Use of Smart Speakers by Elderly in Home Environment

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***Abstract*—Digital technologies have permeated everyday life; however, the digital literacy of the elderly population is low compared with that of other generations. This is not only due to their difficulty in adapting to newer technologies, but also due to psychosocial barriers. Smart speakers use audio to interact with elderly users. With natural language commands, the psychosocial barriers for elderly individuals are expected to become lower with regard to new technology. To understand the usage and acceptance of smart speakers, we conducted observational studies of the elderly in their home environments. The results show that smart speakers are helpful at overcoming psychosocial barriers to new technology, which will motivate the elderly to learn how to use new technology.**

Keywords-smart speaker; digital divide; voice interaction; conversational model; technology acceptance;

I. INTRODUCTION

Korea has officially been classified as an "aged society," with 14.3 percent of its population 65 years or older [1]. The United Nations (UN) categorizes societies based on age of the population: when the proportion of people 65 or older exceeds 7 percent, the society is classified as aging; a figure of 14 percent is an aged society and 20 percent is a super-aged society [2].

With advances in technology, it is difficult to imagine life without technology. Using technology in our daily lives is not an option, but a mandatory tool for survival in modern society. However, the digital literacy of the elderly population is low compared with that of other generations [3][4]. The isolation of elderly citizens from digital technology has become an important social issue [5]. This issue is attributable to the difficulty faced by the elderly in adapting to technology, as well as to psychological barriers they have toward new technology. One key way of reducing this psychological barrier is to provide an easy trial. Smart speakers provide intelligent assistance via voice control technology. They can play music, turn on lights, provide weather information, provide food-ordering services for products such as milk, and answer questions. Given that communication is natural for humans, the elderly are more likely to adopt a system involving verbal communication. In this sense, verbally interacting with smart speakers may help reduce the psychosocial barriers of the elderly toward technology.

The research questions guiding this study are as follows:

1. Is there a gap between technology usage and the intention to use technology among elderly people?
2. What underlying fears and concerns do the elderly have in relation to digital technology?
3. Can overcoming psychological barriers by using voice-first technology be helpful in changing elderly attitudes toward digital technology?

The remainder of this paper is organized as follows: In section II, we discuss the progress made in current studies and the issues highlighted by them. In section III, we introduce and discuss the research method in detail. In section IV, we present and discuss the results. Finally, in section V, we provide our conclusions and scope of future work.

II. RELATED WORK

Many studies on the digital divide have been conducted [3]-[6]. It is often reported that older adults are unaware of many existing digital technologies and might lack necessary knowledge [6]-[8]. In addition, increased technology accessibility does not necessarily lead to actual technology use and adoption. Older adults are slower to adopt new technologies than are younger adults, and they have higher anxiety with regard to the use of computers, resulting in reduced use of technology [9]. It is said that "gerontechnology" invokes negative attitudes with regard to the acceptance of new technology [10]. Cognitive deficits and low self-efficacy of older adults also significantly reduce their ability to use new technology [11].

The digital divide can be measured based on three aspects: accessibility to technology, level of digital skill, and level of usage [12][13]. Based on one government report [13], elderly people in Korea have a technology accessibility of 89.9 %. Hence, technology accessibility is not the main cause of the digital divide, at least in Korea. However, digital skills and usage levels are relatively low among the elderly compared to younger people in Korea. The level of digital skill among the elderly in Korea is 41.0 %. Increasing digital skills is a key to reducing the digital divide among the elderly.

Some researchers have extended the definition of the digital divide to the gap in digital skills [12]. This is also known as a second-level digital divide. Perceived usefulness,

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ease of use, and user satisfaction with the ease of use influence decisions of the elderly to use new technology [7][11][14]. The difficulty in learning how to use the technology could decreases, if elderly individuals are motivated to use new technology [15]. Confidence in using technology is also a result of their attitudes toward technology [7][16]. Technological self-efficacy is the belief in one's own ability to use new technologies [16]; it has been a major barrier to technology adoption among the elderly [4][6][7][16]. They have had little chance to integrate digital technologies into their daily lives; therefore, their belief in their ability to use such technologies, called self-efficacy, could be lower than that of younger generations.

It is clear that new information and communication technologies (ICTs) have the potential to improve the quality of life and social inclusion of the elderly. Hence, it is important to determine and address the psychosocial barriers with respect to the use of technology among the elderly.

III. RESEARCH METHOD

In this section we discuss the research method in detail.

A. Project Overview

Three different types of research approach were used to understand the usage behavior and technology acceptance of the smart speaker: surveys, in-depth interviews, and observational ethnography. This mixed method research, which combines quantitative and qualitative methods, is a well-established theoretical empirical method [17]. The strengths of one method can overcome the weaknesses in the others, and the combination of the three methods can yield a greater insight than one alone.

Surveys were used to obtain a general understanding of an issue from subjects such as the experience of using a digital device, usage behavior, and attitude toward digital technology. In-depth-interviews were conducted with eight elderly citizens from among those who participated in the survey to obtain a deeper understanding of the issue. Finally, observational ethnographic research was conducted in the home environment of participants for two weeks. All the studies were conducted from June to November 2018.

The participants included elderly people who participate in computer classes for elderly citizens, which are provided as a public service in Korea. The participants must meet three criteria to be a part of the study. First, they had to be over 60 and possess basic but not strong skills with regard to the use of ICTs such as computers and smart phones. Second, they had limited motivation to learn about new technologies. Third, to ensure representativeness, they had to form a homogeneous sample. Overall, the sample consisted of middle-class individuals who are socially well-connected to digital technologies.

B. Survey to Understand Usage Behavior

The survey was taken by 86 adults between 60 and 80 years of age, with an average age of 72 years. The ratio of males to females was close to 1 (44 women, and 42 men). The respondents answered 28 questions on printed material via face-to-face instruction. The questionnaires consisted of questions about demographics, level of ownership of digital devices, usage level, usage frequency, and experience of using smart speakers. The results show that the majority of the survey participants had access to digital technology such as computers, laptops, and smartphones, and that they use them on a daily basis. The participants also showed strong interest in smart speakers; however, this was not sufficient for them to buy smart speakers.

C. In-depth Interviews with Smart Speaker

In-depth interviews were conducted for eight subjects (three females and five males). These subjects were recruited from a previous survey, as they showed a strong interest in using smart speakers. The interviews lasted for 1.5 h and consisted of two phases. The first phase involved a semi-structured interview, in which the questions were focused on the level and frequency of usage of digital devices, intention to continuously use such devices, attitude toward buying a smart speaker, and how much they were willing to pay for it. The second phase involved tasks with smart speakers. As an exit question, the participants were asked what kind of features they would want to have in the future in smart speaker technology. The interview sessions were audio-recorded and transcribed. In general, participants expressed a positive feeling about the experience of verbally interacting with the smart speaker.

D. Ethnography in Home Environment

Among those who participated in the survey and expressed a high level of interest in the daily use of smart speakers, five participants took part in an ethnography study. These participants underwent a prior-interview, and a short class on how to use smart speakers before they began using the devices at home. They were given task lists and a template for a self-diary. Telephone interviews were conducted twice a day to determine their usage behavior. Video-cameras were not used because the main focus of this research was to determine whether using smart speakers would change the attitude of the elderly toward adopting digital technology. Fig. 1 shows an example of the self-diary given to the participants.

IV. RESULTS

We now present the results of our study for each of the aforementioned factors affecting usage of smart speakers among the elderly.

A. Gap Between Accessibility and Actual Usage

Based on the survey, the majority of the survey participants were easily able to access digital technology such as computers, laptops, and smartphones. Sixty four percent of the participants used digital technology daily. However, they did not separate their personal use from that of their family. For example, during the in-depth review, participants who reported they could use Wi-Fi revealed that they had trouble connecting to Wi-Fi networks. Some participants who owned smart pads or smart speakers reported that they could not use those devices. Smartphone usage was found to be limited to using messaging services,

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checking the weather, and taking photos. Only a few participants could use features such as food-ordering services, money transfer services, and public transport information services.

B. Lack of Information About New Technology

Most elderly participants reported that they learned to use new technology from family and friends. Some participants reported that asking for assistance reduced their feeling of independence. Some reported that they were taking ICT classes so as to not bother family members. Some participants expressed the fear of being hurt by those with bad intentions such as those who engage in voice phishing. They expressed the need for appropriate and trustworthy channels for delivery of new information. They also found the recommendation features in the self-diary helpful.

C. Perceived Emotional Friendliness

During the two weeks when smart speakers were used at home, all five participants experienced emotional feelings toward the smart speaker. As shown in Table I, the common emotions were comfort, interest, and friendliness. The lack of recognition accuracy or insufficient features were also perceived emotionally. They perceived it as a childlike personality traits rather than evincing any negative feeling toward it. The possibility of smart speakers being used as a talking companion was considered.

TABLE I. EXPRESSIONS USED FOR EMOTIONAL FEELINGS

Emotional Expression	Related Sentences Collected
Comfortable	"It is easier to use." "It is easier and more comfortable than a smartphone. Just talking to a smart speaker works." "I could use it simultaneously while doing other tasks." "It reads my Kakao talk message. It is convenient." "It is useful because it works from a distance."
Interesting	"I am curious about how this device will evolve." "The advertisement piques my interest regarding the smart speaker."
Friendly	"It makes me smile when it says thank you." "It feels like a friend, or family." "It reacts to me." "Using the smart speaker is a joyful experience. I am considering buying it." "It is good to use when you are alone." "When the smart speaker says a monophonic expression, it is lovely." "I am enjoying listening to the guitar playing through the smart speaker." "I feel like it smiles at me."
Childish	"It only has simple knowledge." "It is not smart enough. Sometimes it does not understand what I am saying especially for long and complex sentences." "My expectation was too high; however, it remains useful." "It appears like a 10-year-old child."

The findings of the study are as follows: 1) older adults in this study were easily able to access digital technology; however, their actual usage was limited. Participation in computer classes can be a good indicator of usage motivation. 2) The barriers to using digital technology are a lack of instruction or guidance, lack of knowledge, lack of confidence, and economic issues. 3) Most participants had positive experiences using smart speakers in their homes. They found them easy to use, and they were eager to share their experience with their family and friends. It appears that this positive experience was helpful in improving their self-efficacy. Finally, participants reported that smart speaker had an emotional friendliness.

Our findings suggest that all five participants in the ethnography study were willing to learn to use a smart speaker and eager to adopt new technology. Some even suggested starting classes on how to use smart speakers and provided ideas for new features for the smart speaker.

V. CONCLUSION AND FUTURE WORK

The results show that smart speakers are helpful in reducing psychosocial barriers among the elderly toward new technology, and are perceived as an emotional companions. The comforts of using this technology and the emotional benefits could be ways to increase digital inclusion and self-efficacy among the elderly.

Although this study yielded some important findings, there are some limitations. The sample included only senior citizens enrolled in public ICT classes. These adults may be different from those in the larger community. In addition, the sample for observation may be too small to generalize the findings. However, the major purpose of this study was to obtain a deeper understanding of the use of technology among the elderly by using smart speakers. Smart speakers have the potential to become more popular in promoting the use of ICTs among the elderly.

In the future, we will develop a theoretical framework for further study based on the findings and insights gained from this study. In addition, the possibility of increasing the sample size to enable generalization will be considered.

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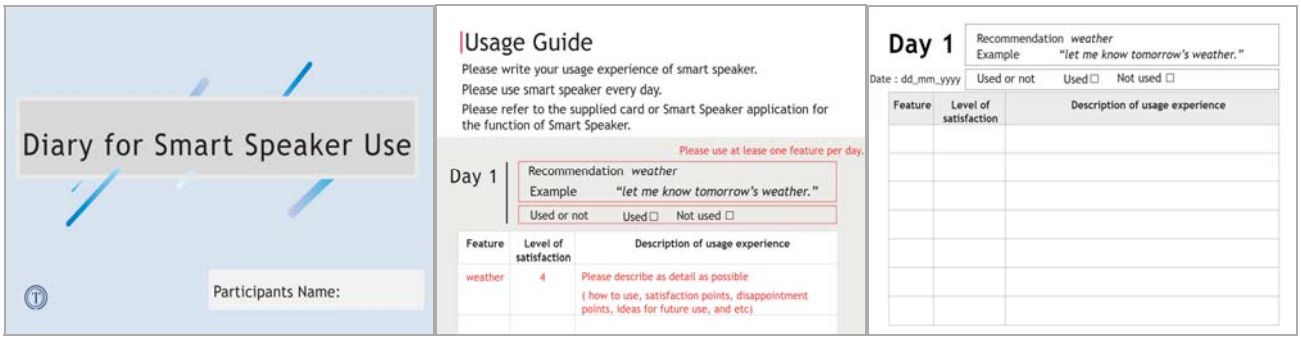

Figure 1. Example of self-diary given to participants (translated into English).