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A Socioecological Approach to ICT Use by Adults over 65 and its Implication on Design

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ABSTRACT

The use of information and communication technology (ICT) by adults over 65 has been studied in the past years extensively to understand any obstacles and facilitators as well as to propose design suggestions that are specific to the group. However, these studies have mainly focused on the adult over 65 as an individual and sometimes also on their immediate social circle. The broader socio-ecological environment of adults over 65 is rarely addressed. In this paper, we present the results of a survey focusing on how highly educated seniors in a highly digitalized society use ICT. We discuss the data from a socio-ecological perspective and draw the attention to the environmental facilitators for the use of ICT in this age group. We conclude with a discussion how design research might address the needs of older adults.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

KEYWORDS

socio-ecological model, design, socio-ecological design, ICT usage

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1 INTRODUCTION

Internet and digital technology are almost as ubiquitous today as water and electricity. In highly digitalized societies, such as the

Nordic countries [12], it is now difficult to perform basic functions without the use of digital technology. Paying bills and managing money is done through apps, and appointments with health care professionals are more easily done through web sites or digital assistants than by telephone. Information and Communication Technology (ICT) plays an important role for social relations where messaging and social media are two ways people stay in contact.

Much research has dealt with studying a digital divide – i.e., people with access and people without access to digital technology (both physical access and access related to the abilities and skills of the users). Typically, this research assumes the aging population has less access to digital technology. Most studies investigating internet and older adults mainly focus on the characteristics of the individual and how these characteristics influence their computer use [9, 15, 19, 46]. These studies, which focus on the characteristics of the users (i.e., older adults), have brought a lot of knowledge to the field of Human Computer Interaction (HCI); however, the relationship between the environment and the behavior (related to the computer use) of this population is rarely discussed [46].

As more and more societies become digitalized, understanding who has access to digital technology is needed. That is, people who fall on the “wrong” side of the digital divide might not have access to important services such as healthcare and be at risk of social isolation, which can lead to health problems especially for older adults. For example, a longitudinal study of internet use among 9,199 older adults in Japan [30] found that online communication with friends and family prevented the development of clinical depression. In addition, they concluded that online communication could be a gateway into other forms of technology use. A large scale questionnaire study conducted in 2021 in Italy found a positive association between social media use and life satisfaction even after controlling for demographic, socio-economic factors, and health conditions [35]. However, these studies do not address who has access to digital services and online communities.

According to Digital Economy and Society Index [12], Italy ranks 20th among the digitalized countries in the European Union (EU). The abovementioned Italian study [35] found that Italy, a country with a large population of older adults, had relatively few social media users compared to Sweden, a country also with a large population of older adults. However, the Digital Economy and Society Index [12] ranks Sweden as third most digitalized country in the

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EU. In addition, Eurostat [13] ranks Sweden as second most digitalized country in the EU with respect to the percentage of older adults who use the internet and online services. Both countries are developed countries, but the internet use among older adults differs vastly.

In this study, we map the relationship between the behavior of 65-year-old and above (65+) adults regarding ICT use and the environment where the behavior occurs. To study this, we combined the results of our questionnaire study with the large-scale data from the national databases and discussed them in light of a five-stage socioecological model [24]. Specifically, this study has three main aims:

- To explore environmental facilitators for ICT use by 65+ adults;
- To illustrate a part of their digital communication with their social environment and family; and
- To update the field in relation to how 65+ adults learn and use technology.

We are not arguing that a digital divide does not exist in Sweden or that all Swedes over 65 years old have easy access to online services. Rather, our intention is to identify the environmental factors that motivate adults over 65 to use technology.

2 BACKGROUND

Adults over 65 years old have often been characterized as “late adopters” of technology. Their ICT use has been researched in different ways to inform the design of technology for this user group. Typically, this research focuses on the individual’s characteristics and behaviors. For example, these studies focus on education and professional background of the 65+ adults who use ICT [45], their physical and cognitive abilities, and their independence levels [15, 29].

Some studies focus on how 65+ adults use ICT (i.e., their interests) [34]. Profiling of the users based on their actions and characteristics is common albeit sometimes questionable [29]. Studies that use Technology Adoption Model (TAM), which has been used to predict or evaluate the computer use for 65+, examine how to encourage this user group to use ICT [2, 22, 43]. Education about the use of ICT and user-friendly interfaces are deemed essential for 65+ adults as well as their access to ICT [27]. However, the above-mentioned research focuses on the user and the design of interfaces as main factors that determine ICT use, often neglecting how 65+ interact with the technology in a broader environment (i.e., broader than the individuals and their social circle), ignoring the relationship between environment and behavior [46].

2.1 Approaching ITC use as a behavior

Apart from physical access to technology, the boarder environmental factors such as policy, training, and design influence the extent of digital inequalities [16]. However, only a few studies have addressed ICT use by 65+ adults in a more holistic way that includes their broader environment [46] either by referring to a specific context (e.g., everyday life) [34] or by referring to a specific country [17]. As society becomes more digitalized, the importance of immediate context and the broader environment increases because

people do not use technology in isolation; technology is interwoven in all aspects of life and influenced by policies, designs, and infrastructures [16, 40].

The HCI field has used behavior change theories and models to inform the design of technology. Several behavior change theories and models are used when designing and evaluating technology, including individual health behavior models such as the health belief model, the transtheoretical model, and the theory of planned behavior and resonated action [5, 7, 20, 21]. However, these models focus on the individual’s role in changing their behavior without discussing many of the environmental factors that can influence the behavior [24]. On the other hand, the socio-ecological models of health behavior consider the individual, the individual’s immediate circle, their context, and their broader environment as they support that focusing solely on the individual and their characteristics reaches the limits of victim blaming [24]. For example, if an individual cannot afford the technology, it cannot be said that the individual does not use technology because they lack specific skills.

The socio-ecological models or ecological models are often used in HCI to describe the situation of a patient in order to find design opportunities for technological solutions [10, 28, 42]. , Socio-ecological models or ecological models are rarely used to describe the use of ICT, with the most prevalent to be Bandura’s social cognitive theory [25]. Ecological or socio-ecological models consider how the environment affects people’s behaviors, representing the environment in different and often interconnected layers and emphasizing the relationships between the layers that influence people’s behaviors [14, 26]. Seeing technology as part of a whole is not a new idea [40]; however, when it comes to 65+ adults, the relationship between environment and behavior (i.e., ICT use) is underexplored [38, 46]. Therefore, this paper uses an ecological perspective to understand how environmental facilitators and barriers of ICT use affect 65+ adults.

2.2 Five levels of influence model

McLeroy et al. [24] present a five level system visualized as five eccentric circles (Figure 1) – the intrapersonal, the interpersonal, the institutional, the community, and the policy levels. The intrapersonal level is the level that is the most discussed by the literature studying 65+ adults and their ICT use. It includes intrapersonal factors such as their knowledge, skills, beliefs, behaviors, and attitudes. The interpersonal level is related to people in the immediate social network of the person, including family members, co-workers, and friends. The institutional level is the context of the person–i.e., the level where people are organized in different groups who follow some formal or informal rules such as schools, work, and family. The community level includes factors related to the relationships between organizations such as relationships between different schools, work environments, associations, and families. Finally, the policy level is used to indicate the applications of policies and strategies on a country level–e.g., the strategy that by a date a country would have reached a specific internet speed in its largest towns.

McLeroy et al. [24] argue that by ignoring a person’s environment, the focus shifts to the individual’s responsibility to sustain the behavior that the environment may or may not promote. In fact, they compare it with the victim blaming approach. In the context

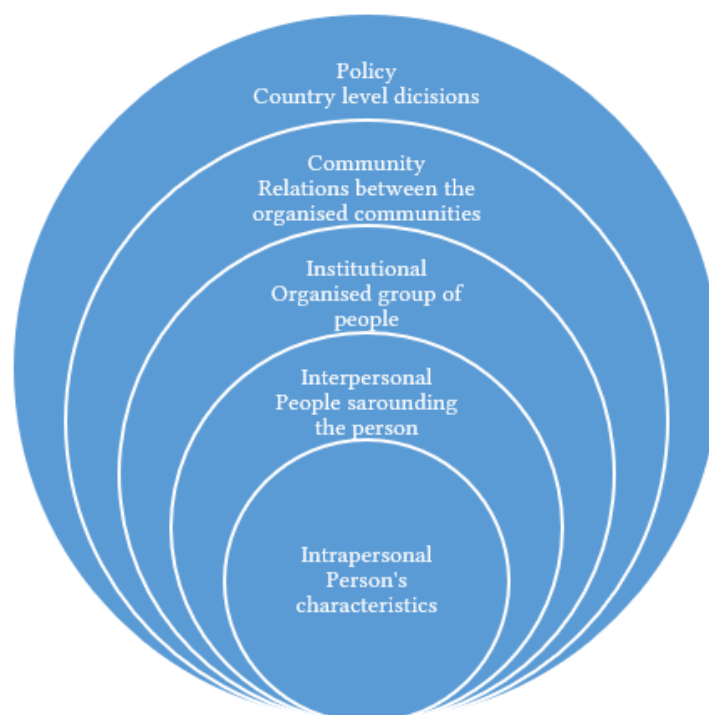


Figure 1: Five levels of the ecological model

of technology use, this means that the focus is on the individual's responsibility to use ICT. That is, if an individual does not use technology, then it is something that they must learn or deal with it. The five-level socioecological model, however, takes the focus away from the individual and places it on the ecosystem. For example, if a person living in an isolated village in Italy uses internet-based services less than a similar person living in a Swedish city, it should not be blamed holistically to their characteristics (i.e., the intrapersonal level) but should also consider the environment and the coverage of the internet each country supported (i.e., the policy level).

In this study, we explore how highly educated 65+ adults experience their use of technology in a highly digitalized society. We present the results of a questionnaire, and we discuss them in combination with the large-scale statistics from national and international databases. The approach we take in the discussion section is a socioecological approach aimed at understanding the ecological factors that influence the use of ICT by adults over 65 in this highly digitalized society. By drawing on real world data, our approach adds to the body of knowledge related to how environmental factors influence the way 65+ adults engage with ICT (i.e., their behavior) [46].

2.3 Setting of the study

This study took place in Sweden, which the European Commission characterized in 2021 as one of the most digital countries in the EU, after Denmark and Finland, with 88% of the population being e-government users [12]. Since 2001, Sweden has used e-governance

[11] and today scores higher than the EU average for public and private digital services [12]. More than 70% of Swedes aged between 66 and 75 use mobile internet daily, and more than 50% of adults over the age of 76 use mobile internet daily [39].

To understand the context of the study and the participants, it is important to describe the SeniorNet (<https://seniornet.se/>) association, which supported our research, for example, by sharing our survey. SeniorNet is a Swedish non-profit organization that aims to help older adults use technology through peer-to-peer learning. The main activity of the organization is to organize study circles where seniors come to learn about different topics related to technology and the digital society, ranging from beginner classes in how to use an iPhone or Android phone to more advanced courses about cloud storage and camera phone editing programs.

Finally, the study was conducted during 2020, when the Swedish government deemed people over 65 as a risk group for getting seriously ill from COVID-19. The Swedish government strongly recommended people over 65 stay as much as possible at home and not to have contact with others. Although Sweden compared to other EU countries took some the most lenient measures regarding pandemic restrictions, we discuss the possible impact that the pandemic had on our results in the discussion section.

3 METHOD

As adults over 65 years old have often been characterized as late adopters of technology, their ICT use has been researched in different ways to inform the design of technology for this user group. Typically, this research focuses on the individual's characteristics.

In this study, however, we focus on a broader view of environmental factors that could influence the use of ICT and consequentially inform the design practice.

This study was part of a larger project using different data collection methods to study how older adults use technology. The study received ethical approval from the Swedish Ethical Review Authority. For this part of the project, we wanted to reach out more broadly to older adults who were familiar with technology. With this in mind, we designed a questionnaire. For the participants to have access to the questionnaire, they had to understand the information sheet and give their consent to allow us to use their answers for this research. We did not consider the use of digital questionnaires to be an issue as we were interested in users who are familiar with technology. The questionnaire was developed by a psychologist with the support of an engineer, social media studies expert, and an interaction designer. The questionnaire consisted of open-ended and closed-ended questions. It was open for four months, between May 1, 2020, and September 1, 2020. It was distributed to members of SeniorNet and through personal contacts. Therefore, the sample is a convenience sample of people over 65. The questionnaire consisted of questions related to demographics, computer use (throughout the years), socializing through technology, and learning new technology. Before the launch of the questionnaire, we added one more group of questions concerning the impact of COVID-19 restrictions (recently set in place) on their ICT use.

The data analysis was conducted by the first author with the support of the co-authors. The quantitative data collected by the close-ended questions were descriptively analyzed with SPSS and presented in the results as a narrative. The qualitative data collected from the open-ended questions were thematically analyzed with open coding followed by axial coding using a color-coding technique. The results of the thematic analysis are presented in the results section to compliment and give a better understanding of the descriptive statistically analyzed data.

4 RESULTS

In this section, we describe the profile of our participants and their relationship with technology in their everyday life. The answers from the participants revealed how long they have used technology, their changes in technology use from working life to retirement, as well as changes from before and during the COVID-19 restrictions. We present the reasons for these changes as they described it and their feelings toward these changes. We also dedicate a section to the participants' social media use as well as their intentions to learn to use new technological tools and the ways they choose to learn them.

4.1 Participants, their context, and digital technology use through their lives

Of the 119 people who completed the questionnaire, 74 were women and 45 were men. The participants' ages ranged between 65 and 90 years old (41% between 65 and 75, 50% between 76 and 86, and 9% between 87 and 90). Most found the questionnaire through SeniorNet. Our participants were highly educated (57.9% had a university degree and 24.8% had a high school degree) and mostly retired (86% fully retired and 6.6% partially retired) with at least

five years of computer use in the work environment (82.2% used computers daily in their work). Little more than half (52.9%) used stationary computers for more than 20 years and more than half (61%) used tablets for the past 10 years. A similar amount (60%) of people mentioned that they used a smartphone for at least five years.

Most of our participants (56.7%) used more technology now than five years ago and the rest of our participants (45%) reported that their technological use has not changed through the years. Most of those who use technology more now than before (64.3%) noted in the open-ended questions that this change in use behaviors was because of technological progress and because of society and the pandemic (Figure 2). They pointed out that lately there are many services fully delivered through digital technologies. Some participants who answered that they used technology more now than before (10.7%) reported that they felt forced to follow technological progress. Some participants who had increased their IT use (14.3%) reported that they used more technology now to socialize (this could be due to COVID-19 restrictions) and some used it to educate themselves on different subject or to sustain a hobby/activity such as creating photo books or searching for extended family (17.9%). Figure 2 shows the three themes that emerged from the open-ended question, which asked them to explain why they increased their ICT use during the last five years.

Only a few of the participants (8.3%) answered that they used less technology now than five years ago and most of them attributed it to them stopping work, so they have no need to use IT (70% of those answered less). Two participants answered that before they were using more technology because they were using it for work and leisure, whereas now they use it only in their leisure time (20% of those answered less).

4.2 Learning IT

Most of our participants (69.1%) expressed interest in learning new IT-related tools. When we asked them how they learn new IT tools, half (50%) responded that they learn by trial and error (i.e., clicking around), and only 24% responded that they searched for support online (i.e., Google search). The least preferred option for learning a new IT tool was to ask someone for help such as a family member or friend. However, 83% reported that they will never ask their children or grandchildren to help them learn a new IT tool, and 88% will never or rarely ask any family member in general. Similarly, 87% will never or rarely ask friends to help them learn how to use IT tools.

4.3 Communicating and socializing

In their daily lives, our participants used email (75%) more often than video calls (17%). Regardless of how often they use email services, almost all perceived email use as easy (i.e., 92% found no or little difficulties using email) and they would like to keep using email in the same way (85%). Video calls were perceived as a bit more difficult: 66% found little or no difficulties using video calls and 35% wanted to increase their use of video calls.

| Infrastructure | Activities and Hobbies | Socialising |
|--|---|---|
| <ul style="list-style-type: none"> • Acquisition of a tablet or smartphone • Technology is more developed now than 5 years ago, e.g., fiber technology improved the speed of the internet. • Services are more developed to be accessed fully online and there is more content online, e.g., information seeking, online purchases, eBanking services, mobile payment (Swish), library services, newspapers, and TV. • More people can be contacted or found online. | <ul style="list-style-type: none"> • Exploring and finding extended family • Searching for information about day-to-day questions • Learning new things, including things about technology • Creating digital photobooks • Planning trips, buy tickets • Contacting public and private services | <ul style="list-style-type: none"> • Communication with grandchildren and children • Communication with friends |

Figure 2: Reasons given by our participants (adults over 65) for increasing their ICT use the last five years

Table 1: Participant quotes related to control, privacy, and recollection

| THEME | QUOTATION |
|-------------------|---|
| Control | I want to control my news feed; I do not have the energy to go always through the settings to see what I can influence. |
| Control | Sometimes it is hard to interpret what the different settings give as a result [when chosen]. |
| Control | I do not like Facebook's friend suggestions. |
| Control & Privacy | Have poor control of the different permissions [and that] creates unease over who sees what in my posts. |
| Privacy | I am unsure of how public my posts are to friends and groups [I am part in]. |
| Recollection | When you have forgotten your password, [it feels that] you cannot "reset" it but you are "forced" to open a new account. |
| Recollection | [. . .] when I wanted to [create a] fundraiser in connection to my birthday, the dollar currency appeared and could not be changed! For each change, there was one more new collection! |

Facebook was used by 68.6%, Instagram by 35.5%, and WhatsApp by 33.1%. Twitter and Snapchat were used by fewer participants—13.2% and 3.3%, respectively. Some of our participants (23.1%) mentioned that they used other means of social networking such as LinkedIn and Workplace. Some also mentioned using Skype as a social network.

Most of our participants (80%) experienced no to little difficulties using Facebook. Most common difficulties that emerged from the answers to the open-ended questions were related to the feeling of being in control, privacy, and recollection of how to perform rare actions. Table 1 lists some comments for each one of the three difficulties.

Little more than half of our participants (59%) looked at other people's posts on Facebook daily and 46% "liked" or commented on other people's posts daily or weekly. However, their own posts were less often "liked" (once per month or once per several months). For example, 57% chose to post a question they needed to get answered monthly or less often, 44% posted multimedia, and 48% posted their own multimedia (e.g., their own pictures or videos). Finally, 28% never re-shared other people's posts and 64% never bought or sold items through Facebook.

4.4 IT use during COVID-19

Our participants reported that their use of technology during the pandemic stayed the same (48%) or increased (52%). None of our participants expressed that they reduced their technology use. Most participants reported that they shopped more online (41%) and that they watched more TV online (46%) after the pandemic became an issue. More people reported reading newspapers online (31%) and getting informed about health-related matters online (33%). In addition, our participants reported that they increased their use of email (23%) and videocalls (33%) during the pandemic.

5 DISCUSSION

This study explores how highly educated 65+ adults use technology in a highly digitalized society (i.e., Sweden). We found that their use changed through the years and some of the factors that supported this change. The study gave us insights into their main concerns about using social media, how they chose to communicate using social media, how they chose to learn new technology, and how COVID-19 influenced their communication and technological use. In the next section, we discuss our results from a socio-ecological perspective. Then, we discuss, for each level, the factors that can facilitate the use of ICT by people over 65+.

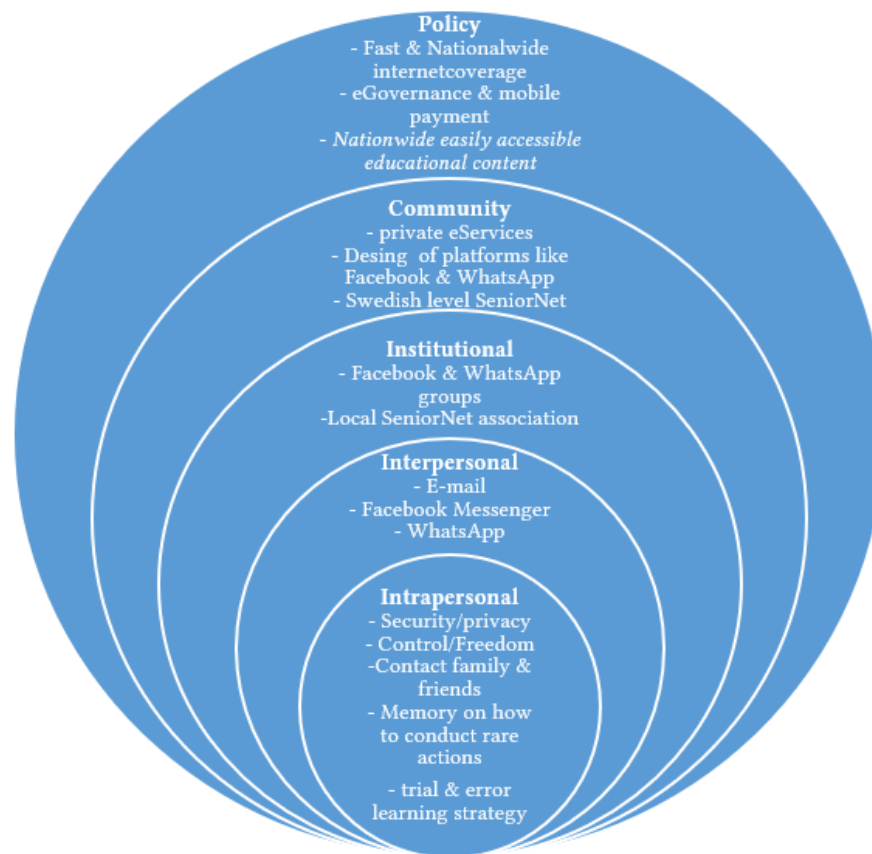


Figure 3: Implications presented in the five-level ecological model by McLeroy et al. [24]

5.1 Socio-ecological perspective

Because we believe ICT use is a behavior, we used the socioecological model (Figure 1) to map the individuals and their contexts as shown in Figure 3. By seeing the use of ICT for seniors through a socio-ecological perspective, we were able to identify what influences their ICT use not only from an individual perspective but also from the interpersonal, institutional, community, and policy or country perspectives.

5.1.1 Country-wide level (Policy). According to our participants, infrastructure (i.e., fiber technology and services provided by the Swedish state and private sector) is one of the two main facilitators that helped them use computers more now than five years ago. The five years up to 2019 were characterized as “fiber fever” by the CEO of the Swedish Local Fiber Alliance as 200 out of 290 municipalities achieved to operate fiber networks by 2019 [48]. This focus on fiber infrastructure could have also motivated companies to invest in their online presence since the internet would be faster and accessible in most of Sweden (community level). The Statistic Database of Sweden (SCB, www.statistikdatabasen.scb.se) also confirms the claims of our participants—through the years they increased their ICT use.

According to SCB [36], between 2018 and 2019, there was an increase in the use of public authorities’ websites or apps to submit

a digital form to the tax authorities (e-declaration), schools, police, and municipalities. The increase was 3% for adults between 65 and 75 and 7% for adults between 75 and 85. Similarly, there was an increase of 3% of people between 65 and 75 who bought or ordered goods or services via the internet. However, there was a 3% decrease for people between 75 and 85, which increased to 10% in 2020 possibly due to pandemic restrictions. The fiber technology in combination with the plethora of digital services provided by the public and private sector seem to have played an important role for our participants to use technology more intensively in 2020 than in 2015.

One last factor that might have influenced the use of ICT was the start of the pandemic. The Swedish government urged people to stay at home and avoid unnecessary travel. From March 10, 2020, extra measures were pushed on senior facilities and on adults over 65 as they were deemed a risk group [23]. This isolation might have led to an increase of ICT use by our participants. Many participants reported that they increased their online shopping, which is in line with the SCB statistics. According to SCB [36], between 2019 and 2020, adults over 65 increased their buying or ordering goods or services via the internet. The adults between 65 and 75 had a 7% increase during 2020 and the adults between 75 and 85 had a 10% increase. The restrictions seemed to have pushed them (as some of

our participants mentioned) to use online services to buy or order goods or services. In addition, the Swedish National Bank reported that even though citizens over 65 adopted the mobile payment Swish at a slower rate than their younger counterparts, their use increased during the pandemic [41].

Our participants reported an increase in watching (online) TV during the pandemic. Since 2006, the public television broadcaster Swedish National Television (SVT) has provided an online service called SVT play, an on-demand video service that broadcasts content from all SVT channels. Watching online TV should not be considered a new activity for our participants as it existed and was possibly used before the pandemic. However, the pandemic increased the use of this service by our participants. Although our participants did not mention it, an example of a national effort to facilitate education on ICT for people over 65 is the TV program “Seniorsurfarna” (“Senior Surfers”), which is hosted by SVT. Starting in 2020, SVT included “Seniorsurfarna” in its on-line offerings. “Seniorsurfarna” is designed to empower and educate adults over 65 to use everyday and cutting-edge technology [49].

Finally, the pandemic and the local restrictions put in place by the Swedish government influenced how Swedes over 65 chose to communicate with their social circle. Our participants reported an increase in video calls and email exchanges. We suspect that this increase happened because they did not get visits and they could not participate physically in activities they may have been involved in before the pandemic. Therefore, they started increasing their use of ICT to remain in touch with their social circle during the pandemic. This case shows how the infrastructures that give them the option of different ways of communication were used to sustain connections with interpersonal and institutional level.

5.1.2 Community and Institutional Level. We had little input from our participants regarding the community and institutional levels. The input on the institutional level related to their online groups (such as Facebook groups or WhatsApp family groups), and the organizations they are part of such as SeniorNET.

Most of our participants were members of SeniorNET, a non-profit national organization with 40 local associations. That is, SeniorNet association is at the community level and its 40 local associations are at the institutional level. Most likely our participants who mentioned that they received the survey from SeniorNet might have visited their local association and become members by giving their email as this is the way the association would have had their email and consequently shared our questionnaire. Finally, most of our participants are members of their local SeniorNet group, which shows their interest to get involved with a group that among other things increases their technological knowledge and support others to increase their technological knowledge and skills.

Most of our participants used Facebook to stay in contact with their social circle in a community and institutional level. We will use Facebook as a case of a community level infrastructure as it consists of many organized groups (e.g., Facebook groups) with their own rules that could be connected to each other. The Facebook groups can be considered part of the structural level. However, few of our participants mentioned that they are part of a group, but recent research shows signs that people over 65 are interested in such groups [47].

Regarding public social media use such as Facebook, our participants are similar to participants in several previous studies of older adults who use of social media network services [15]—i.e., they are highly educated. Previous reviews of studies of older adults have called for more studies of the complexities of social media use [8, 15], and we provide a more nuanced understanding of the particular services and the way that they are used. We show how active use is much less common than passive use, as older adults more often comment on and “like” other people’s posts than post their own material. This behavior can be related to the main motivation of older adults to keep up with the activities and lives of friends and families rather than reaching out and connecting with new acquaintances. It can also be connected to the privacy-related issues our participants reported. They felt unsure who reads what they post, but they were aware that the audience who watches their timeline (based on their privacy settings) may differ from the audience who watches their posts in a group. In particular, privacy concerns are one of the aspects referred to in the literature that discourage social media use [34]. We will come back to privacy issues in the section related to the intrapersonal level.

In addition to privacy, the online community level (Facebook) poses two more obstacles for our participants that could have influenced their institutional and interpersonal level. Our participants wanted to have more control over Facebook’s features such as News Feed and friend suggestions. In addition, they were often confused when Facebook required them to perform an unfamiliar action (i.e., they felt some actions were not intuitive). For our participants, it was complicated to retrieve their password, so they had to open a new account losing all the connections they had with the different people (interpersonal level) and groups (institutional level). We speculate that our participants stayed logged in a long time and when they logged out and needed to log in again, they had forgotten their password. Similarly, another comment relevant to rare actions was the creation of fund raisers; if a person is using this feature once every year, it is normal to forget how it works. Regardless of these difficulties, our participants reported that they felt little to no difficulties performing actions that interested them. That is, although Facebook is not perfect, it can facilitate their participation in the institutional level and help them stay in touch with family and friends (interpersonal level) through Facebook Messenger.

5.1.3 Interpersonal level. To communicate and stay connected with individual friends and family members (interpersonal level), our participants mainly used email and Facebook, but some used Instagram and WhatsApp and wanted to increase their video call use. Our results are in line with past literature and an annual survey used to estimate internet use in Sweden and its development throughout the years [50]—*Svenskarna och internet* (The Swedes and the Internet).

According to past literature, older adults have initially been more hesitant than other age groups to adopt social media and network services [4]. However, they are now increasingly using social media services to communicate and socialize. In a systematic review of previous work on the use of social network services among older adults, Quan-Haase and Elueze (2018) conclude that older adults’ motivations for using these services were to maintain

contact with family and friends, including staying connected with younger generations [33].

According to The Swedes and the Internet survey [50], pensioners (in Sweden the average age of retirement is 65) increased their email use during 2020 by 10%, which was interpreted as 50% of the pensioners who use the internet use email services at least once per day. Texting on Facebook had a 2% increase in 2020 for pensionaries who used the internet (from 34% to 36%), WhatsApp had a 5% increase (from 14% to 19%), and Instagram had a 3% increase (from 8% to 11%). Regarding video calls, adults between 66 and 75 had a 10% increase, and adults over 76 had a 30% increase, which doubles their use of video calls from the beginning of 2020. In addition, our participants reported little or no problems when receiving or making video calls.

According to The Swedes and the Internet survey and our participants, the pandemic (which is part of the policy/country level) influenced the way adults over 65 communicated with their friends and family. The way that they turned to technology and started using it to sustain their interpersonal relationships gives the impression that using or not using ICT to communicate is more of a preference than a skill issue for this group of adults. In other words, they used already built networks to stay connected with their social environment. We will come back to the reasons adults over 65 use the internet and social networks in the intrapersonal level.

5.1.4 Intrapersonal level. The interpersonal level is the one most studied when focusing on adults over 65 regarding how they use and perceive digital technology. We add to this body of knowledge with what our participants reported that they do online and how they chose to learn new technology.

Past research reported that their participants were not as interested in social networks as our participants and as the Swedish statistics present. In particular, Quan-Haase and Elueze [33] report that aspects that prevented older adults to use social media, apart from privacy concerns, include perceived usefulness and the perception of social media as trivial or unimportant. One of the three biggest concerns of our participants when it comes to Facebook were privacy issues, which is in line with past research. Particularly, when it comes to privacy, the older adult user group differs from other age groups in their considerations of privacy and integrity while using social media. Quan-Haase and Elueze (2018) [33] explored social media privacy concerns among seniors and found that both senior users and non-users of social media shared similar concerns, most often involving possible unauthorized access to personal information and misuse of that information.

Apart from privacy, our participants presented as challenges the control over what they can see in regards with Facebook features and the difficulties they face performing rare actions such as password retrieval. These two challenges were described in the community and institutional section as well, as they can be perceived as a combination of usability issues related to the online community level (Facebook) and the specific needs of this group of adults related to their intrapersonal needs. These needs are related to desiring a high level of control over what appears on the interface they use, the information they retrieve, and the performance of rare actions (i.e., the organization should adopt better strategies to help users achieve what they want such as retrieval of passwords

through mobile identification or other ways that do not rely on memory).

For our participants, we can see that staying connected with family and friends is important. That is, they increased the use of ICT to contact family when pandemic restrictions were put in place. In addition, some reported searching for immediate and extended family online. We presume that they mean on online communities such as Facebook, but in Sweden this could be on designated sites where information about people who live in Sweden are presented (e.g., hitta.se).

Finally, one more activity our participants do online is searching for information needed in their daily life (e.g., health-related information about the pandemic) and learning new things as one of our participants wrote “You can google to gain better knowledge about everything possible”. In fact, when it You can] google to gain better knowledge about everything possible of older adults who are used to several ICT devices such as smartphones and tablets seem more secure (intrapersonal level) doing things on their own to learn new features. This could be due to better interfaces, services, and infrastructures, (policy/country and community level), or the fact that they feel more secure handling different types of ICT devices (intrapersonal level). Using independent strategies also allows the user to learn at their own pace and therefore avoid bothering relatives with repetitive questions. However, the shift in learning strategies may also have been driven by the pandemic and related restrictions, since many older adults may have refrained from contacting their relatives due to self or official quarantine rules as well as not wanting to bother relatives who might be suffering from stressors related to the pandemic [37].

5.2 General discussion, limitations, and design implications

As presented, the biggest reasons that our participants use technology more now than five years ago were mainly part of the policy/country level. Better infrastructures both tangible such as fiber cable and intangible such as easily accessible online services were developed and the prevalence and affordability of the mobile technology increased.

On the organizational and community level, a literature review published in 2018 [3] (i.e., before the pandemic) reports that 65+ adults have been increasingly using social media to connect with their social circle. In the case of our participants, they used social media to keep in touch with their family and friends but mainly as observers and commentators when it came to public interactions (institutional level) (e.g., posts on Facebook). They use social media (e.g., Facebook Messenger) to produce content on a private level (interpersonal and partially institutional if it is organized family group) to stay in touch with family and friends, a behavior that increased and was enriched with video calls during the pandemic. The differences in their behavior between the institutional level and the interpersonal level related to social interaction can be due to feelings of losing control, especially over their privacy. For example, adults over 65 produce content when they feel in control and sure with whom they are sharing it (e.g., WhatsApp family groups) [47]. Therefore, the participation on their organizational level seems

to be limited only when they feel that they have no control over matters of security and who can see what they have posted.

Finally, on the intrapersonal level, our participants use technology to learn new skills. Their learning strategies to learn IT tools have been transferred toward the intrapersonal level from the interpersonal level, as they argue that they rarely ask friends and families, and they prefer to learn by trial and error. This shift from asking family and friends to learning by trial and error is seen in the recent literature as well [32]. However, adults over 65 who live in Sweden were using most of the technology before the pandemic, whereas in countries with less developed digital infrastructure and policies (e.g., Saudi Arabia) adults over 65 report that using ICT to book a COVID-19 vaccination was problematic [1].

5.2.1 Limitations. Our sample is relatively small for statistically significant results to be reported or to be representative of the whole 65+ population in Sweden. However, the national and international statistics were in line and confirm the quantitative results of our small-sample questionnaire. Therefore, we argue that the results of this study are transferable to similar environments, can inform our understanding of the needs of this specific user group, and provide some insight into how 65+ adults use technology and how the greater environment influences their ICT behaviors. Although Sweden had a less harsh policy than other EU member states in relation to COVID-19 measures, we are aware that our data on IT use could be influenced by these measures.

5.2.2 Design implications. In the policy/country level, well designed and unified infrastructures are the basis for ICT use. Examples of such infrastructures from the Swedish context are listed below:

1. **High speed internet through fiber technology.** Several of our participants mentioned that one of the reasons they now use more technology than before is the internet speed due to fiber technology (Figure 2).
2. **State services that offer and promote online alternatives.** These services possibly even show their costumers how to use them if they visit their physical office. Several of our participants mentioned that they use technology more now than before due to the increase in online services (Figure 2)
3. **Nationwide educational programs.** For example, “Senior Surfers” could be an opportunity for someone to learn in the comfort and privacy of their home. This program was not mentioned by the participants of this study; however, its existence shows a top-down approach to promoting the use of digital technology to groups of people who often are considered digitally illiterate.

At the community and institutional level, national hubs can be valuable for citizens who wish to learn more about ICT. When it comes to institutional communication, the users face issues only when they feel insecure about who can see their posts. Below are examples of such hubs:

1. Social nationwide networks such as SeniorNet promote peer learning through their local hubs. However, most of our participants mentioned that they learn by trial and error, and they would never or rarely ask a peer/friend for support. Most of the participants

were members of SeniorNET. That is, they were supporting their peers to learn such as people who did not take part in the study.

2. When designing online services and platforms for the community and institutional levels, the focus should be on the needs of the specific user group (intrapersonal level) rather than comparing it to another user group [29]. In the case of 65+ adults, our results (Table 1) and previous research [33, 47] indicate that security and control are important intrapersonal needs that should be covered before they accept using the service. For example, if the focus of the communication platform is to connect people and does not exclude 65+ adults, then the platform should be designed in a way that ensures security and control over the user’s content and data.

The user’s needs come from the intrapersonal level. According to our participants, privacy/security, control/freedom, and ways to reinforce how to conduct rarely performed actions are the most important issues (Table 1).

3. Make it easy to find, recognize, and understand the privacy settings. Our participants mentioned that they felt that they have poor control over the different permissions they can choose on Facebook and that they often do not know who has access to see their posts (Table 1). As mentioned above, 65+ adults value their privacy. This could explain why their behavior has been characterized as viewers and commenters of social media context rather than producers [8, 15]. That is, posting on, for example, Facebook, results in feelings of insecurity and loss of control over their privacy. Therefore, their behavior is not the problem; the problem is the inability of the platform to address their intrapersonal needs related to privacy.

4. Visualize the results of the users’ actions before they do the action. Our participants mentioned that often it is hard to interpret what the different settings entail (Table 1). This is related to the sense of control they have, and it can be also connected with their control over their privacy settings. This is one step further than Nielsen’s first heuristic: visibility of system status [31], which gives the user information about the current state of a system. Apart from showing its status, a system can also indicate to the user what will happen if they do an action. This may increase their sense of control over the results of their potential actions.

5. Do not rely on users’ memory. Our participants mentioned that they forget how to do rarely performed actions such as password changes or fund raisers (Table 1). Although these examples are Facebook specific, the general idea is related to all actions the user rarely performs in any platform. If an action is rarely performed (e.g., with a use of an accordion menu), it should be minimized rather than hidden. If it is a matter of security (e.g., changing password), make it so a person can access the service without a password (e.g., by mobile identification). This is one step further than Nielsen’s sixth heuristic [31]: use recognition rather than recall, as in security, as it does not rely on memory but on identification through Application Programming Interface (API) with different devices. The interpersonal level was not mentioned because our participants were using different online platforms to communicate with friends and family. In the last two levels that concern individuals and their interactions, we cannot directly influence the individuals to use something that falls into one of these categories:

1. Using technology is not working due to poor infrastructure at the policy level.
2. Using technology is hard to handle due to poor design and explanation of matters users are interested in (i.e., does not address their intrapersonal needs).
3. Using technology is not a skill they are interested in developing. Many adults prefer face-to-face physical interaction rather than digital calls; this does not mean that when it is needed due to a societal factor (e.g., the pandemic), they will not use digital means that were available to them before the societal factor appears.

6 CONCLUSIONS

In this paper, we do not argue that the digital divide for 65+ adults [37] does not exist. We emphasize that by focusing only on the ICT use of 65+ adults and 65+ adults as individuals (i.e., person behavior relationship) we may neglect other factors (e.g., environment behavior relationship) that influence ICT use [46]. A behavior of a person is not fully responsible as use of technology is heavily influenced by the greater environment [24, 37]. When focusing on intrapersonal characteristics (person) and behavior, the design of technology runs the risk of stereotyping, medicalizing, and patronizing the user [6, 29].

Through the design implication in the section 5.2.2, we present our findings through the five-level ecological model. We highlight the environmental factors—policy, institutional, and community levels—that facilitate the increase of the ICT use in the user group 65+. The design implications in the intrapersonal level are based on our results and are in line with Nielsen’s heuristics.

Many developed countries are increasingly digitalized, and this study could help envision future services in these societies where they will include the senior v0.2 not only by focusing on their intrapersonal characteristics and behaviors towards a technology but also on the greater environment and what could hinder or facilitate the use of technology. Our research focuses on the relation between the environment and the behavior (use of ICT) of 65+ adults, adding to the limited body of knowledge studying this relationship [46]. Further research is needed in more countries that use the perspectives of ecological model to understand better how the environment can influence the use of technology by 65+ adults.

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A APPENDICES

In this section, you will find the questionnaire we shared with our participants. The structure has been adjusted to fit the publisher’s format.

Digital seniors survey - Main survey

-----Start of Block: Introduction-----

Q1 How did you get this survey?

1. It was sent via Seniornet
2. A friend shared it with me via email
3. It was shared with me via Facebook
4. Other (please specify how in the box below)

-----End of Block: How did you get it from the survey-----

-----Start of Block: Background Questions-----

Q2 What is your gender?

1. Female
2. Male
3. Other

Q3 Please enter your age, in numbers (ex. 67) in the box. [text entry]

Q4 Sometimes you can feel both older or younger than you actually are. How old do you feel like? Write the number that best matches your perceived age right now. [text entry]

Q5 What is your highest level of education?

1. Less than primary school level
2. Primary school, real school, elementary school or equivalent
3. Upper secondary school, folk high school or equivalent
4. University, college or equivalent

Q6 Do you live in any type of relationship?

1. Married/Partner
2. Cohabitation
3. Partners who live separately
4. Single/Separated
5. Widower/Widower

Q7 What is your current occupation?

1. Full-time retiree
2. Retired and Working
3. Working
4. Other (please write what)

Q8 Where do you live?

1. Metropolitan: City Center
2. Metropolitan: Suburban or outlying areas
3. Medium City: City Center
4. Medium City: Outlying Areas
5. Small Town
6. Rural

Display This Question:

If What is your current occupation? = Retired and working
Or What is your current occupation? = Working

Q9 What is your main profession? Preferably leave as detailed a professional title as possible, such as bus driver, construction carpenter, dealer in specialist trade, caretaker, assistant nurse, preschool teacher, cleaner, warehouse worker, shop assistant, clerk, kitchen and restaurant assistant, doctor, etc. [Text entry]

Display This Question:

If What is your current occupation? = Retired and working
Or What is your current occupation? = Working

Q10 To what extent do you use computers or other digital technology in your work?

1. Not at all
2. To a small extent
3. To some extent
4. To a large extent
5. To a very large extent

Display This Question:

If What is your current occupation? = Full-time pensioner
Or What is your current occupation? = Other (please write what)

Q11 What was your main profession when you worked? Preferably leave as detailed a professional title as possible, such as bus driver, construction carpenter, dealer in specialist trade, caretaker, assistant nurse, preschool teacher, cleaner, warehouse worker, shop assistant, clerk, kitchen and restaurant assistant, doctor, etc. [text entry]

Display This Question:

If What is your current occupation? = Full-time pensioner
Or What is your current occupation? = Other (please write what)

Q12 To what extent did you use computers or other digital technology in your work during the last five years of your professional life?

1. Several times a day
2. Sometime a day
3. Several times a week
4. Once per week
5. Several times a month
6. Sometime per month
7. Less frequently than once a month
8. Never

-----End of Block: Background Questions-----

-----Start of Block: Block 3-----

Q13 If you compare it to how much you used digital technology five years ago, what would you say your use looks like now?

1. I use digital technology more now than I did five years ago
2. I use it as much as I did five years ago

3. I use less digital technology now than I did five years ago

Display This Question:

If you compare it to how much you used digital technology five years ago, how would you say... = I use digital technology more now than I did five years ago

Q14 You replied that you use digital technology more now than five years ago. How come you use it more widely? [text entry]

Display This Question:

If you compare it to how much you used digital technology five years ago, how would you say... = I use digital technology less now than I did five years ago

Q15 You replied that you use digital technology less now than you did five years ago. How come you use it to a lesser extent? [text entry]

Q16 How well does the following statement apply to you: I enjoy testing new digital tools and programs.

1. Very untrue
2. Somewhat untrue
3. Neither untrue nor true
4. True to some extent
5. Totally true

Q17 Does it happen that you help others with their use of digital tools such as computers, smartphones, tablets and the like?

1. Never
2. Rarely
3. Sometimes
4. Often

-----End of Block: Block 3-----

-----Start of Blocks: Different Uses and Difficulties with These-----

Q18 How long have you been using any of the following regularly (i.e. at least once a week)?

Q19 How often do you use digital technology such as computer, tablet or mobile to read and write emails?

1. Several times a day
2. Sometime a day
3. Several times a week
4. Once per week
5. Several times a month
6. Sometime per month
7. Less frequently than once a month
8. Never

Q20 Do you experience difficulties reading and writing emails?

1. No difficulties
2. A little difficulty
3. Some difficulties
4. A lot of difficulties
5. A lot of difficulties

Q21 If you compare with your use today to what extent would you like to read and write emails?

1. To a much lesser extent
2. To a lesser extent
3. I'm happy with my use
4. To a greater extent
5. To a much greater extent

| | Not using regularly | 0-1 year | 2-5 years | 6-10 years | 11-20 years | 21-30 years | More than 30 years |
|---|------------------------|-------------|--------------|---------------|----------------|----------------|-----------------------|
| Desktop | | | | | | | |
| Laptop | | | | | | | |
| Tablet e.g. ipad or similar | | | | | | | |
| Smartphone | | | | | | | |
| Other digital device (please specify which one) | | | | | | | |

Display This Question:

If you compare with your use today to what extent would you like to read and write emails?... = To a greater extent

Or If you compare with your use today to what extent would you like to read and write emails?... = To a much greater extent

Q22 What prevents you from reading and writing emails to the extent you would like? [text entry]

Q23 How often do you use digital technology such as computer, tablet or mobile to play games?

1. Several times a day
2. Sometime a day
3. Several times a week
4. Once per week
5. Several times a month
6. Sometime per month
7. Less frequently than once a month
8. Never

Q24 Are you experiencing difficulties using digital technology to play games?

1. No difficulties
2. A little difficulty
3. Some difficulties
4. A lot of difficulties
5. A lot of difficulties

Q25 If you compare with your use today to what extent would you like to play games using digital technology?

1. To a much lesser extent
2. To a lesser extent
3. I'm happy with my use
4. To a greater extent
5. To a much greater extent

Display This Question:

If you compare with your use today to what extent would you like to play games using a... = To a greater extent

Or If you compare with your use today to what extent would you like to play games using a... = To a much greater extent

Q26 What's stopping you from playing games using digital technology to the extent you'd like? [text entry]

Q27 How often do you use digital technology such as computer, tablet or mobile to make or receive video calls with moving images?

1. Several times a day
2. Sometime a day
3. Several times a week
4. Once per week

5. Several times a month

6. Sometime per month

7. Less frequently than once a month

8. Never

Q28 Are you experiencing difficulties with making or receiving video calls with moving images?

1. No difficulties
2. A little difficulty
3. Some difficulties
4. A lot of difficulties
5. A lot of difficulties

Q29 If you compare with your use today to what extent would you like to make or receive video calls with moving image?

1. To a much lesser extent
2. To a lesser extent
3. I'm happy with my use
4. To a greater extent
5. To a much greater extent

Display This Question:

If if you compare with your use today to what extent would you like to call or receive us... = To a greater extent

Or If you compare with your use today to what extent would you like to call or receive us... = To a much greater extent

Q30 What's stopping you from making or receiving video calls with moving image to the extent you'd like? [text entry]

-----End of Block: Different Uses and Difficulties with These-----

-----Start of Block: Social Networking Sites-----

Q31 Which of the following social networks have you visited in the past year?

1. Facebook
2. Instagram
3. Snapchat
4. Twitter
5. WhatsApp
6. Other

Display This Question:

If Which of the following social networks have you visited in the past year? = Facebook

Q32 Now come some questions about what you do when you are on Facebook:

Display This Question:

If Which of the following social networks have you visited in the past year? = Facebook

| | Several times a day | Sometime a day | Several times a week | Once per week | Several times a month | Sometime per month | Less frequently than once a month | Never |
|--|----------------------------------|--------------------------|--------------------------------------|-------------------------------------|---------------------------------------|-----------------------|--|-------|
| Reading other people's posts and pictures | | | | | | | | |
| Posting your own posts with questions you want answered | | | | | | | | |
| Posting posts with pictures or videos where you want to tell or show something | | | | | | | | |
| Post your own posts without pictures /videos where you want to tell about or show something you have done | | | | | | | | |
| Sharing other people's posts and pictures further | | | | | | | | |
| Likes or comments on other people's posts and pictures | | | | | | | | |
| Buying and Selling Things | | | | | | | | |
| Other (specify what below) | | | | | | | | |
| | To a much lesser extent | To a lesser extent | To a slightly lesser extent | Nothing more and nothing less | To a slightly greater extent | In higher range | Significantly more | |
| read and write emails | | | | | | | | |
| read newspapers | | | | | | | | |
| play games | | | | | | | | |
| watch TV shows or movies/videos | | | | | | | | |
| perform banking, tax and the like e.g. timetables , cinema, telephone number | | | | | | | | |
| search health-related medical information | | | | | | | | |
| make or receive video calls with video | | | | | | | | |
| order goods and services, for example, books or cleaning services? | | | | | | | | |

Q33 Are you experiencing difficulties doing what you want to do on Facebook?

9. No difficulties
10. A little difficulty
11. Some difficulties
12. A lot of difficulties
13. A lot of difficulties

Display This Question:

If Which of the following social networks have you visited in the past year? = Facebook

Q34 What are the most common difficulties you experience?
[text entry]

-----End of Block: Social Networking Sites-----

-----Start of Block: Questions during the Coron era-----

Q35 During the spring of 2020, the new coronavirus has spread in society and older people are encouraged to isolate themselves.

We would now like to ask you if you feel that your use of digital technology has changed with these restrictions. How do you feel your use of digital technology has changed with the spread of the coronavirus?"

1. I use digital technology to a much lesser extent now
2. I use digital technology to a lesser extent now
3. I use digital technology to a slightly lesser extent
4. Nothing more and nothing less
5. I use digital technology to a slightly higher extent
6. I use digital technology to a greater extent now
7. I use digital technology to a much greater extent now

Q36 If you compare with before the Corona spread began, in how much coverage do you now use digital technology such as computer, tablet or mobile to do the following things:

Q37 Due to the spread of the Corona virus, have you started using digital tools and programs (eg Skype) or visited social networks (eg

Facebook) or pages on the internet (eg skatteverket.se) that you have never or almost never used or visited before? Please specify the type of tool/program/page in the fields below. Please enter only one per field: [text entry]

Display This Question:

If If Due to the spread of the Corona virus, you have started to use digital tools and programs (eg Skype) or visited social networks (eg Facebook) or pages on the internet (eg skatteverket.se)... Text Response Is Not Empty

Q37b How come you started using \${Q37/ChoiceTextEntryValue} during the Covid19 crisis? [text entry]

Display This Question:

If If Due to the spread of the Corona virus, you have started to use digital tools and programs (eg Skype) or visited social networks (eg Facebook) or pages on the internet (eg skatteverket.se)... Text Response Is Not Empty

Q37c How easy did you find it to learn how to use \${Q37/ChoiceTextEntryValue}?

14. Very easy
15. Pretty easy
16. Medium
17. Quite difficult
18. Very difficult

Display This Question:

If If Text Response Is Not Empty

Q38b How come you started using \${Q38/ChoiceTextEntryValue} during the Covid19 crisis? [text entry]

Display This Question:

If If Text Response Is Not Empty

Q38c How easy did you find it to learn how to use \${Q38/ChoiceTextEntryValue}?

1. Very easy
2. Pretty easy
3. Medium
4. Quite difficult
5. Very difficult

Display This Question:

If If Text Response Is Not Empty

Q39b How come you started using \${Q39/ChoiceTextEntryValue} during the Covid19 crisis? [text entry]

Display This Question:

If If Text Response Is Not Empty

Q39c How easy did you find it to learn how to use \${Q39/ChoiceTextEntryValue}?

1. Very easy
2. Pretty easy
3. Medium

4. Quite difficult

5. Very difficult

Display This Question:

If If Text Response Is Not Empty

Q40b How come you started using \${Q40/ChoiceTextEntryValue} during the Covid19 crisis? [text entry]

Display This Question:

If If Text Response Is Not Empty

Q40c How easy did you find it to learn how to use \${Q40/ChoiceTextEntryValue}?

1. Very easy
2. Pretty easy
3. Medium
4. Quite difficult
5. Very difficult

Display This Question:

If If Due to the spread of the Corona virus, you have started to use digital tools and programs (eg Skype) or visited social networks (eg Facebook) or pages on the internet (eg skatteverket.se)... Text Response Is Not Empty

Or Or Text Response Is Not Empty

Or Or Text Response Is Not Empty

Or Or Text Response Is Not Empty

Q41 To what extent did you do any of the following to learn how to use the new digital tools?

-----End of Block: Questions during the Corona era-----

-----Start of Block: Block 4-----

Q42 You have now answered the questions in the survey. If you have any comment or comment, you can write it in the field below. [text input]

Q43 Would you consider helping us further in our research project on older people and digital technology use? Please click below on what you would be willing to help us with. Please note that your answer is not binding, but we will contact you at a later date with a request to join:

1. I would be willing to partake in an interview
2. I would be willing to test apps developed to help seniors with their use of digital technology
3. I would be willing to answer a follow-up survey in about 1 years time

Q44 If you clicked for any of the above options, please enter your email address below so we can get in touch with you. We process your data in accordance with the EU Data Protection Regulation. [text input]

----- End of Block: Block 4-----

| | Not at all | To a small extent | 3 | 4 | 5 | 6 | To a large extent |
|--|------------|-------------------|---|---|---|---|-------------------|
| I tried on my own by clicking my way around the system | | | | | | | 1. |
| I was looking for information on google | | | | | | | 1. |
| I asked a child or grandchild for help | | | | | | | 1. |
| I asked a friend for help | | | | | | | 1. |
| I asked a relative for help | | | | | | | 1. |