required. Assessing the survey sample's current knowledge of smart home technology, 66% know what smart home means and 21% have used a smart device. In the focus group, all participants were familiar with at least one smart home device (cameras and/or voice assistants).

Answering to an open question, survey participants pointed out the following expected benefits from smart home technology:

- Home security (15 participants)
- Living in one's own home for longer in old age (10 participants)
- Simpler, cheaper life (9 participants)
- Comfort (4 participants),
- Energy saving (3 participants)
- Control /automation of processes (2 participants)

From the survey results, security and a self-determined life in older age were elected as the most important positive factors of such technology, which was also confirmed in the focus group. In addition, focus group

participants discussed health related benefits of smart home technology, such as recognition of accidents, recognition of unusual behaviour, and health-monitoring. Besides home security, health benefits were pointed out as the most valuable aspects of smart home technology, followed by comfort, and energy saving. Focus group participants also pointed out that devices should be designed in a way that allows older adults to use them independently, perceiving smart home appliances as helpful in their daily lives.

In the form of an open survey question, the mentioned concerns in relation to smart home technology are, as follows:

- Data protection (13 participants)
- User-friendliness (10 participants)
- Lack of reliability of technical component or power failure (7 participants)
- Trust (6 participants)
- Costs (5 participants)

For the survey participants, data protection and ease of use of smart home technology are pointed out as the biggest concerns. This was also echoed in the focus group. Topics of hacking and data protection emerged under the broader discussion of concerns over smart home technology. Participants reminded on different hacking scandals reported by the media and wondered if it was even possible to protect such appliances in a way that no one else could access them. All focus group participants agreed that there is a wide range of smart home appliances, but there remains a concern on the kinds of devices and services that will solidly facilitate daily life in the future. Yet, according to the participants, not all appliances are as useful as they might seem at first glance.

As to learning about smart home technology and with the six below alternatives provided, survey participants could select more than one alternative in this question. They would prefer a blended delivery mode to learning: a combination of several analogue and digital elements.

- Intergenerational learning (2 participants)
- Video (2 participants)
- Textbook (6 participants)
- Face-to-face/in-group learning (7 participants)
- Online courses (6 participants)
- A mix of all of the above (14 participants)

Over two thirds of the survey participants would prefer to spend between 1-4 hours per week learning about smart home technology. The focus group discussion illuminated an interest from the participants to know more about data protection and to understand how smart-home technology works – and why it is possible to be hacked.

German older adults have an interest and openness towards smart home technology which is also represented by the fact that more than half of survey participants (54.5%) are willing to become an e-tutor for a course about smart home technology. Overall, German older adults would find smart home technology helpful if it is simple, understandable, and safe.

4.2 Ireland

Ireland has more than 5 million inhabitants with 24,59% of the population over 55 years and a life expectancy at birth of 81,2 years (CIA, 2020). 29% of 55-74 years-old individuals have basic or above basic overall digital skills (Eurostat, 2020).

Survey participants (n=20) were familiar with basic technology with 80% considering themselves as an advanced or expert user. Focus group participants (n=11) use computers and smartphones on a daily basis. When asked whether they would need any particular help with the use of technological devices, focus group participants stated that overall no assistance would be needed but they would eventually obtain help from their "kids". 70% of survey participants know what smart home means and 20% have used a smart device. Only a minority (n=2) of focus group participants make use of some smart home devices, such as voice assistants. Survey participants were asked to state the areas where smart home technology could bring benefits, as follows:

- Home security (7 participants)
- Lower energy costs (5 participants)

- Increased communication for those who may be isolated (2 participants)
- Convenience (2 participants)
- Better time utilisation (1 participant)
- Ease of access to services (1 participant)
- A longer and less stressful life (1 participant)
- Health care (1 participant)

In the focus group, the discussion on the benefits focused on control over personal environment, flexibility, and energy efficiency. Other main factors that would motivate one to make one's home smarter are security, comfort and independent living. Those benefits were associated with the use of smart devices, such as doorbells, lights, alarm systems, and cameras. One participant concluded that: "security brings comfort; and security is an issue for everybody, not only for the elderly". Despite their initial lack of familiarity with smart home concepts, participants were progressively developing their perspectives on this technology and the possibilities it brings to its users. As one participant puts it: "(…) smart homes…it's way over my head, but it's not too bad".

In the Irish survey, the main concerns in relation to smart home technology are, as follows:

- Data security (5 participants)
- Savings (3 participants)
- Preoccupation with installation and maintenance costs (2 participants)
- Trust (2 participants)
- Overdependence on technology (2 participants)
- Usability (2 participants)
- Low digital skills (2 participants)
- Stress (1 participant)

As in the survey, focus group participants were mainly concerned with their privacy and data security, including fear of hacking and data protection issues. One participant referred to "Alexa", raising concerns whether the device collects information without users' awareness. Preoccupations with installation and maintenance costs of smart home devices were also mentioned. One focus group participant highlighted his lack of trust in technology: "(…) the other day I was in the middle of nowhere and my car keys didn't work because of the battery, and there is no place to turn the car on…this is technology that backfires".

The majority of survey participants would prefer to learn about smart home technology via blended delivery mode, as follows:

- Textbook: (0 participant)
- Face-to-face/in-group learning (1 participant)
- Intergenerational learning (1 participant)
- Video format (2 participants)
- Online courses (5 participants)
- A mix of all of the above (10 participants)

In terms of the number of weekly hours dedicated to learning about smart homes, more than three quarters of the participants would be willing to dedicate 1-4 hours. Over 75% of survey participants were interested to becoming an e-tutor in a future *SmartYourHome* course.

Overall, Irish respondents "find the idea [of smart home technology] a little scary", and simultaneously described it as "progressive and beneficial" and "the way forward for our future". As one survey participant writes, "poor digital literacy, however, may hinder or limit the take-up of this initiative".

4.3 Spain

Spain's population is over 50 million people, of which 31,48 % are over 55 years old with an average life expectancy at birth of 82 years (CIA, 2020). 31% of 55-74 years-old individuals have basic or above basic overall digital skills (Eurostat, 2020).

The survey sample (n=80) was divided in terms of self-assessment of their digital skills. 65% of participants considered themselves as "beginners" and 31.2% as "advanced". All participants (survey and focus group) have

experience with smartphone and computer use. The focus group (n=8) revealed that older adults use smartphones on a daily basis and most of them use a computer regularly. Assessing the survey's sample current knowledge of smart home technology, 55% of survey participants know what smart home means and 14% have used a smart device.

Participants are confident with messaging and social network use, which they regularly do, and to that which they are taught, normally by a son or daughter. However, all focus group participants emphasised caution when using either the internet or apps, being careful with the websites they access. Most participants stated that technology is a relatively recent phenomenon: "it was not part of our professional lives, and it got us too old to learn efficiently".

The most mentioned expected benefits of smart home technology in Spain are, as follows:

- Home security (22 participants)
- Assistance (19 participants)
- Energy cost savings (16 participants)
- Comfort (6 participants)
- Home entertainment (3 participants)
- Quality of life (3 participants)
- Connectivity with others (2 participants)

Those expected benefits were also evident in the focus group. Besides enhancing home security, Spanish participants noted that smart home technology could prolong their life at home, as it reduces "tedious housework", and increases mobility and safety at home. Focus group participants also discussed the aspect of energy consumption and how smart home technologies could lessen the human impact on the environment.

Most survey participants are most concerned with cost, usability, and data security, as exposed below:

- Cost (31 participants)
- Complexity of the technology (27 participants)
- Data security (21 participants)
- Overdependence on technology (3 participants)
- Reliability (2 participants)

In the beginning of the discussion, focus group participants were unsure whether they could need a smart home and could not imagine how it would help to improve their lives in terms of safety and care. Although privacy was raised as a major concern, a few participants would feel comfortable with the technology as long as the service provider assured them it is safe. Another main concern mentioned refers to the price of smart home technology as too high. During the focus group, all participants claimed that technology is not so easy to learn and "can get too complicated if you want to do anything more than a few basic things". Participants agreed that "old technology is more reliable and easier to use than new one". Ultimately, as the conversation progressed, most participants expressed willingness to engage with smart home services if the benefits were clear to them and if their data was secure.

Survey participants indicated their preference to learn about smart home technology through face-to-face encounters, as follows:

- Textbook (no participant)
- Video format (no participant)
- Online courses (10 participants)
- Intergenerational learning (10 participants)
- Face-to-face/in-group learning (49 participants)
- Mix of all of the above: (30 participants)

Over 80% of Spanish survey participants indicated they would like to spend between 1-4 hours per week learning about smart home technology. Spanish participants are sceptical but openness towards learning about smart home technology also occurred: 18.75% of survey participants expressed their interest in becoming an e-tutor for the *SmartYourHome* course.

4.4 Italy

Italy has more than 62 million citizens of which 36.08% are over 55 years with a life expectancy at birth of 82.5 years (CIA, 2020). 23% of 55-74 years-old individuals have basic or above basic overall digital skills (Eurostat, 2020).

More than 75% of survey participants (n= 29) were at a beginner level of digital skills. All focus group participants (n=9) owned a mobile phone and had a computer at home. Focus group participants stated that they use phones more frequently than the computer. Albeit the need for assistance is rare, they eventually ask "younger family members or friends for support". Referring more specifically to smart home technology, 65,5% of survey participants know what smart home means and 6,9% have used a smart home device. These results are also mirrored in the focus group. The majority of participants were not familiar with smart home technology. One participant knew Google Home and Alexa, which when mentioned, was then considered as "convenient to have" by the other participants.

The majority of survey participants expected smart home technology to be beneficial within the following areas:

- Home security (22 participants)
- Comfortable living (14 participants)
- Easy day-to-day support (14 participants)
- Simplification of life (2 participants)
- Entertainment (2 participants)

Those benefits were also discussed in the focus group, suggesting that security and independence at home are expected from smart home technology use. Overall, focus group participants showed interest in smart home devices, displaying willingness to install them in their homes at some point if convenient. A few participants highlighted the comfort and safety deriving from automation and distant controlling devices of doors, windows and gates in their homes One participant was "enthusiastic to own those devices but the setup and installation needed to be done by a technician or a more IT skilled person, maybe a family member or friend".

Survey participants raised concern over the following aspects in relation to smart home technology:

- Cost of acquisition (29 participants)
- Data security (29 participants)
- Usability (2 participants)

As to the focus group, participants showed that lack of digital skills was their main concern. Several participants stated that they would not be able to use the devices correctly due to their lack of technological knowledge. Moreover, a discussion over losing autonomy given technological developments was held in the focus group: As one participant puts it: "I'm afraid of losing autonomy and ability to do things (…) and to become too dependent on the important support and help provided by the home once it was made smart".

The survey suggests that participants preferred to learn about smart home technology from online courses, as follows:

- Face-to-face / in group learning (no participant)
- Intergenerational learning (4 participants)
- Video (5 participants)
- Textbook (12 participants)
- Online courses (18 participants)
- A mix of all above (no participant)

As to future engagement with the technology, 70% of survey participants would be willing to invest 1-4 hours per week learning about smart home technology. Overall, focus group participants were curious to get more knowledgeable about smart home technology towards the end of the session. They expressed an interest in learning "how to use the devices". This curiosity and openness to learning was also reflected in 70% of survey participants being interested to become an e-tutor in future *SmartYourHome* initiatives.

4.5 Romania

Romania has more than 21 million citizens. 29,31 % are over 55 with a life expectancy at birth of 76 years (CIA, 2020). 13% of 55-74 years-old individuals have basic or above basic overall digital skills (Eurostat, 2020).

77% of survey participants (n=23) assess themselves as beginners regarding their level of digital skills, where 41% of participants know what smart home means, and 9% have used smart home products. All focus group participants (n=9) confirmed to have wireless internet in their home, using it daily. The majority however had never heard of the term smart home. One participant had an idea what a smart home could be as he had used "smart home products".

The most mentioned expected benefits of smart home technology in the Romanian survey are, as follows:

- Home security (10 participants)
- Health assistance (independent life) (8 participants)
- Energy cost savings (5 participants)
- More free time (1 participant)

These benefits were also discussed in the focus group, suggesting that security and independence at home are the expected benefits of this technology for the participants. All participants highlighted independence as an important aspect of their lives, where smart home devices may be "useful" for such purpose.

The concerns emerging from the use of smart home technology extracted from the Romanian survey results are, as follows:

- Costs (11 participants)
- Utility (9 participants)
- Trust and confidentiality (3 participants)

The discussion of concerns during the focus group in Romania resulted in an increased curiosity from the participants in smart home technology. Rather than pointing out possible concerns from the use of these technologies given their unfamiliarity with the subject, participants raised a few questions, such as: "how complicated is to use the devices? How much do they cost? Do I have to pay monthly instalments or only at the moment of purchase? Where are such devices available for sale?".

The survey shows that older Romanians preferred "face-to-face/in group learning" in relation to the learning approach to smart home technology, as follows:

- Textbook (1 participant)
- Video (1 participant)
- Intergenerational learning (4 participants)
- Online courses (6 participants)
- Face-to-face/in group learning (9 participants)
- A mix of all of the above (4 participants)

When the discussion of learning preferences was brought to the focus group, participants agreed that "it is easier to understand the content when attending a face to face meeting, rather than watching videos or attending online courses". The explanation for preferring this method lies in their lack of comprehension of "these modern terms that are used nowadays", which would require clarification. As one participant exemplifies: "I will buy a new device and it will remain unopened until one of my children will have time to help install it". 72% of the survey sample would like to invest 1-4 hours per week learning about smart home devices, while 14% expressed their interest in being an e-tutor in a smart home course.

5. Zooming out: discussion

5.1 Overview of descriptive case studies

We provide Table 4 below with the key findings of all the case studies in order to facilitate the reader's visualisation of our analytical efforts to "zoom out" the data.

	Germany	Ireland	Spain	Italy	Romania
Level of digital skills	Majority are advanced/ expert users	Majority are advanced/expert users	Majority are beginners	Majority are beginners	Majority are beginners
Knowledge and experience with smart home technology	66% know what it is; 21% have used smart home technologies	70% know what it is; 20% have used smart home technologies	55% know what it is; 14% have used smart home technologies	65,5% know what it is; 6,9% have used smart home technologies	41% know what it is; 9% have used smart home technologies
Expected benefits	Home security; Living in one's own home for longer in old age; Simpler, cheaper life; Comfort; Enhanced health care	Home security; Lower energy costs; Increased communication for isolated individuals; Convenience; Better time utilisation; Ease of access to services; A longer and less stressful life; Control; Enhanced health care	Home security; Independency; Energy cost savings; Comfort; Home entertainment; Quality of life; Connectivity with others	Home security; Comfortable living; Easy day-to-day support; Simplification of life; Entertainment; Independence	Home security; Independence; Energy cost savings; More free time; Enhanced health care
Concerns	Data security; User-friendliness; Reliability; Trust; Costs	Data security; Savings; Preoccupation with installation and maintenance costs; Trust; Overdependence on technology; Usability; Low digital skills; Stress	Costs; Complexity of the technology; Data security; Overdependence on technology; Reliability	Cost of acquisition; Data security; Usability; Low digital skills; Overdependence on technology	Costs; Utility; Trust; Data security
Preferred delivery mode	Blended	Blended	Face-to-face/in-group learning	Online learning	Face-to-face/in-group learning
Preferred hours per week to learn	1-4 hours	1-4 hours	1-4 hours	1-4 hours	1-4 hours
Interest to be an e-tutor	Over half would be interested (55.4%)	Majority would be interested (75%)	Some would be interested (18.75%)	Majority would be interested (70%)	Some would be interested (14%)

Table 4. Overview of Case Studies.

One way to address digital inclusion is to increase the engagement of the European ageing society with new technologies. This study set out to explore learners' perspectives on smart home technology before designing a course for older adults on the subject. From the findings summarised in Table 4, we observe the differences in the level of digital skills and in the degree of familiarity with smart home technologies within Europe. Irish and German participants had more experience with such technologies than participants in Spain, Italy, and Romania. Participants with lack of experience with smart home technologies would also tend to have lower digital skills. In addition, countries with more participants with beginner level of digital skills prefer analogue learning methods. However, the findings of Italy demonstrate that older adults with beginner level of digital skills could also be interested in online learning, which may also be related to the fact that overall participants of this study were internet users. Participating countries with more advanced digital skills would have more participants

interested to become an e-tutor, with Italy as an exception. Overall, the findings suggest that a course should be within the range of 1-4 weekly learning hours.

For the participants across all the five nations, the main benefits of smart home technologies are a safer, more autonomous, and more independent life at home. Main concerns of participants are data security, costs of installation and maintenance, and the usability of smart home technologies. Moreover, motivational indifference (perceived uselessness) or deficient knowledge of digital advancements (Friemel, 2016) are a concern for older adults to engage with smart home technologies. For example, in Romania, participants had little prior knowledge about smart homes. Consequently, they could not draw any expected benefits from smart home technology before taking part in the research. When participants however were introduced to potential benefits of the technology in the focus group, we observed their increased interest in the subject. As indicated by Hernández-Encuentra, Pousada & Gómez-Zúniga (2009), older adults should know the function of the technological device beforehand and should be confident that the technology ensures their independence and autonomy. They point out that attitudes, experience of use, and perceived benefits should be considered when teaching digital skills to older adults.

5.2 Discussing the design of a smart home technology course for older adults

The future *SmartYourHome* course is one medium in which older adults can empower themselves, therefore participating in the digital society. The identified benefits of, and concerns about, the technology offer insights for the curriculum of a course on the subject. The main benefits suggest that a course should inform how smart home technologies can make a home safer and more autonomous, and the areas in which technological options are currently available. Here, the usability of smart home technologies should be emphasised to address the perceived uselessness (Friemel, 2016), evident across the sample. The main concerns of the participants in this study suggest that the course should also cover data security, and ways to improve deficient knowledge of digital advancements (Friemel, 2016), for example, by learning where to find news and information about maintenance and costs of smart home technology. The learning objectives of a course about smart home technology should be tailored to the adequate level of "smartness" (see Table 1 – Sovacool & Fursyzfer Del Rio, 2020) of the given cohort of older learners. The national contexts offer further guidance to identify learning outcomes, equipping older adults to move onto the next level of smartness in smart home technology.

The findings of this study and the surveyed literature suggest a few issues to consider when designing courses about smart home technologies for older adults: (1) self-efficacy; (2) past learning experience, (3) learning preferences, and (4) current ICT skills.

(1) In spite of contextual asymmetries, the lack of self-efficacy was evident in all five case studies. Self-efficacy, one's belief in their capability to perform a course of action when dealing with a given situation (Bandura, 1997), was highlighted as an important predictor of the pleasant use of ICT's (Dogruelet al., 2015). In all countries, participants emphasised "userfriendliness/usability/complexity/utility of smart home technology as a major concern. This confirms findings by Hernández-Encuentra et al (2009), noting that older adults may perceive a "lack of usefulness (of technology) in everyday life" (p.227). Several studies have related self-efficacy and use of technology, identifying challenges of technology acceptance in older adults (Laver et al. 2011; Koopman-Boyden and Reid, 2009; Morris, Goodman & Brading, 2007; Melenhorst, Rogers & Bouwhuis, 2006). Henceforth, the successful design of learning units about smart home technology, especially online, may consider the recommendations to enhance one's self-efficacy, such as mastery, modelling and encouragement (Bandura, 1997) to name a few. Vroman, Arthanat & Lysack (2015) concluded that the most practical approach will be, first, the identification of functions and features of smart home devices that suit the individual needs of older adults, followed by learning about the benefits of relevant technologies.

(2) & (3) The preferred learning delivery mode varies across the national contexts, from blended to face-to-face/in group. Designing learning experiences for older adults about the utilisation of smart home technologies requires awareness that older adults are more familiar with analogue learning, such as via books, where the learner consumes the information provided and neither change the content nor is responsible for organising the information (Castilla, Botella, Miralles, Bretón-López, Dragomir-Davis, Zaragoza et al., 2018). Mooij et al. (2014) study revealed, that "psychological differences among learners seem to be more relevant than differences among European educational conditions, cultures or countries" (p. 525). This confirms Boulton-Lewis (2010) position that older adults' preferences are subjective, which in turn suggests that courses for older adults must combine different delivery methods with analogue and digital learning elements. Ross (2010) explored the perspectives of older adults about online learning and concluded that they are open for it. Nevertheless, it must be interactive and meaningful to them, as for older adults the main drawbacks of online courses happen when

these are too intensive, the online platform is too complex, and there is no personal interaction (Ross, 2010). Pincas (2007) added that older adults require: educators who are mindful of one's learning conditions, personalised support, and a space for self-fulfilment. Similarly, Chiu, Tasi, Yang & Guo (2019) conducted a multiple case study about the teaching strategies of experienced instructors at senior learning centres in Taiwan. The instructors combined various teaching strategies for older learners, such as reversed teaching, unscripted performance, and assistance from peers. Older adults require a flexible, self-regulated yet interactive approach, where learners can revise content and have a space to ask questions, preferably to peers, in a setting that allows them to complete the learning sequences at their own pace.

(4) The five case studies show that overall older adults have access to the internet but different levels of digital skills. Most older adults in this study must still advance their digital skills before engaging with smart home technologies. The lack of trust, emphasised by participants across all the five countries, is important to consider when designing learning experience for older adults about smart home technologies. Despite constantly more emerging IoT devices, this study confirmed that ICT tend to be not very popular among older adults (Pachis and Zonneveld, 2019; Schreurs, Quan-Haase and Martin 2017). According to Castilla et al. (2018, p.25), all causes of digital exclusion are related to "the lack of the fundamental requirements", such as: hardware access and mastery of technology. Schreurs et al. (2017) point out that poor digital literacy levels and lack of availability of support are the main barriers to a greater engagement of older adults with technology. The utilisation of smart home technologies requires that users perceive the benefits and accept the potential risks (Wilson et al., 2017).

6. Conclusion

Lack of familiarity with, and little or no previous knowledge of, smart home technology do not appear as barriers for future engagement of older adults with these innovations. However, this study confirms that the lack of experience and knowledge of ICT and low self-efficacy in its use hinders the relationship between smart home technology and older adults (Czaja & Lee. 2007; Hernández-Encuentra et al. 2009; Schreurs et al. 2017). They therefore require tailored learning experiences that address their needs and provide a space to gain experience and to experiment with technology. Learners need constant personal support to emerging questions, as well as having discussions on the benefits and challenges of these technologies. Designing a smart home technology course for older adults is timely as it helps fostering digital inclusion in an every-day older Europe. As to future research, one could illuminate the perspectives of older adults on learning about smart home technology in light of the consequences brought by the coronavirus crisis, such as issues surrounding health and social distancing.

References

Ali, B., & Awad, A. I. (2018). Cyber and physical security vulnerability assessment for IoT-based smart homes. *Sensors (Switzerland)*, *18*(3), 1–18.

Balta-Ozkan, N., Davidson, R., Bicket, M., & Whitmarsh, L. (2013). Social barriers to the adoption of smart homes. *Energy Policy*, *63*, 363–374.

Bandura A. (1997). *Self-Efficacy: the exercise of control.* W.H. Freeman and Company: New York.

Blatter, J. (2008). Case studies. In Given, L. (Ed.), *The Sage encyclopaedia of qualitative research methods* (pp.68–71). London: Sage.

Boulton-Lewis, G. M. (2010). Education and learning for the elderly: why, how, what. *Educational Gerontology*, *36*(3), 213–228.

Castilla, D., Botella, C., Miralles, I., Bretón-López, J., Dragomir-Davis, A. M., 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*(May), 24–37.

Central Intelligence Agency (2020). Germany. In The world factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/gm.html Accessed 4 June 2020

Central Intelligence Agency (2020). Ireland. In The world factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/ei.html Accessed 4 June 2020

Central Intelligence Agency (2020). Italy. In The world factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/it.html Accessed 4 June 2020

Central Intelligence Agency (2020). Romania. In The world factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/ro.html Accessed 4 June 2020

Central Intelligence Agency (2020). Spain. In The world factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/sp.html Accessed 4 June 2020

Chaffin, A. J., & Harlow, S. D. (2005). Cognitive learning applied to older adult learners and technology. *Educational Gerontology*, *31*(4), 301–329.

Chan, M., Esteve, D., Escriba, C., Campo, E., (2008). A review of smart homes—present state and future challenges. *Computer Methods and Programs in Biomedicine*, *91*(1), 55–81.

Chan, M., Campo, E., Estève, D., & Fourniols, J. Y. (2009). Smart homes - current features and future perspectives. *Maturitas*, *64*(2), 90–97.

Chiu, C. J., Tasi, W. C., Yang, W. L., & Guo, J. L. (2019). How to help older adults learn new technology? Results from a multiple case research interviewing the internet technology instructors at the senior learning center. *Computers and Education*, *129*, 61–70.

Czaja, S.J., & Lee, C.C. (2007). Information technology and older adults. In J.A. Jacko & A. Sears (Eds.), *The human-computer interaction handbook* (2nd ed., pp. 777–792). New York: Erlbaum.

Davis, F. D. (1986). A technology acceptance model for empirically testing new end-user information systems: theory and results. Doctoral Dissertation, MIT Sloan School of Management.

Davis, F. D. (1989). IT usefulness and ease of use. *Technology*, (September), 319–340.

Davis F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, *38*, 475–487.

Dogruel, L., Joeckel, S., & Bowman, N. D. (2015). The use and acceptance of new media entertainment technology by elderly users: development of an expanded technology acceptance model. *Behaviour and Information Technology*, *34*(11), 1052–1063.

EC (2015). Communication from the Commission C(2015) 6317 final. Towards an integrated strategic energy technology (SET) plan: accelerating the European energy system transformation. European Commission, Brussels, Belgium, (EC). https://ec.europa.eu/energy/sites/ener/files/publication/Complete-A4-setplan.pdf Accessed 12 June 2020

Eurostat (2020). Individuals level of digital skills. https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/database Accessed 8 July 2020

Flick, U. (2002). *An introduction to qualitative research*. (2nd ed). London: Sage.

Flores-Martin, D., Pérez-Vereda, A., Berrocal, J., Canal, C., & Murillo, J. M. (2019). Interconnecting IoT devices to improve the QoL of elderly people. *Communications in Computer and Information Science*, *1016*, 83–93.

Friemel, T.N. (2016). The digital divide has grown old: determinants of a digital divide among seniors. *New Media & Society*. *18*(2), 313–331.

Fuchs, C. (2015). *Culture and economy in the age of social media*. London: Routledge.

González-Oñate, C., Fanjul-Peyró, C., & Cabezuelo-Lorenzo, F. (2015). Use, consumption and knowledge of new technologies by elderly people in France, United Kingdom and Spain. *Comunicar*, *23*(45), 19–28.

Hartley, J. (2004). Case study research. In Cassell, C. & Symon, G. (Eds.), *Essential guide to qualitative methods in organizational research* (pp. 323–333). London: Sage.

Hernández-Encuentra, E., Pousada, M., & Gómez-Zúniga, B. (2009). ICT and older people: beyond usability. *Educational Gerontology*, *35*(3), 226–245.

Kamberelis, G. & Dimitriadis, G. (2005). Focus groups: strategic articulations of pedagogy, politics and inquiry. In Denzin, N. & Lincoln, Y. (Eds.). *The Sage handbook of qualitative research* (pp.887–907). Thousand Oaks: Sage.

Kania-Lundholm, M., & Torres, S. (2018). Ideology, power and inclusion: using the critical perspective to study how older ICT users make sense of digitisation. *Media, Culture and Society*, *40*(8), 1167–1185.

Kelly, D., McLoone, S., & Dishongh, T. (2009). Enabling affordable and efficiently deployed location based smart home systems. *Technology and Health Care*. 17, 221–235

Koopman-Boyden, P., and Reid, S. (2009). Internet/email usage and well-being among 65–84 year olds in New Zealand: policy implications. *Educational Gerontology*, *35*(11), 990–1007.

Laver, K., George, S., Ratcliffe, J., & Crotty, M. (2011). Measuring technology self efficacy: reliability and construct validity of a modified computer self efficacy scale in a clinical rehabilitation setting. *Disability and Rehabilitation*, *34*(3), 220–227.

Mabry, L. (2008). Case study in social research. In Alasuutari, P., Bickman, L. & Brannen, J. (Eds.), *The Sage handbook of social research methods* (pp. 214–227). London: Sage.

Melenhorst, A. S., Rogers, W.A. and Bouwhuis, D. G. (2006). Older adults' motivated choice for technological innovation: evidence for benefit-driven selectivity. *Psychology and Aging*, *21*(1),190–195.

Mooij, T., Steffens, K., & Andrade, M. S. (2014). Self-regulated and technology-enhanced learning: a European perspective. *European Educational Research Journal*, *13*(5), 519–528.

Morris A, Goodman J, Brading H. (2007). Internet use and non-use: views of older people. *Universal Access in the Information Society*, *6*(1), 43–57.

Pachis, J. A., & Zonneveld, K. L. M. (2019). Comparison of prompting procedures to teach internet skills to older adults. *Journal of Applied Behavior Analysis*, *52*(1), 173–187.

Pincas, A. (2007). How do mature learners learn? *Quality in Ageing*, *8*(4), 28–32.

Ross, A.K. (2010). *The perspectives of older adults regarding online learning*, California State University, Long Beach.

Schreurs, K., Quan-Haase, A., & Martin, K. (2017). Problematizing the digital literacy paradox in the context of older adults' ICT use: aging, media discourse, and self-determination. *Canadian Journal of Communication*, *42*(2), 359–377.

Sovacool, B. K., & Furszyfer Del Rio, D. D. (2020). Smart home technologies in Europe: a critical review of concepts, benefits, risks and policies. *Renewable and Sustainable Energy Reviews*, *120*(May 2019), 1–20.

Stake, R. (2005). Qualitative case studies. In Denzin, N. & Lincoln, Y. (Eds.). *The Sage handbook of qualitative research* (pp.443–466). Thousand Oaks: Sage.

Tse, M. M. Y., Choi, K. C. Y., & Leung, R. S. W. (2008). E-Health for older people: the use of technology in health Promotion. *CyberPsychology & Behaviour*, *11*(4), 475–479.

Twice (2019). Are consumers ready for connected home? All signs point to … almost. https://www.twice.com/retailing/twice-ces-2019-retail-roundtable-connected-home-almost-ready Accessed 22 June 2020

UN (2017). United Nations world population ageing 2017 highlights. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf Accessed 5 May 2020

Vroman, K.G., Arthanat, S., Lysack, C., (2015). "Who over 65 is online?" Older adults' dispositions toward information communication technology. *Computers in Human Behavior*, *43*, 156–166.

Waters, J. (2015). Snowball sampling: a cautionary tale involving a study of older drug users. *International Journal of Social Research Methodology*. *18*(4), 367-–380.

WHO (2018). World Health Organization. Ageing and health. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health Accessed 5 May 2020

Wilson, C., Hargreaves, T., & Hauxwell-Baldwin, R. (2015). Smart homes and their users: a systematic analysis and key challenges. *Personal and Ubiquitous Computing*, *19*(2), 463–476.

Wilson, C., Hargreaves, T., & Hauxwell-Baldwin, R. (2017). Benefits and risks of smart home technologies. *Energy Policy*, *103*(January), 72–83.

Wolcott, H. (1994). *Transforming qualitative data: description, analysis, and interpretation*. London: Sage.

Yin, R. K. (2018). *Case study research and application: design and methods.* (6th Edition). Thousand Oaks: Sage.