International Journal of Information Management 55 (2020) 102209

Contents lists available at ScienceDirect

International Journal of Information Management

journal homepage: www.elsevier.com/locate/ijinfomgt

Research Note

Wearable device adoption among older adults: A mixed-methods study

Samira Farivar[a,*], Mohamed Abouzahra[b], Maryam Ghasemaghaei[c]

[a] Sprott School of Business, Carleton University, Ottawa, Ontario, Canada
[b] College of Business, California State University, Monterey Bay, United States
[c] DeGroote School of Business, McMaster University, Hamilton, Ontario, Canada

ARTICLE INFO

Keywords:
Smart wearable devices
Older adults
Cognitive age
Complexity
Subjective well-being

ABSTRACT

Recently, the popularity of smart wearable technologies, such as Fitbit, has significantly increased. There are numerous potential benefits in using these devices, especially among seniors. Yet, little is known about seniors' adoption behavior. Through a mixed-methods approach, this study investigates the factors that impact seniors' intention to use wearable devices. Results from an online survey and interviews showed that seniors' perception of the complexity of working with these devices is a barrier to their adoption decisions. Looking more deeply into the role of complexity revealed that seniors' concern about the complexity of reading and interpreting the output of wearable devices is the main deterring element. Furthermore, we explored the role of two important elements: seniors' cognitive age, and the influence of their subjective well-being on their adoption behavior. Results demonstrated that cognitive age does not significantly impact use intention by itself; nonetheless, subjective well-being moderates its effect. This result revealed an interesting finding, which is that the influence of cognitive age on seniors' use intention depends on seniors' level of subjective well-being. When seniors' subjective well-being is low, surprisingly, cognitive age increases seniors' intention to use the device. These findings provide interesting implications for practice and future research.

1. Introduction

The growing popularity of mobile devices has led to the development of smart wearable technologies (Fang & Chang, 2016). Today, "smart wearable technologies" or "wearable devices" are widely available and have become increasingly popular, especially among young users. These devices, such as Fitbit, Smart Watches, etc., allow users to track and monitor physical activity, nutrition, health records, or sleeping habits. Recently, there has been a significant increase in the purchase and use of wearable devices; it has been estimated that the number of users in the US will grow from 45.8 million in 2018 to 67 million in 2022 (Wurmser, 2019). Academic and industry research has provided enough evidence that wearable devices are beneficial to their users as they can enhance users' physical activity through monitoring progress, sending motivational notifications, providing social support, and using other tested techniques (Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015; Lyons, Lewis, Mayrsohn, & Rowland, 2014; Mercer, Li, Giangregorio, Burns, & Grindrod, 2016; O'Brien, Troutman-Jordan, Hathaway, Armstrong, & Moore, 2015).

Despite the evident benefits of wearable devices for older generations, these devices are mainly appealing to young people. 17 % of US users are between 25–34, while only 3.3 % of users are 65 years of age or older (Wurmser, 2019). The number of older adults (age 65 and older) has been projected to rise from 46 million in 2016 to over 98 million by 2060, representing nearly 24 percent of the total population in the US (PRB, 2019). For older adults, being able to continue independent living is an important and critical issue. Wearable devices have the potential to help and support older adults' autonomy and improve the quality of their life by encouraging them to maintain a healthy lifestyle (Popescu, 2014). Furthermore, wearable devices can be integrated with healthcare systems to provide physicians with accurate and up to date information about older adults' vital signs and activity levels (Grover, Kar, & Davies, 2018; Lobelo et al., 2016). This integration can help in improving care for older patients and reduce their readmission rates.

The COVID-19 pandemic and its huge influence on the older population across the world shows that this population requires a high level of monitoring and care (Pan, Cui, & Qian, 2020). Smart wearable devices can play a significant role in improving the monitoring and tracking older adults' health. However, past research in seniors' use of technology has shown that seniors' attitudes and adoption behavior are mostly impacted by their perceptions of the complexity and the deterioration of their mental and physical capabilities (Ghasemaghaei, Hassanein, & Benbasat, 2019). To date, very few empirical studies have

* Corresponding author.
E-mail addresses: samira.farivar@carleton.ca (S. Farivar), mabouzahra@csumb.edu (M. Abouzahra), ghasemm@mcmaster.ca (M. Ghasemaghaei).

https://doi.org/10.1016/j.ijinfomgt.2020.102209
Received 15 April 2020; Received in revised form 25 July 2020; Accepted 27 July 2020
Available online 04 August 2020

focused on the adoption of wearable devices among older adults, especially in terms of the complexity of wearable devices and the impact of seniors' age and cognition. Hence, there is a limited understanding of the effects of these elements and their influence on seniors' adoption behavior. Moreover, as stated by a recent article (Dwivedi et al., 2020), in the current literature, there is still a lack of studying the behavior of vulnerable populations such as seniors. This study aims to fill this research gap by utilizing the complexity literature, aging theories, and well-being theories to investigate the role of cognitive age, perceived complexity, and subjective well-being of older adults in influencing their intention to use wearable devices.

Cognitive age refers to the individuals' self-perception of their age. In the IS literature, age has been mostly considered as the number of years from the birth of an individual (i.e. chronological age); nevertheless, studies have found that cognitive age is a better predictor of the behaviors of individuals, specifically among older adults (e.g. Hong, Lui, Hahn, Moon, & Kim, 2013). Moreover, it has been found that cognitive age impacts technology use among older adults; those who perceive themselves to belong to a younger age group are more interested in using high-tech products (Chang, 2008). Extending this literature, we focus on cognitive age to understand how it impacts the intention to use wearable devices among seniors. We suggest that older adults with lower cognitive age are more interested in using wearable devices.

Another important factor that might impact older adults' intention to use wearable devices is perceived complexity. Perceived complexity has been defined as "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers & Shoemaker, 1971, p. 180). Perceived complexity has been studied as an important barrier in using technology (e.g. Sullivan & Koh, 2019; Taylor & Todd, 1995). Following the findings in the literature, we are proposing that the perceived complexity of working with wearable devices would negatively impact the intention to use them.

Finally, the last element which we consider in this study is subjective well-being. Subjective well-being (SWB) explains individuals' evaluations of their lives. SWB has been found to be an important goal in human lives; individuals evaluate their lives to be going well if they consider their SWB as positive (Diener, 2000; Şimşek, 2009). SWB has been extensively studied in the fields of health and psychology (e.g. Bookwala & Schulz, 1996; Costa & McCrae, 1980; Diener, 1984; Diener, Oishi, & Lucas, 2003), and the literature has emphasized its importance in our lives, especially as we become older (e.g. Diener & Suh, 1997; Pinquart & Sörensen, 2000). According to the literature, SWB plays a role in technology adoption among older adults (Scherer, Craddock, & Mackeogh, 2011). Extending the current findings, we are interested in exploring the role of SWB in influencing the intention to use wearable devices among older adults. More specifically, we are suggesting that SWB impacts these two relationships: cognitive age-intention to use, and perceived complexity-intention to use.

In this study, we opted to use a mixed-methods approach by first analyzing a quantitative survey to test our hypotheses, which was followed by interviewing seniors who have not used a wearable device before. Seniors' adoption of technology is a relatively understudied domain with few studies focusing on seniors' use of technology in general and wearable devices in particular (Fox & Connolly, 2018). Using mixed-methods allowed us to address this lack of research by triangulating our findings from the quantitative survey while helping us to understand the context and processes associated with using wearable technology (Ben Yahia, Eljaoued, Bellamine Ben Saoud, & Colomo-Palacios, 2019; Creswell & Clark, 2007). By conducting this study, we not only provide practical suggestions to enhance the development of wearable devices, but also, we contribute to technology adoption literature by integrating complexity literature and psychological research to investigate seniors' adoption of wearable devices. This investigation will help to improve our understanding of this important population.

The rest of this paper is organized as follows. The next section describes a background of key concepts and theories. We then present the research framework and hypotheses, and report the methodology, data analyses, and results. Finally, we conclude by highlighting the research and practice implications, acknowledging the limitations, and pointing to potential future directions.

2. Theoretical background

2.1. Wearable devices and older adults

In this study, the term "Wearable Devices" refers to the devices that will be physically attached to the users in order to monitor some aspects of their behaviors, such as their physical activity (number of steps, distance, calories burned, etc.) and their vital signs (heart rate, blood pressure, etc.) (EL Idrissi, Idri, & Bakkoury, 2019; Sultan, 2015). Wearable devices are able to improve the quality of life by enhancing individuals' physical activity (e.g. Finkelstein et al., 2016; Lee, Kim, Ryoo, & Shin, 2016; Park & Jayaraman, 2003). These devices encourage the users to be more active by sending motivational notifications, comparing their statistics with their social peers, and other techniques, such as using systems of rewards and social interactions (Patel, Asch, & Volpp, 2015).

The increasing popularity of wearable devices has led to an emergent research area. However, the existing studies mostly focus on establishing the reliability and accuracy of wearable devices (e.g. Byun, Barry, & Lee, 2016; Diaz et al., 2015; Huang, Xu, Yu, & Shull, 2016; Leininger, Cook, Jones, Bellumori, & Adams, 2016; Mahar, Maeda, Sung, & Mahar, 2014). In the current literature, very few studies have explored the factors influencing the use and adoption of wearable devices. For instance, Nasir and Yurder (2015) studied the role of perceived benefit and perceived risk in the adoption of wearable healthcare devices, and they found both elements play significant roles. In another study, Kim and Shin (2015) used the Technology Acceptance Model (TAM) to understand the adoption of smartwatches; they also considered the role of subcultural appeal and smartwatch cost. Potnis, Demissie, and Deosthali (2017) identified elements such as social influence, trusting beliefs, and effort expectancy as the main drivers of intention to use wearable devices. Marakhimov and Joo (2017) focused on consumers' concerns about their privacy and studied how these concerns impact use. However, there is still a lack of understanding of the most critical factors that impact seniors' intention to use these devices.

Wearable devices have numerous potential benefits, specifically for older adults. Despite calls to focus on older samples in technology adoption literature (Li, Gupta, Zhang, & Sarathy, 2014), this group still remains largely understudied. Moreover, there have been inconsistency in defining older adults and their age range in the literature (Fox & Connolly, 2018). The retirement age is usually 60 or 65 across countries and according to reports, in many countries, including North America, older adults or seniors refer to individuals who are 65 or greater years old (WHO, 2013). In this study, to represent older adults, we also use 65 as the age threshold; since, this age group (65 +) has been mostly used by research centers' reports (e.g. PEW, 2020; Statista, 2018), and current literature (e.g. Choi, 2011; Ghasemaghaei et al., 2019) to represent older adults; and individuals in this age group have been found to have a limited technology use compared to younger adults (Fields, 2019; Forbes, 2019); hence, we believe it is important to focus on this age group and understand barriers in their technology, specifically, wearable device adoption.

Wearable devices track users' daily activities to understand their behaviors and improve them; for instance, if the user has been sitting longer than usual, the device would notify the user to get up and move, or they can help the user to improve their breathing pattern. In addition, these devices can send notifications to remind taking medications or attending appointments. Hence, they can help seniors to have independent and healthy lives. Despite the potential benefits for older adults, the adoption rate is still low among seniors (Levine, Lipsitz, & Linder, 2016). The review of pertinent literature in IS shows that very few studies have focused on the older adults as the potential users of wearable devices to better understand the elements that can increase use among this age group. Moreover, the limited literature in this domain either followed technology acceptance models (TAM, UTUAT) (e.g. Niehaves & Plattfaut, 2014) or used qualitative methods to describe the adoption of technology among seniors (e.g. Abbey & Hyde, 2009). While current literature and theories exploring older adults' behavior have emphasized the important role of age (e.g. Dwivedi et al., 2020; Hong et al., 2013; Ziefle & Bay, 2005), complexity perceptions (e.g. Chouk & Mani, 2019; Pattison & Stedmon, 2006), and subjective well-being in influencing seniors' behaviors (Chopik, 2016; Garatachea et al., 2009) there is still a lack of understanding on the role of these factors in senior's behavior in the literature. In this study, we try to address this research gap. Specifically, few follow the complexity, cognitive load theory, and aging theories to explore the role of seniors' cognitive age, subjective well-being, and perceptions regarding the complexity of these devices, in terms of input data and output data, in their adoption behavior.

2.2. Complexity perception

Complexity refers to the degree to which individuals perceive innovation to be difficult to use or understand (Rogers & Shoemaker, 1971). Following this definition, we define complexity as older adults' perceptions about the difficulties of using wearable devices. Cognitive complexity theory (Kieras & Polson, 1985) explains the difficulties in accepting and adopting new technologies by considering the interaction between users and their devices. One critical concept that is being considered throughout the design of human-centered technologies is reducing the complexity and users' experienced cognitive load. Cognitive load has been defined as "the mental resources a person has available for solving problems or completing tasks at a given time" (Oviatt, 2006, p. 873). Cognitive load theory (Van Gerven, Paas, Van Merriënboer, & Schmidt, 2000) mainly discusses the limitations of human working memory capacity and suggests optimizing the design of tasks to efficiently use the limited capacity of human memory. This concept becomes more important in designing new technologies, specifically for older adults (Goodman, Syme, & Eisma, 2003; Pattison & Stedmon, 2006). Hence, in this study, we focus on the perceived complexity of wearable devices as an important element that impacts older adults' adoption intention. To better understand the role of perceived complexity, we consider it from two perspectives: 1: the complexity of working with the device in the initial setup, such as entering personal data (e.g. weight, height, age, etc.) and pairing the device with smartphones, and 2: the complexity of working with the device to read and interpret the results (e.g. steps taken, mileage walked, exercised, heart rate data, breathing pattern, etc.). We believe that understanding seniors' perceptions regarding the complexity of wearable devices in both input and output stages are very important, especially for developers; it will enable them to focus on specific concerns of seniors and make wearable devices more acceptable and easier to use among this specific age group.

2.3. Aging theories

Theories of psychological aging suggest that seniors experience challenges and limitations in their cognitive abilities (Kooij, de Lange, Jansen, & Dikkers, 2008). Because of these limitations, older adults face difficulties in using information technology applications (Becker, 2004). Three relevant aging theories are the resource, speed, and inhibition theory (Cabeza, 2002). Resource theory focuses on attentional capacity and explains the limitations older adults face in allocating the cognitive resources to a specific cognitive task (Kahneman, 1973). Speed theory suggests that aging reduces the information-processing speed, which leads to difficulties in cognitive functioning (e.g., Birren, Woods, & Williams, 1980; Cerella, 1985; Salthouse, 1996). Inhibition theory argues that aging is associated with impairments in the ability to filter and dismiss irrelevant information when focusing on a given task (e.g., Balota, Dolan, & Duchek, 2000; Hartman & Hasher, 1991; Hasher, Stoltzfus, Zacks, & Rypma, 1991).

Following these theories, studies show that older adults face much greater difficulties in using new technologies when compared to younger users (e.g. Charness & Boot, 2009), which could be a result of having less cognitive resources, lower speed in information processing, and difficulties ignoring irrelevant information. It is thus harder for older adults to adapt to new technologies (Page, 2014). Therefore, developers should put more effort into making IT applications simpler for this age group (Czaja et al., 2006). Following the extant literature, we are interested in exploring whether the negative impact of aging on adopting new technology is also true for wearable devices. In this study, we consider "cognitive age" as a measure for understanding the impact of age on wearable device adoption. Cognitive age refers to individuals' perceptions of their age based on their looks, feelings, actions, and interests (Barak & Gould, 1985; Barak & Schiffman, 1981). According to aging research, most adults tend to perceive themselves younger than their chronological age (Kastenbaum, Derbin, Sabatini, & Artt, 1972); therefore, their behaviors cannot be predicted solely based on their chronological age (Hong et al., 2013; Lindberg, Näsänen, & Müller, 2006). Therefore, researchers have suggested using cognitive age as the appropriate measure of older adults' age since it can better describe older adults' lifestyle (e.g. Iyer, Reisenwitz, & Eastman, 2008), explain their decisions (e.g. Ying & Yao, 2010), and predict their behaviors, such as purchasing (e.g. Myers & Lumbers, 2008).

Furthermore, in the context of IT, cognitive age has been found to better represent users' age rather than chronological age (Chang, 2008; Eastman & Iyer, 2004; Ghasemaghaei et al., 2019; Hong et al., 2013). For instance, according to the literature, older adults who feel cognitively younger and not necessarily chronologically age younger, show more interest in using new technologies (Wenzke, 2014). Hence, in this study, we use cognitive age as the appropriate measure to understand the impact of age on using wearable devices.

3. Research model and hypotheses

Fig. 1 depicts our proposed research model which illustrates the impact of complexity perception and cognitive age on intention to use wearable devices. It also shows the moderating role of subjective wellbeing on these associations.

3.1. Complexity and intention to use

Perceived complexity has been identified as an element that can demotivate individuals to use a technology/innovation (e.g., Marshall & Byrd, 1998; Taylor & Todd, 1995). Following Thompson, Higgins, and Howell (1991), we consider two perspectives for the perceived complexity of wearable devices: input complexity and output complexity. Input complexity refers to older adults' perceptions regarding the level of complexity in working with wearable devices to enter the input data (i.e. their personal information such as weight, age, etc.), and output complexity describes the perceptions about the complexity of working with the wearable device to read and interpret the output data (such as heart rate, the distance walked, sleeping habits, etc.). As we described, cognitive complexity theory emphasizes the limitations of human memory and how these limitations impact interests and abilities in performing complex activities (Kieras & Polson, 1985). Applying cognitive complexity theories in different contexts, studies have shown that the perceived complexity of technology increases resistance and reduces individuals' adoption intention (e.g. Joseph, 2010; Ram, 1987; Schmitz, Teng, & Webb, 2016; Thompson et al., 1991). For instance, human-computer interaction literature has shown that complex

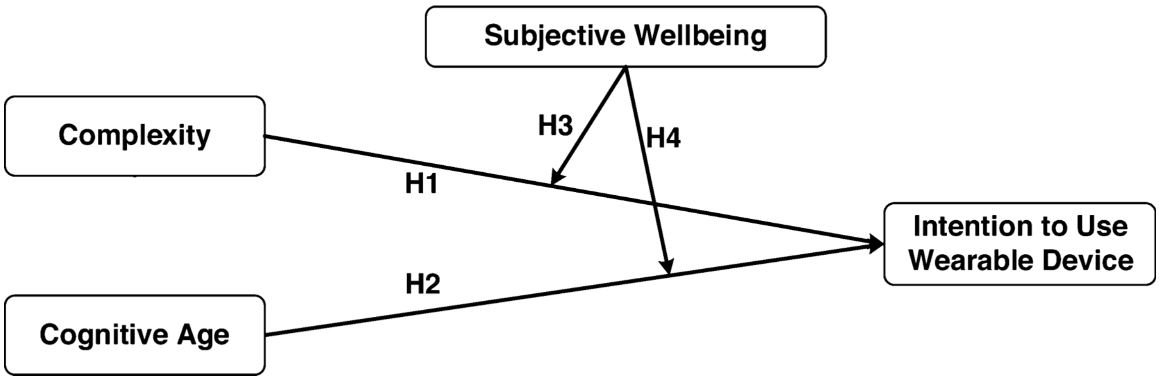

Fig. 1. Research Model.

computer technologies will be adopted at lower rates (e.g. Jiang, Wang, Tan, & Yu, 2016; Moore & Benbasat, 1991; Page & Uncles, 2014; Thong, 1999). In other contexts, such as internet and mobile banking, perceived complexity has also been identified as a significant barrier (e.g. Laukkanen, Sinkkonen, Kivijärvi, & Laukkanen, 2007). The deterring role of perceived complexity becomes more significant in seniors' adoption behavior since the limitations of human working memory increase with age (Goodman et al., 2003; Pattison & Stedmon, 2006). Following the literature and applying cognitive complexity theory, we consider perceived complexity as a deterrent element in seniors' adoption of wearable devices.

H1. Perceived complexity of wearable devices would reduce seniors' intention to use the device.

3.2. Cognitive age and intention to use

Aging theories suggest that interest in experiencing new activities reduces with age (e.g. Charness & Boot, 2009) because older adults face greater limitations in their cognitive resources and information processing (Page, 2014). As we described in the previous section, cognitive age has been found to better measure individuals' age and predict behaviors (Sudbury-Riley, Kohlbacher, & Hofmeister, 2015; Teller, Gittenberger, & Schnedlitz, 2013). Cognitive age refers to individuals' perceptions regarding their age level based on their feelings, looks, actions, and interests (Barak & Gould, 1985). Thus, following the literature, we consider individuals' cognitive age instead of their chronological age.

Current literature on cognitive age has shown that individuals with greater cognitive age are less efficient, have less attentional capacity, and process information more slowly (e.g., Ziefle & Bay, 2005). Following the aging theories, limitations in processing information deter older adults from experiencing new activities. Applying aging theories to the context of technology use, studies have found a negative relationship between cognitive age and technology use. For instance, in the context of Internet use, seniors with lower cognitive age have been found to be more interested and enthusiastic about using and learning a new technology (e.g. Eastman & Iyer, 2005). By extending the aging theories and current findings in cognitive age literature, we hypothesize that older adults with lower/greater cognitive age will be more/less interested in using wearable devices.

H2. Cognitive age is negatively associated with seniors' intention to use the device.

3.3. Subjective well-being

Subjective well-being (SWB) is a psychological concept representing individuals' evaluations of their lives (Diener, 1984). SWB is usually considered to be one of the most important goals of individuals throughout their lives (Tay, Kuykendall, & Diener, 2015). Literature has shown that people consider SWB to be a more important factor in evaluating the quality of life than moral goodness or wealth factor (Chiu, Cheng, Huang, & Chen, 2013; Diener, 2000; King & Napa, 1998). One of the most relevant interpretations of SWB belongs to Diener (2006), who defines it as "all of the various types of evaluations, both positive and negative, that people make of their lives" (p. 153). Following Lawton (1975), we measure SWB through three first-order constructs: *agitation*, *attitude toward aging*, and *dissatisfaction*. Agitation describes anxiety and worries; attitude toward aging refers to individuals' perceptions of the changes in their lives as they age; and dissatisfaction measures how dissatisfied are individuals with their lives (Shmotkin & Hadari, 1996).

SWB has been extensively studied in the medical and psychological literature (e.g. Costa & McCrae, 1980; Diener, 1984; Diener, Lucas, & Oishi, 2002). Previous studies show that SWB plays a role in affecting people's tendencies in adopting technology (e.g. Scherer et al., 2011). Current findings on SWB reveal that people with higher SWB show more passion for attaining future goals and giving meaning to their lives (e.g. Pinquart, 2002). Extending these findings, we suggest that in the context of wearable devices, SWB would influence the adoption of wearable devices in older adults by moderating the impacts of cognitive age and complexity on intention.

Lower levels of SWB mean that seniors have higher levels of stress and anxiety (i.e. agitation), have a negative attitude toward aging, and are also unsatisfied with their lives. Studies on technology literacy have extensively studied stress and anxiety as the main negative elements influencing attitudes toward technology and technology adoption (Tarafdar, Pullins, & Ragu-Nathan, 2015; Lee, Chen, & Hewitt, 2011). Moreover, individuals with higher levels of anxiety are found to react more adversely to uncertainty (Ladouceur, Gosselin, & Dugas, 2000). The literature on older adults suggests that seniors with lower SWB have been found to react more intensely to stressful situations (Bellingtier & Neupert, 2016; Laidlaw, 2010; Neupert & Bellingtier, 2017). Furthermore, studies have demonstrated that seniors who are not happy with their lives deal with greater physical and mental health problems (Steptoe, De Oliveira, Demakakos, & Zaninotto, 2014; Ziółkowski, Błachnio, & Pąchalska, 2015). Following these findings, we hypothesize that seniors who have lower levels of SWB show more stress and would react more negatively to the unknown and stressful conditions; hence, the negative effects of their complexity perceptions on their use intention would become more significant. On the other hand, for older adults who have higher subjective well-being, the negative role of perceived complexity in reducing their intention would be less significant.

H3. SWB will positively moderate the relationship between perceived complexity and intention to use such that the negative relationship will become stronger (more negative) when subjective well-being is low.

As suggested by literature, lower levels of SWB increase the negative emotions and unfavorable reactions among individuals (Mackinnon, Kehayes, Leonard, Fraser, & Stewart, 2017). Low SWB is an indicator that the person is experiencing stress and anxiety, has negative attitudes toward aging, and is not satisfied with his/her life (Lawton, 1975). Thus, seniors with low levels of SWB would form more negative feelings around their age and will see aging as an obstacle in their lives. Building on these findings, we suggest that for seniors with lower levels of SWB, the negative impact of cognitive age on intention to use the wearable device would be more intense and on the other hand, when seniors have higher levels of SWB, the negative impact of cognitive age would become weaker.

H4. SWB will positively moderate the relationship between cognitive age and intention to use such that the negative relationship will become stronger (more negative) when SWB is low.

4. Methodology

There have been recent calls in Information Systems (IS) literature to use mixed-methods approach to generate meaningful insights in studying complex and underdeveloped contexts (Venkatesh, Brown, & Bala, 2013). To develop a multi-perspective understanding of wearable device adoption among seniors, we have opted to use the mixed-methods approach (combination of qualitative and quantitative methods). Participants in this study were all aged over 65. The study commenced by collecting data through an online survey to test the research model. We then conducted interviews with seniors to support our survey findings.

4.1. Quantitative study

The quantitative study started by conducting a pilot test. We collected a sample of 50 responses from seniors (age greater than 65). The reliability and validity of the adapted measurement scales (Table 1) were checked. All scales' alpha, composite reliability, and average variance extracted (AVE) scores were greater than 0.7 and the expected factor loading structure was presented for most constructs. The "dissatisfaction" subconstruct had six items in the reference we used Lawton (1975); however, two of these items ("I often feel lonely", "I do not often see my friends and relatives") did not show significant loadings in our pilot test, we believe the reason is that these items are mostly reflecting the loneliness and not dissatisfaction. Therefore, in collecting data for hypotheses testing, we did not include these two items. Data were collected from 280 seniors, and the collected data were analyzed using SmartPLS 3.0 (Ringle, Wende, & Becker, 2015).

4.1.1. Participants and procedure

We collected data through an online survey, which was distributed to North American seniors (age 65 years and above). We targeted seniors who are aware of wearable devices, how it functions, and have some experiences in using the device in the past. We sent the survey to 600 seniors and obtained 280 valid responses (response rate:46 percent), which included 143 male, and 137 female. Out of the sample, 38.5 % had a high school degree, 36.7 % had a college diploma, 7.5 % had a bachelor's degree, and 16.7 % had a graduate degree. Regarding the use of the device, 75 % of respondents had low amount of experience, 11 % had some experiences, and 14 % had a high to very high amount of experience in using wearable devices.

4.1.2. Measurement

We adapted the measurement items from well-established scales in the literature (Table 1). All items were measured on a 7-point Likert scale. SWB and perceived complexity were operationalized as second-order formative constructs, which support their conceptualization and operationalization in previous literature. All other constructs were measured as reflective. We also controlled for the impact of demographic factors, including users' gender, education level, and experience in using wearable devices. Fig. 1 depicts our proposed research model.

4.2. Qualitative study

While the quantitative component of this study employed the general theories associated with aging to examine the effect of complexity and cognitive age on the use of wearable devices, it does not consider the contextual characteristics of wearable device use, and does not provide insights into the cognitive processes that govern the interactions between cognitive age, complexity, and subjective well-being that influence the use of wearable devices. Therefore, we followed our quantitative study with a qualitative study that focuses on contextualizing our quantitative findings and explaining the socio-cognitive processes that underlie the effects of the study constructs. Mixed-methods approach (sequential Quantitative → Qualitative) can enable us to triangulate findings from both quantitative and qualitative studies and develop a multi-perspective understanding of wearable device adoption among seniors.

Participants in this study were male and female seniors (age 65 and up) living in Ontario, Canada and in California, USA, who have not used any wearable devices before. Participants were recruited by direct advertising in a local paper and from local seniors' centers. Forty-four participants were recruited and in total, we conducted eighty-eight (88) interviews before and after using wearable devices (here Fitbit). Specifically, we conducted two interviews for each participant: one interview before using Fitbit and one interview after using it. Table 2 below describes the demographics of the participants.

4.2.1. Data collection and analysis

Data were collected in phases and from different sources. At *phase 1*, we conducted semi-structured interviews with individual participants. The interview questions focused on current level of activity, exercise routine, perceptions of wearable devices, and potential use of wearable devices. After the interview, we provided each of the participants with a wearable device ("Fitbit") and asked them to keep it on all the time for one week.

At *phase 2* (one week after the first interview), we conducted a second interview. The second interview focused on whether seniors' perceptions of wearable devices had changed after use. Collected interview data were transcribed and anonymized for further analysis.

To enhance the reliability and validity of the qualitative study, verification methods (Morse, Barrett, Mayan, Olson, & Spiers, 2002; Wacker, 1998) were implemented by: (1) Employing purposive sampling to make sure that participants who were sampled covered the whole range of wearable device users in terms of behavior and demographics. In this case, interviews were planned to contain a representative sample of seniors from 65 to 75 years old of both genders and of different income levels; (2) Carrying out data collection and analysis simultaneously. The outcome of one interview was used to drive subsequent interviews, creating an iterative process to make sure that all themes were covered; (3) Findings of the analysis were discussed with participants to refine the outcomes; and (4) An audit trail was maintained throughout data collection and analysis.

The interview transcriptions were reviewed by one of the researchers to verify their accuracy. They were coded by two independent researchers. Differences between coders were resolved through discussions. Analysis was conducted using thematic analysis (Braun & Clarke, 2006). The themes used in the analysis were based on the theoretical model constructs (input/output complexity, SWB, and cognitive age). In addition to these constructs, we looked for other themes that can help in understanding the context of the quantitative findings. The results of the qualitative study are used to triangulate and explain the quantitative results.

Table 1
Measurement Items.

Construct	Items	Resource
Intention to use device	1. In the future, I intend to use a wearable device. 2. In the future, I plan to use a wearable device. 3. In the future, I predict that I would use a wearable device.	(Venkatesh, Morris, Davis, & Davis, 2003)
Perceived complexity		(Thompson et al., 1991)
Perceived input complexity	1. Working with a wearable device to enter the input data is complicated; it is difficult to understand how to input data in the setup stage. 2. Using a wearable device involves too much time doing operations in the setup and initial data entry stage. 3. In the setup stage, it takes too long to learn how to enter the input data into a wearable device to make it worth the effort. 4. Working with a wearable device in the initial setup stage (to enter the input data) is so complicated.	
Perceived output complexity	1. Working with a wearable device to read the output data is complicated; it is difficult to understand how to read and interpret data. 2. Using a wearable device involves too much time doing operations in the output stage (to read and interpret data) 3. It takes too long to learn how to read the output data from a wearable device to make it worth the effort. 4. Working with a wearable device in the output stage (to read the output data) is so complicated.	
Cognitive age	Please specify which age group (20 s, 30 s, 40 s, 50 s, 60 s, 70 s, 80 s, 90 s) you FEEL you really belong to regardless of your chronological age (the date of birth age)? 1. I FEEL as though I am in my… 2. I LOOK as though I am in my… 3. I DO most things as though I were in my… 4. My INTERESTS are mostly those of a person in his/her…	(Barak & Schiffman, 1981)
Subjective well-being (all items were revered to measure positive well-being)		(Lawton, 1975)
Agitation	1. Little things bother me more this year. 2. I sometimes worry so much that I can't sleep. 3. I get mad more than I used to. 4. I am afraid of a lot of things. 5. I take things hard.	
Negative attitude toward aging	1. Things keep getting worse as I get older. 2. I do not have as much energy as I had last year. 3. As I get older, I am less useful. 4. As I get older, things are worse than I thought they would be. 5. I am not as happy now as I was when I was younger. *	
Dissatisfaction	1. I am not satisfied with my life. 2. I have a lot to be sad about. 3. Life is hard for me most of the time. 4. I sometimes feel that life isn't worth living.	

Note: * items dropped in analyses.

Table 2
Participants' Demographics.

Dimension	Category	Number
Male	65–69 years old	11
	70–75 years old	9
Female	65–69 years old	14
	70–75 years old	10
Income	Less than $30,000	19
	$30,000–$50,000	12
	50,000–70,000	10
	More than 70,000	3

5. Results

5.1. Quantitative study results

The proposed model was tested using PLS techniques with Smart PLS 3.2 (Ringle et al., 2015) and bootstrapping with 1000 re-samples (Gil-Garcia, 2008). First, we assessed the validity and reliability of the measurement model. Table 3 shows the values for Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). As demonstrated in this table, the results showed reasonable convergent validity (alpha and CR over 0.7 and AVE over 0.5), and discriminant validity (square root of AVE larger than correlations). Table 4 shows the loadings and cross-loadings. All items except one (marked with star in Table 1) loaded nicely on their relevant construct. One item of attitude toward aging cross-loaded on dissatisfaction; this likely happened because of the phrase "I am not happy" in this item. This item was dropped from subsequent analysis. To test the potential presence of common method bias, we followed several procedures. First, we performed Herman's single factor test; according to the results, 5 factors accounted for 70 % of the variance and no single factor described more than 30 % of the variance. Following the recommendation by Kock (2015), we also conducted a full collinearity test in SmartPLS; the result showed that all VIFs (factor level) are lower than 3.3. Thus, we can assume that common method bias is not part of our model.

After assuring the reasonableness of the measurement model, we tested the structural model. Fig. 2 shows the results of testing the structural model. As it is shown in this figure, one of our hypotheses (H1) was supported; however, H2 and H3 were not supported. The results regarding the moderation effect of SWB on the relationship between cognitive age and intention (H4) were surprising. We hypothesized a positive moderation; however, the results showed that there is a negative moderation. This means that when seniors consider their well-being as not good (low SWB) and they perceive their age to be relatively old (higher cognitive age) and they are actually more interested in using wearable devices. Additionally, when they consider their SWB as high, cognitive age does negatively impact their intention.

Table 3
Reliability and Discriminant Validity.

Construct	α	CR	AVE	1	2	3	4	5	6
1. Agitation	0.801	0.862	0.557	**0.746**					
2. Attitude Toward Aging	0.805	0.865	0.564	0.6	**0.751**				
3. Dissatisfaction	0.793	0.865	0.617	0.596	0.67	**0.785**			
4. Input Complexity	0.916	0.941	0.8	−0.229	−0.273	−0.207	**0.895**		
5. Intention to use	0.982	0.988	0.965	−0.002	0.030	0.049	−0.477	**0.982**	
6. Output complexity	0.943	0.959	0.855	−0.232	−0.321	−0.228	0.790	−0.492	**0.925**

Notes: n = 280. CR, composite reliability; AVE, average variance extracted.

Table 4
Cross-Loadings.

Note: *Items Cross-loaded or showed nonsignificant poor loadings.

That is an interesting finding, which will be explained in detail in the discussion. Among control variables, gender and experience had positive and significant impacts on intention. Female users as well as those who have the experience of working with devices showed more interest in using the devices in future.

5.1.1. Post-hoc analyses

To shed more light on quantitative findings, we performed several post-hoc analyses. First, we considered the possibility that there might be differences between users' perceptions regarding the complexity of entering data into the wearable device (i.e. input complexity) and reading the results from the device (i.e. output complexity). To investigate this, we checked the direct relationship between input complexity and intention to use the device, and between output complexity and intention to use the device. The results of this test showed that only users' perception about *output complexity* (reading data and interpreting it from the device) is demotivating, and there was no significant relationship between input complexity and intention to use the device. This is an interesting finding that can provide insights for developers of these devices.

Second, in order to better understand the moderation effects, we used common moderation plotting techniques. Fig. 3 shows the interaction plot. As SWB changes from high to low, the negative relationship between cognitive age and intention becomes less negative. It shows that cognitive age reduces intention only for high values of SWB, and this negative relationship becomes less negative as SWB decreases. For low values of SWB (smaller than one standard deviation below the mean), the relationship becomes positive. This means that older adults' cognitive age negatively affects their use intention only when older adults' SWB is high (equal to the mean of SWB in the sample or higher). However, when they are not happy with their well-being (SWB lower than one standard deviation below the mean), as they perceive themselves to be older, they become even more interested in using wearable devices. This is a surprising result which shows that older adults who have low SWB are probably afraid of losing their physical abilities, and this fear is stronger when they also see themselves older (low cognitive age). Therefore, they show more interest in using devices, as they think that using devices can help them to improve their situation.

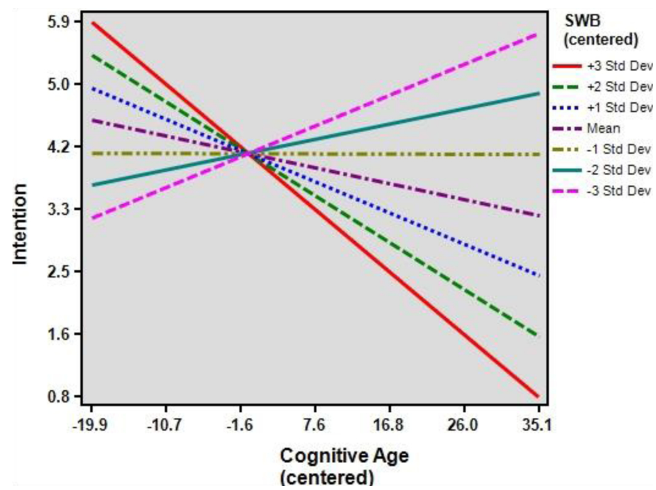

Fig. 3. Interaction plot.

Finally, we conducted another post-hoc to compare cognitive age and chronological age and assess whether using chronological age

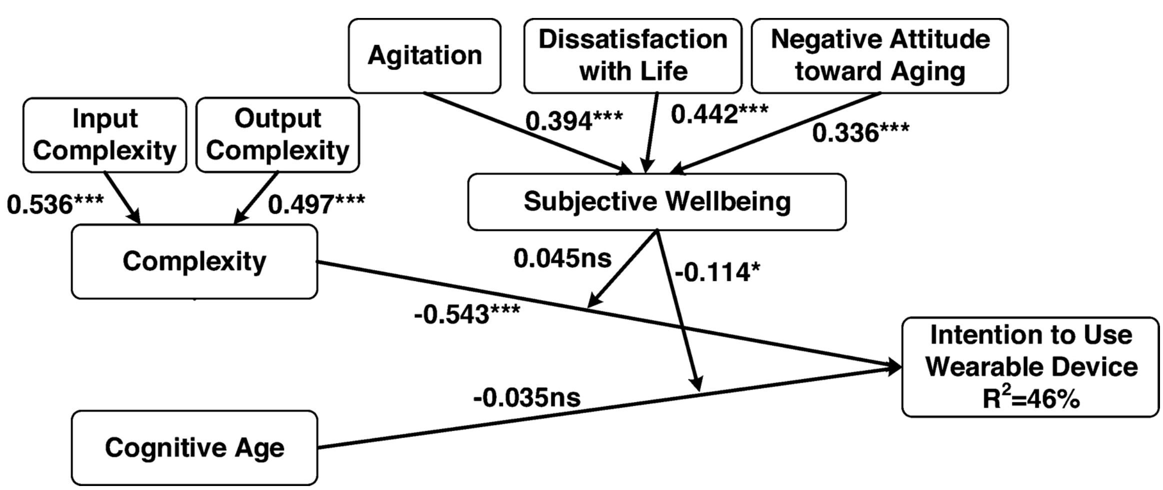

Fig. 2. The Structural Model.
Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

instead of cognitive age may result in different findings. Among our respondents, the average chronological age was 71 and the average cognitive age was 54. By including chronological age in the model, the impact of chronological age on intention to use was not significant (similar to the model with cognitive age). Further, the moderation effect of subjective well-being on the age-intention relationship was not significant in the model with chronological age. This is contrary to the finding in the original model using cognitive age, in which subjective well-being moderates the effect of cognitive age on intention to use. As indicated in the interaction plots, when seniors' well-being is low, as they perceive themselves to be older and they become more interested in using wearable devices. This behavior might occur because seniors who have lower subjective well-being are more afraid of their health and physical condition, and this fear increases as they consider themselves older; hence, they become more interested in using wearable devices to improve their condition. However, this behavior was not observed through chronological age. We call for future studies to investigate the impacts of chronological age in greater detail and elaborate on the differences between cognitive and chronological age in this context.

5.2. Qualitative results

5.2.1. Complexity and the use of wearable technology

The interviews showed that the input and output complexity of wearable devices had significant impacts on seniors' use of wearable devices. Seniors discussed several forms of complexity and how it impacts their decision to use wearable devices. While explaining how to use wearable devices to seniors during the first set of interviews, some of the seniors doubted their ability to manage the "complex" system of wearable devices, especially when we explained how to set up the mobile application and synchronize the wearable device with the smartphone. For example, one senior said that "It sure takes a long time to use this Fitbit, I'm not sure it's worth it." Several of the seniors, despite seeing the value of using wearable devices, showed reluctance to use them due to the long process of entering their data into the wearable device app. On the other hand, some seniors had no issues with the complexity, and they were able to set up their own devices and enter their data with no issues. One of these seniors said, "You young people think we cannot use technology. You forget our generation invented computers."

After using the devices, as the second set of interviews showed, seniors were more concerned with the output complexity of the wearable device. Wearable devices presented them with different forms of data, including heart rate, calories burnt, steps taken, and sleep patterns. In our post-use interviews, seniors talked mostly about their steps and the number of floors they ascended. They were sometimes frustrated by the device "inaccuracy" in calculating their steps. One senior said, "I don't want to use Fitbit anymore, I kept going up and down the stairs and it didn't show that." That was because these measurements were direct and easy to understand. However, many of them faced difficulties in understanding the meaning of other measurements and how they should respond to them. They asked a lot about how to interpret those measurements and how to use them.

When we asked seniors if they were willing to use the wearable device, the complexity of using the device was a major reason for saying no. They felt that the complexity of using the wearable device and interpreting its output were major obstacles for them. Interviews also exposed the factors that influence seniors' perception of the complexity of the wearable device. Seniors perceived wearable devices as less complex when they observed others using it. For example, a senior mentioned that "everyone in the gym is wearing one, I'm sure I can use it too." This was especially true for those who practiced in groups. Another factor that emerged was the seniors' level of comfort with technology. Seniors who were familiar with using different technologies such as smartphones and smart TVs thought of wearable devices as less complex than seniors who had less or no experience with technology.

5.2.2. Cognitive age and wearable device use

Some seniors used the proverb "You can't teach an old dog new tricks" during initial interviews and indicated that they were too old to use a wearable device, and followed up by saying "I'm going to stick to the gym" in the post-use interviews. However, most of the seniors we interviewed (over 85 %) did not mention their age when they talked about their ability to use the wearable device in the initial interviews. In the post-use interviews, they blamed the technology itself either by pointing to the complexity or inaccurate data or by suggesting "perhaps I had a faulty one." Our interpretation is that cognitive age does not play an important role in seniors' use of wearable devices compared to the perceived complexity of the technology. Seniors are reluctant to blame their own cognitive or age-related abilities for the failures of the technology.

An interesting finding is that while the use of wearable devices did not depend on cognitive age, the depth of this use did. While seniors who perceived themselves as younger used more features of the wearable device, such as sleep pattern monitoring and activity sharing with others, seniors with a higher cognitive age used fewer and more simple features, such as the calorie counter and step counter.

5.2.3. Subjective well-being role

Subjective well-being was an interesting construct. Our interviews showed that study participants, regardless of their activity or exercise level, evaluated their subjective well-being by comparing their level of activity with their peers' activities or with their own activities when they were in a better condition.

During the initial interviews, participants significantly linked their subjective well-being with their level of exercise. Those who talked about being unhappy with aging and not being satisfied with their life conditions expressed their discontent with their current activity level compared to their peers or to themselves when they felt better. Several participants were reluctant to use the wearable devices because they thought that the measurements of the devices would be too low compared to their previous levels of activities. We heard participants saying, "I am still recovering from an injury and my readings will not be good" or "I wish I had this device when I was in a better condition". When we explained how the wearable devices work, especially the reward system and alarms, even though these participants expressed their concerns regarding the complexity of these devices, they also were curious about how these devices could improve their physical performance compared to their peers. On the other hand, participants with a better sense of well-being were more open to using the wearable devices and showed interest in recording and understanding their performance metrics. After participants used the wearable device, those with lower subjective well-being used more features of the wearable device than those with a higher sense of well-being. Furthermore, participants with low subjective well-being were more motivated to continue to use the device.

6. Data integration and discussion

To provide a more comprehensive picture, we examined the relationships in our model to determine whether the quantitative and qualitative results were complementary (offer similar views), convergent (enhance findings when combined), or dissonant (offer differing insights) (Fox & Connolly, 2018; O'Cathain, Murphy, & Nicholl, 2010). The integrated results are presented in Table 5.

6.1. Discussion

This research aimed to understand the use of wearable devices among seniors and the role of cognitive age, complexity, and subjective well-being in impacting their use intention. We developed a mixed-

Table 5
The integration of quantitative and qualitative results.

Hypothesis	Supported in quantitative study	Qualitative findings	Integration
Input complexity- > complexity	Yes	Input complexity (entering user info, setting up device) contributed to seniors' perception of WD complexity.	Convergent
Output Complexity- > Complexity	Yes	Output complexity (interpreting device results increased seniors' perception of complexity after using WD	Convergent
Cognitive age- > INT	No	cognitive age was rarely considered as a factor in seniors' decision to use WD	Complementary
SWB- > (Complexity-INT)	No	Complexity has a salient effect of seniors' decision to use WD irrespective of SWB	Convergent
SWB- > (Cognitive age-INT)	Yes	The lower the SWB, the greater the effect of cognitive age on seniors' use of wearable devices.	Complementary

methods approach and gathered data from an online survey and interviews with seniors. Integration of quantitative and qualitative findings is a critical aspect of the mixed-methods approach (Venkatesh et al., 2013). Our quantitative and qualitative results converged and/or complemented each other very well.

Our first hypothesis suggesting the negative impact of perceived complexity on intention was supported. Older adults' perceptions about the complexity of the device demotivate them from using it. While studies in other contexts such as online shopping (Jiang & Benbasat, 2007) and social media use (Herrero, San Martín, & del M. Garcia-De los Salmones, 2017) found a moderate effect of complexity on the use of information systems, complexity was more salient in the case of seniors' use of wearable devices. The interviews showed that seniors were unlikely to blame deterioration in their cognitive capabilities and instead focused on the complexity of the technology. One explanation of this finding can be found in the cognitive dissonance theory. Seniors do not want to admit the deterioration of their cognitive abilities since this admission would mean they are getting older and losing their abilities, and as a result, they blame an external factor (Cooper & Feldman, 2019; Ron, 2007). Interestingly, previous studies confirmed that seniors willingness to exercise is indeed influenced by the cognitive dissonance between their current and previous health conditions (Cooper & Feldman, 2020). Another explanation is that seniors may not be familiar with the technology; hence, they have low self-efficacy (Bandura, 2010) resulting in a high perception of complexity (Choi & DiNitto, 2013; Hunsaker & Hargittai, 2018) and hence less use of wearable devices. This result is consistent with previous studies in wearable technology adoption which reported complexity perception as a barrier in adoption (e.g. Chouk & Mani, 2019; Ko, Sung, & Yun, 2009).

We expected a negative relationship between cognitive age and intention (H2); however, this relationship was *not* significant. Our interviews show that older adults did not perceive their age, whether chronological age or cognitive age, to have any effect on their use of wearable devices. Cognitive age does not impact the intention to use the device by itself. This result is interesting given that prior research has shown that cognitive age influences older adults' use of technology (e.g. Ghasemaghaei et al., 2019). This apparent contradiction may be attributed to the nature of the technology itself. While recommendation agents studied in Ghasemaghaei et al. (2019) are related to decision-making and selecting a product (requiring cognitive effort), wearable devices are more associated with exercise and activity. Previous studies examining the effect of cognitive age on behavior found that this effect is only significant in decision making situations (Teller et al., 2013; Zimmer, Brayley, & Searle, 1995). Wearable devices have features that range from simple to complex. The interviews we conducted show that seniors adapt the use of wearable devices to their age and are therefore willing to use these devices irrespective of their age. However, the extent or the effectiveness of use may be affected by cognitive age. This result confirms the current findings in the wearable device adoption literature, which suggest that individuals may use different features of the wearable devices depending on their age group (e.g. Jee & Sohn, 2015; Ridgers et al., 2018).

Interestingly, when we consider subjective well-being, the role of cognitive age becomes important. More specifically, our survey results show that subjective well-being negatively moderates the relationship between cognitive age and intention. This is contrary to what we proposed in our research model (H3). We expected to see a positive moderation; nonetheless, the qualitative results also supported the negative moderation. The interviews showed that seniors perceived their well-being by comparing themselves with others of the same age and comparing their current health status with their health at a younger age. When seniors are satisfied with their well-being (subjective well-being is high) and they see themselves as equal or better than their peers, then as we expected, cognitive age would negatively impact their intention. Again, the nature of technology plays an important role in explaining this result. Wearable devices are associated with exercise and activity and hence the more seniors perceive themselves as capable of exercising, the younger they feel and the more willing they are to use wearable devices to maintain their subjective well-being. However, as seniors subjective well-being becomes lower (less satisfied with their well-being) and they perceive that their health or quality of life has degraded compared to others or compared to themselves at a younger age, the negative impact of cognitive age on intention becomes less negative and even for low values of subjective well-being it becomes positive. This means that when seniors are not happy with their well-being, as they consider themselves older, they become more interested in using the device. This happens because these seniors with a low sense of well-being are worried about their physical abilities in the future.

As the qualitative study shows, seniors with lower subjective well-being believed that using wearable devices can improve their performance compared to their peers. As a result, they were not only motivated to start using the wearable device, but also more interested in the device readings and more motivated to continue using the wearable device. Our study shows that in the context of wearable device use, subjective well-being is not only a cognitive process but a social process as well in which seniors compare themselves with their peers and perceive their well-being based on this comparison. This process is so significant that it governs the effect of cognitive age on the use of wearable devices. While previous studies found that seniors' perceptions of their age (cognitive age) influence seniors' behavior indirectly by influencing their perception of well-being (Meisner, 2012; Westerhof et al., 2014), the role of subjective well-being in seniors' adoption of wearable devices was largely ignored by previous studies; hence, we call for future studies to focus more on this factor and explore its impact in conjunction with other important elements in wearable device context.

Hypothesis 4 suggesting the moderation of subjective well-being on the relationship between perceived complexity and intention was not supported by our result. This means that seniors' perception of the complexity of devices and its impact on their intention cannot be changed by their perception regarding their well-being. In fact, our interviews showed that complexity is a salient factor in seniors' decision to use wearable devices, and seniors tend to blame complexity for not using wearable devices more than any other factor.

6.2. Contributions to research

This study contributes to the current literature on wearable devices by considering the impacts of complexity, cognitive age, and subjective well-being on seniors' intention to use wearable devices. The first contribution of this study is the consideration of cognitive age instead of chronological age. There have been recent calls in the literature to study the impacts of age on IS phenomena (e.g. Tams, Grover, & Thatcher, 2014). Further, recent findings in other contexts, such as recommendation agents, marketing, health, and etc. (e.g. Catterall & Maclaran, 2001; Ghasemaghaei et al., 2019; Teller et al., 2013), have demonstrated that cognitive age is a better predictor of changes in individuals' attitudes and behaviors. Cognitive age becomes even more important in studying seniors' behaviors. Existing literature has shown that older people usually see themselves as younger than their chronological age and they act and even look younger accordingly (Van Auken, Barry, & Anderson, 1993; Catterall & Maclaran, 2001; Leventhal, 1997; Wilkes, 1992). Following suggestions in the literature, we focused on cognitive age. As shown in our post-hoc analyses, consistent with literature findings, we found differences between cognitive age and chronological age. Hence, contrary to most IS studies that focused on chronological age in technology use, we used seniors' cognitive age instead of their chronological age. To the best of our knowledge, no prior research has studied the impact of cognitive age on older adults' adoption of wearable devices. Future research on older adults should focus more on the role of cognitive age instead of chronological age. We also call for more future research to study the differences between cognitive and chronological age in different contexts.

Our results show that the effect of individuals' cognitive age on their use intention can vary with different technologies. In the case of wearable device use, cognitive age becomes important only after seniors consider their subjective well-being compared to their peers. Moreover, the cognitive age can positively affect use intention depending on the level of subjective well-being. This finding is contrary to the studies in other contexts, which suggest that age negatively influences the use of technology (e.g. Chang, 2008; Ghasemaghaei et al., 2019). This contradiction can be attributed to the technology. The use of technologies like recommendation agents (Ghasemaghaei et al., 2019) are related to decision-making and need more cognitive effort; nonetheless, wearable devices are associated with exercise and activity. Future research should also examine how the effect of cognitive age on technology use varies in different contexts.

Our next contribution is the exploration and comparison of the two possible types of perceived complexity. In the context of wearable devices, users will interact with devices in two different phases: entering their data (e.g. age, height, weight, etc.) and reading the device output (e.g. steps, calories, sleep behavior, etc.). Thus, it is crucial to understand their perceptions of complexity at each phase. Previous studies in wearable devices mostly consider the complexity of working with the device in general and were not specific to each phase (e.g. Chouk & Mani, 2019; Ko et al., 2009). As our survey and interview results show, users are more concerned about the second phase, which is reading the output. The perceived complexity of reading data and interpreting the output of the wearable device demotivates seniors from using the device. Furthermore, our study extends the literature on subjective well-being among older adults by exploring how it works in conjunction with cognitive age. Subjective well-being has rarely been studied in IS literature and its role in adopting and using information technology was largely unknown. Our study demonstrates the significant role of subjective well-being in impacting the effect of cognitive age on seniors' intention to use wearable devices. IS research should focus more on the role of subjective well-being in different contexts, especially in studying older adults' behavior. Our results show that we cannot easily conclude that older adults become reluctant to use the wearable device as they age, since this relationship depends on their well-being. As they consider themselves older and perceive their well-being as not very well, they surprisingly become more interested in using the wearable device. This behavior explains that seniors are aware that using wearable devices can improve their health and physical conditions. As they become worried about their health condition (i.e. have low well-being and see themselves older) they develop an interest in using the device to enhance their situation. This result is a very important finding, and we call for more research on the impacts of subjective well-being in other contexts.

Finally, use of wearable devices among seniors is still an understudied phenomenon; furthermore, there is not much agreement on the role of cognitive age on technology use among seniors (e.g. Ghasemaghaei, Hassanein, & Benbasat, 2019; Hong et al., 2013; Vuori & Holmlund-Rytkönen, 2005). Applying a mixed-methods approach helped us to gain a holistic view on the effects of subjective well-being, cognitive age, and complexity perception on seniors' use of wearable devices. By conducting a mixed-methods approach, we also adhered to recent calls in IS literature that encourage researchers to develop more mixed-methods research "as it offers substantial benefits over and above mono-method research by answering research questions that a single method cannot answer, providing better (stronger) inferences, and presenting a greater diversity of views" (Venkatesh et al., 2013).

6.3. Contributions to practice

Recently, COVID-19 pandemic affected almost all of the world. While the economic and healthcare consequences of this pandemic were devastating for all demographic groups, seniors were the most group affected by this pandemic with a death rate significantly higher than other age groups (Pan et al., 2020). Wearable technology (such as smart thermometers, and activity tracking wearable devices) have the potential to help in monitoring seniors' health and activity, especially in the time of social distancing. However, to have the wearable devices useful, seniors need to use these devices on a bigger scale. This study provides several insights to practitioners to expand the use of wearable devices.

As our results show, perceived complexity is a major deterrent for the use of wearable devices among seniors. In order to attract seniors and increase use among this age group, developers should focus more on making these devices easier to use for seniors. Developers can enhance the use of wearable devices by using cognitive interventions as part of the wearable device system that enhance seniors' perception of self-efficacy (for example by including short advice to seniors on how to use a specific feature) and interventions that help seniors overcome the effects of their complexity perceptions (for example by using motivational storytelling and step by step activity planning).

In addition, our further analyses showed that seniors' concern regarding the complexity of reading and interpreting data from the device is a primary demotivating element for them. Accordingly, the developers should improve the presentation of the output data to make the interpretation and understanding of the results easier for seniors. For instance, developers should add more graphical and intuitive cues to these devices, or they can add features such as reading the results aloud which can help seniors who might have difficulties in reading small texts on small screens of these devices. In addition, complexity issue can be addressed through educational sessions organized by community and health centers in which the step by step use of the device would be demonstrated to help the older adults to overcome the complexity in using these devices. Our interviews also highlighted the role of training and observing how others use the device in improving seniors' complexity concerns.

Furthermore, our results show that subjective well-being has a significant effect on the relationship between age and intention. Developers should be aware that older adults (even those who consider themselves old) could still be a good target. If older adults consider their well-being to be low, cognitive age could have a reverse (positive) effect on their intention to use; we believe this happens when older adults consider wearable devices to be helpful in improving their condition. Developers can use this finding in order to increase the number of users among seniors. For instance, in their advertisement messages, developers can focus more on the health benefits of wearable devices for seniors and explain how it can change and improve physical and mental conditions. Moreover, to reap the potential benefits, health professionals can use our findings to increase the use of wearable devices among their patients. As findings show, contrary to the intuitions, seniors' cognitive age does not have any negative impact on their use intentions. In addition, this study shows that lower levels of SWB can even make the impact of cognitive age on use intention positive. Hence, health professionals should be aware of these findings and should recommend and encourage the use of devices to all seniors no matter how old they perceive themselves or how low is their SWB.

6.4. Limitations and future research

There are several limitations that should be acknowledged. First, the quantitative study was cross-sectional. Future research can design longitudinal studies to better understand how seniors' behavior might change over time. Second, we considered intention to use the device as a proxy for actual use; this is a very common approach in IS literature, and previous studies have shown that intention are a good proxy for actual behaviors (Davis, 1989). Nevertheless, future studies could consider the actual use of wearable devices and explore whether there is a difference between intention and actual use in this context. Third, we focused on focal elements that could impact use intention among seniors. Our interviews also supported the critical roles of these factors. While these elements explained reasonable levels of variance, there is still room for improving the results. Furthermore, our interviews revealed some other interesting factors (such as social comparison) which might play a role in intention behaviors among seniors. Future research can take a broader perspective and include more predictors of use intention, such as trust and risk perceptions to extend the model we developed. Finally, we compared cognitive age and chronological age in this context. Our result showed that for chronological age, subjective well-being does not moderate the age-intention relationship. This is consistent with previous findings that reveal differences between these two age measures and that demonstrate that cognitive age is a better predictor of behaviors. We call for more future research on the difference between cognitive age and chronological age in this context.

7. Conclusion

In this study, we focused on understanding elements that impact seniors' intention to use wearable devices. There are numerous potential benefits in using wearable devices specifically for seniors; however, the rate of adoption is very low among older adults. Thus, it is crucial to understand the factors that can discourage seniors from using wearable devices. To address this, we developed a research model to study the impact of cognitive age, perceived complexity, and subjective well-being on seniors' use intention. To test our model, first we conducted a quantitative study and collected online survey responses. That was followed by conducting interviews with seniors to confirm our quantitative results. Our results showed that seniors' perception regarding the complexity of working with wearable devices (specifically reading and interpreting the outputs) is the most salient deterrent. Moreover, we found that cognitive age does not impact the intention by itself, and its influence depends on the seniors' subjective well-being. This interesting finding shows that when seniors are happy with their well-being, cognitive age will negatively influence the intention as we expected. Nonetheless, when they are not satisfied with their well-being, cognitive age positively influences the intention. These results extend the IS literature by providing a novel insight. Considering the fast-growing older adult population in most developed countries, we call for more research to better understand IT adoption among this age group.

CRediT authorship contribution statement

Samira Farivar: Conceptualization, Methodology, Writing - original draft, Formal analysis, Software, Validation, Writing - review & editing. **Mohamed Abouzahra:** Methodology, Writing - original draft, Formal analysis, Investigation, Validation, Writing - review & editing. **Maryam Ghasemaghaei:** Investigation, Funding acquisition, Writing - review & editing, Validation.

Acknowledgment

This work was supported by the McMaster Institute for Research on Aging [grant number 20007956].

References

Abbey, R., & Hyde, S. (2009). No country for older people? Age and the digital divide. *Journal of Information Communication and Ethics in Society, 7*(4), 225–242. https://doi.org/10.1108/14779960911004480.

Van Auken, S., Barry, T. E., & Anderson, R. L. (1993). Observations: Toward the internal validation of cognitive age measures in advertising research. *Journal of Advertising Research, 33*(3), 82–85.

Balota, D., Dolan, P., & Duchek, J. (2000). *Memory changes in healthy older adults. The Oxford handbook of memory*395–409.

Bandura, A. (2010). *Self-efficacy. The Corsini encyclopedia of psychology*. Hoboken, NJ, USA: John Wiley & Sons, Inc1–3. https://doi.org/10.1002/9780470479216.corpsy0836.

Barak, B., & Gould, S. (1985). Alternative age measures: A research agenda. *Advances in Consumer Research, 12*(1), 53–58.

Barak, B., & Schiffman, L. G. (1981). Cognitive age: A nonchronological age variable. *Advances in Consumer Research, 8*(1), 602–606.

Becker, S. A. (2004). A study of web usability for older adults seeking online health resources. December 1 *ACM Transactions on Computer-Human Interaction*. https://doi.org/10.1145/1035575.1035578 ACM.

Bellingtier, J. A., & Neupert, S. D. (2016). Negative aging attitudes predict greater reactivity to daily stressors in older adults. *Journals of Gerontology: Series B, 73*(7), 1155–1159. https://doi.org/10.1093/geronb/gbw086.

Ben Yahia, N., Eljaoued, W., Bellamine Ben Saoud, N., & Colomo-Palacios, R. (2019). Towards sustainable collaborative networks for smart cities co-governance. *International Journal of Information Management*(November), Article 102037. https://doi.org/10.1016/j.ijinfomgt.2019.11.005.

Birren, J. E., Woods, A. M., & Williams, M. V. (1980). Behavioral slowing with age: Causes, organization, and consequences. In L. W. Poon (Ed.). *Aging in the 1980s: Psychological issues* (pp. 293–308). American Psychological Association. https://doi.org/10.1037/10050-021.

Bookwala, J., & Schulz, R. (1996). Spousal similarity in subjective well-being: The cardiovascular health study. *Psychology and Aging, 11*(4), 582–590. https://doi.org/10.1037/0882-7974.11.4.582.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Byun, W., Barry, A., & Lee, J.-M. (2016). Accuracy of the fitbit for measuring preschoolers' physical activity. *Medicine and Science in Sports and Exercise, 48*(5S), 778. https://doi.org/10.1249/01.mss.0000487337.24755.a2.

Cabeza, R. (2002). Hemispheric asymmetry reduction in older adults: The HAROLD model. *Psychology and Aging, 17*(1), 85–100. https://doi.org/10.1037/0882-7974.17.1.85.

Cadmus-Bertram, L. A., Marcus, B. H., Patterson, R. E., Parker, B. A., & Morey, B. L. (2015). Randomized trial of a fitbit-based physical activity intervention for women. *American Journal of Preventive Medicine, 49*(3), 414–418. https://doi.org/10.1016/j.amepre.2015.01.020.

Catterall, M., & Maclaran, P. (2001). Body talk: Questioning the assumptions in cognitive age. *Psychology & Marketing, 18*(10), 1117–1133. https://doi.org/10.1002/mar.1046.

Cerella, J. (1985). Information processing rates in the elderly. *Psychological Bulletin, 98*(1), 67–83. https://doi.org/10.1037/0033-2909.98.1.67.

Chang, C. (2008). Chronological age versus cognitive age for younger consumers: Implications for advertising persuasion. *Journal of Advertising, 37*(3), 19–32. https://doi.org/10.2753/JOA0091-3367370302.

Charness, N., & Boot, W. R. (2009). Aging and information technology use: Potential and barriers. *Current Directions in Psychological Science, 18*(5), 253–258. https://doi.org/10.1111/j.1467-8721.2009.01647.x.

Chiu, C. M., Cheng, H. L., Huang, H. Y., & Chen, C. F. (2013). Exploring individuals' subjective well-being and loyalty towards social network sites from the perspective of network externalities: The Facebook case. *International Journal of Information Management, 33*(3), 539–552. https://doi.org/10.1016/j.ijinfomgt.2013.01.007.

Choi, N. (2011). Relationship between health service use and health information technology use among older adults: Analysis of the US national health interview survey. *Journal of Medical Internet Research, 13*(2), e33. https://doi.org/10.2196/jmir.1753.

Choi, N. G., & DiNitto, D. M. (2013). The digital divide among low-income homebound older adults: Internet use patterns, eHealth literacy, and attitudes toward computer/Internet use. *Journal of Medical Internet, 15*(5), e93.

Chopik, W. J. (2016). The benefits of social technology use among older adults are

mediated by reduced loneliness. *Cyberpsychology, Behavior and Social Networking, 19*(9), 551–556. https://doi.org/10.1089/cyber.2016.0151.
Chouk, I., & Mani, Z. (2019). Factors for and against resistance to smart services: Role of consumer lifestyle and ecosystem related variables. *Journal of Services Marketing, 33*(4), 449–462. https://doi.org/10.1108/JSM-01-2018-0046.
Cooper, J., & Feldman, L. A. (2019). Does cognitive dissonance occur in older age? A study of induced compliance in a healthy elderly population. *Psychology and Aging, 34*(5), 709–713. https://doi.org/10.1037/pag0000338.
Cooper, J., & Feldman, L. A. (2020). Helping the "couch potato": A cognitive dissonance approach to increasing exercise in the elderly. *Journal of Applied Social Psychology, 50*(1), 33–40. https://doi.org/10.1111/jasp.12639.
Costa, P. T., & McCrae, R. R. (1980). Influence of extraversion and neuroticism on subjective well-being: Happy and unhappy people. *Journal of Personality and Social Psychology, 38*(4), 668–678. https://doi.org/10.1037/0022-3514.38.4.668.
Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research.* Thousand Oaks: CA: Sage Publications.
Czaja, S. J., Charness, N., Fisk, A. D., Hertzog, C., Nair, S. N., Rogers, W. A., ... Sharit, J. (2006). Factors predicting the use of technology: Findings from the center for research and education on aging and technology enhancement (create). *Psychology and Aging, 21*(2), 333–352. https://doi.org/10.1037/0882-7974.21.2.333.
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340.
Diaz, K. M., Krupka, D. J., Chang, M. J., Peacock, J., Ma, Y., Goldsmith, J., ... Davidson, K. W. (2015). Fitbit®: An accurate and reliable device for wireless physical activity tracking. *International Journal of Cardiology, 185*, 138–140. https://doi.org/10.1016/J.IJCARD.2015.03.038.
Diener, E. (1984). Subjective well-being. *Psychological Bulletin, 95*(3), 542–575. https://doi.org/10.1037/0033-2909.95.3.542.
Diener, E. (2000). Subjective well-being: The science of happiness and a proposal for a national index. *The American Psychologist, 55*(1), 34–43. https://doi.org/10.1037/0003-066X.55.1.34.
Diener, E. (2006). Guidelines for national indicators of subjective well-being and ill-being. February 1 *Journal of Happiness Studies: An Interdisciplinary Forum on Subjective Well-Being.* https://doi.org/10.1007/s11482-006-9007-x Springer. Kluwer Academic Publishers.
Diener, E., & Suh, M. E. (1997). Subjective well-being and age: An international analysis. *Annual Review of Gerontology & Geriatrics, 17*, 304–324.
Diener, E., Lucas, R. E., & Oishi, S. (2002). *Subjective well-being: The science of happness and life satisfactionThe Oxford handbook of positive psychology* (2 ed.). https://doi.org/10.1093/oxfordhb/9780195187243.013.0017.
Diener, E., Oishi, S., & Lucas, R. E. (2003). Personality, culture, and subjective well-being: Emotional and cognitive evaluations of life. *Annual Review of Psychology, 54*(1), 403–425. https://doi.org/10.1146/annurev.psych.54.101601.145056.
Dwivedi, Y. K., Ismagilova, E., Hughes, D. L., Carlson, J., Filieri, R., Jacobson, J., ... Wang, Y. (2020). Setting the future of digital and social media marketing research: Perspectives and research propositions. *International Journal of Information Management*(May), Article 102168. https://doi.org/10.1016/j.ijinfomgt.2020.102168.
Eastman, J. K., & Iyer, R. (2004). The elderly's uses and attitudes towards the Internet. *The Journal of Consumer Marketing, 21*(3), 208–220. https://doi.org/10.1108/07363760410534759.
Eastman, J. K., & Iyer, R. (2005). The impact of cognitive age on Internet use of the elderly: An introduction to the public policy implications. *International Journal of Consumer Studies, 29*(2), 125–136. https://doi.org/10.1111/j.1470-6431.2004.00424.x.
EL Idrissi, T., Idri, A., & Bakkoury, Z. (2019). Systematic map and review of predictive techniques in diabetes self-management. *International Journal of Information Management, 46*(October 2018), 263–277. https://doi.org/10.1016/j.ijinfomgt.2018.09.011.
Fang, Y. M., & Chang, C. C. (2016). Users' psychological perception and perceived readability of wearable devices for elderly people. *Behaviour & Information Technology, 35*(3), 225–232. https://doi.org/10.1080/0144929X.2015.1114145.
Fields, J. (2019). *We are leaving older adults out of the digital world.* Retrieved April 16, 2020, fromhttps://techcrunch.com/2019/05/05/we-are-leaving-older-adults-out-of-the-digital-world/.
Finkelstein, E. A., Haaland, B. A., Bilger, M., Sahasranaman, A., Sloan, R. A., Nang, E. E. K., ... Evenson, K. R. (2016). Effectiveness of activity trackers with and without incentives to increase physical activity (TRIPPA): A randomised controlled trial. *The Lancet Diabetes & Endocrinology, 4*(12), 983–995. https://doi.org/10.1016/S2213-8587(16)30284-4.
Forbes (2019). *More seniors are embracing technology. But can they use it? UCSD researchers suggest asking them.* Retrieved April 16, 2020, fromhttps://www.forbes.com/sites/robinseatonjefferson/2019/06/28/more-seniors-are-embracing-technology-but-can-they-use-it-ucsd-researchers-suggest-asking-them/#cd8aba123233.
Fox, G., & Connolly, R. (2018). Mobile health technology adoption across generations: Narrowing the digital divide. *Information Systems Journal, 28*(6), 995–1019. https://doi.org/10.1111/isj.12179.
Garatachea, N., Molinero, O., Martínez-García, R., Jiménez-Jiménez, R., González-Gallego, J., & Márquez, S. (2009). Feelings of well being in elderly people: Relationship to physical activity and physical function. *Archives of Gerontology and Geriatrics, 48*(3), 306–312. https://doi.org/10.1016/J.ARCHGER.2008.02.010.
Ghasemaghaei, M., Hassanein, K., & Benbasat, I. (2019). Assessing the design choices for online recommendation agents for older adults: Older does not always mean simpler information technology. *MIS Quarterly, 43*(1), 329–346. https://doi.org/10.25300/MISQ/2019/13947.
Gil-Garcia, J. R. (2008). Using partial least squares (PLS) for digital government research. *Proceedings of the 2008 International Conference on Digital Government Research* (pp. 459–460).
Goodman, J., Syme, A., & Eisma, R. (2003). Older adults' use of computers: A survey. *Proceedings of HCI, 2*, 25–38.
Grover, P., Kar, A. K., & Davies, G. (2018). "Technology enabled Health" – Insights from twitter analytics with a socio-technical perspective. *International Journal of Information Management, 43*(June), 85–97. https://doi.org/10.1016/j.ijinfomgt.2018.07.003.
Hartman, M., & Hasher, L. (1991). Aging and suppression: Memory for previously relevant information. *Psychology and Aging, 6*(4), 587–594. https://doi.org/10.1037/0882-7974.6.4.587.
Hasher, L., Stoltzfus, E., Zacks, R. T., & Rypma, B. (1991). Age and inhibition. *Journal of Experimental Psychology Learning, Memory, and Cognition, 17*(1), 163.
Herrero, Á., San Martín, H., & del M. Garcia-De los Salmones, M. (2017). Explaining the adoption of social networks sites for sharing user-generated content: A revision of the UTAUT2. *Computers in Human Behavior, 71*, 209–217. https://doi.org/10.1016/J.CHB.2017.02.007.
Hong, S. J., Lui, C. S. M., Hahn, J., Moon, J. Y., & Kim, T. G. (2013). How old are you really? Cognitive age in technology acceptance. *Decision Support Systems, 56*(1), 122–130. https://doi.org/10.1016/j.dss.2013.05.008.
Huang, Y., Xu, J., Yu, B., & Shull, P. B. (2016). Validity of FitBit, Jawbone UP, Nike+ and other wearable devices for level and stair walking. *Gait & Posture, 48*, 36–41. https://doi.org/10.1016/J.GAITPOST.2016.04.025.
Hunsaker, A., & Hargittai, E. (2018). A review of Internet use among older adults. *New Media & Society, 20*(10), 3937–3954. https://doi.org/10.1177/1461444818787348.
Iyer, R., Reisenwitz, T., & Eastman, J. K. (2008). The impact of cognitive age on seniors' lifestyles. *Marketing Management Journal, 18*(2), 106–118.
Jee, S. J., & Sohn, S. Y. (2015). Patent network based conjoint analysis for wearable device. *Technological Forecasting and Social Change, 101*, 338–346. https://doi.org/10.1016/J.TECHFORE.2015.09.018.
Jiang, Z. (Jack), & Benbasat, I. (2007). The effects of presentation formats and task complexity on online consumers' product understanding. *MIS Quarterly, 31*(3), 475–500. https://doi.org/10.2307/25148804.
Jiang, Z. (Jack), Wang, W., Tan, B. C. Y., & Yu, J. (2016). The determinants and impacts of aesthetics in users' first interaction with websites. *Journal of Management Information Systems, 33*(1), 229–259. https://doi.org/10.1080/07421222.2016.1172443.
Joseph, R. C. (2010). Individual resistance to IT innovations. *Communications of the ACM, 53*(4), 144. https://doi.org/10.1145/1721654.1721693.
Kahneman, D. (1973). *Attention and effort.* Prentice-Hall.
Kastenbaum, R., Derbin, V., Sabatini, P., & Artt, S. (1972). "The ages of me": Toward personal and interpersonal definitions of functional aging. *Aging and Human Development, 3*(2), 197–211. https://doi.org/10.2190/TUJR-WTXK-866Q-8QU7.
Kieras, D., & Polson, P. G. (1985). An approach to the formal analysis of user complexity. *International Journal of Man-Machine Studies, 22*(4), 365–394. https://doi.org/10.1016/S0020-7373(85)80045-6.
Kim, K. J., & Shin, D. H. (2015). An acceptance model for smart watches: Implications for the adoption of future wearable technology. *Internet Research, 25*(4), 527–541. https://doi.org/10.1108/IntR-05-2014-0126.
King, L. A., & Napa, C. K. (1998). What Makes a Life Good? *Journal of Personality and Social Psychology, 75*(1), 156–165. https://doi.org/10.1037/0022-3514.75.1.156.
Ko, E., Sung, H., & Yun, H. (2009). Comparative analysis of purchase intentions toward smart clothing between Korean and U.S. consumers. *Clothing and Textiles Research Journal, 27*(4), 259–273. https://doi.org/10.1177/0887302X08327086.
Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of E-Collaboration, 11*(4), 1–10. https://doi.org/10.4018/ijec.2015100101.
Kooij, D., de Lange, A., Jansen, P., & Dikkers, J. (2008). Older workers' motivation to continue to work. *Journal of Managerial Psychology, 23*(4), 364–394.
Ladouceur, R., Gosselin, P., & Dugas, M. J. (2000). Experimental manipulation of intolerance of uncertainty: A study of a theoretical model of worry. *Behaviour Research and Therapy, 38*(9), 933–941. https://doi.org/10.1016/S0005-7967(99)00133-3.
Laidlaw, K. (2010). Are attitudes to ageing and wisdom enhancement legitimate targets for CBT for late life depression and anxiety? *Nordic Psychology, 62*(2), 27–42. https://doi.org/10.1027/1901-2276/a000009.
Laukkanen, T., Sinkkonen, S., Kivijärvi, M., & Laukkanen, P. (2007). Innovation resistance among mature consumers. *The Journal of Consumer Marketing, 24*(7), 419–427. https://doi.org/10.1108/07363760710834834.
Lawton, M. P. (1975). The Philadelphia geriatric center morale scale: A revision. *Journal of Gerontology, 30*(1), 85–89. https://doi.org/10.1093/geronj/30.1.85.
Lee, B., Chen, Y., & Hewitt, L. (2011). Age differences in constraints encountered by seniors in their use of computers and the internet. *Computers in Human Behavior, 27*(3), 1231–1237. https://doi.org/10.1016/j.chb.2011.01.003.
Lee, J., Kim, D., Ryoo, H.-Y., & Shin, B.-S. (2016). Sustainable wearables: Wearable technology for enhancing the quality of human life. *Sustainability, 8*(5), 466. https://doi.org/10.3390/su8050466.
Leininger, L. J., Cook, B. J., Jones, V., Bellumori, M., & Adams, K. J. (2016). Validation and accuracy of fitbit charge. *Medicine and Science in Sports and Exercise, 48*(2), 96. https://doi.org/10.1249/01.mss.0000485293.86436.f1.
Leventhal, R. C. (1997). Aging consumers and their effects on the marketplace. *The Journal of Consumer Marketing, 14*(4), 276–281. https://doi.org/10.1108/07363769710188527.
Levine, D. M., Lipsitz, S. R., & Linder, J. A. (2016). Trends in seniors' use of digital health technology in the United States, 2011-2014. August 2 *JAMA - Journal of the American Medical Association.* https://doi.org/10.1001/jama.2016.9124 American Medical Association.

Li, H., Gupta, A., Zhang, J., & Sarathy, R. (2014). Examining the decision to use standalone personal health record systems as a trust-enabled fair social contract. *Decision Support Systems, 57*, 376–386. https://doi.org/10.1016/J.DSS.2012.10.043.

Lindberg, T., Näsänen, R., & Müller, K. (2006). How age affects the speed of perception of computer icons. *Displays, 27*(4–5), 170–177.

Lobelo, F., Kelli, H. M., Tejedor, S. C., Pratt, M., McConnell, M. V., Martin, S. S., ... Welk, G. J. (2016). The wild wild west: A framework to integrate mHealth software applications and wearables to support physical activity assessment, counseling and interventions for cardiovascular disease risk reduction. *Progress in Cardiovascular Diseases, 58*(6), 584–594. https://doi.org/10.1016/j.pcad.2016.02.007.

Lyons, E. J., Lewis, Z. H., Mayrsohn, B. G., & Rowland, J. L. (2014). Behavior change techniques implemented in electronic lifestyle activity monitors: A systematic content analysis. *Journal of Medical Internet Research, 16*(8), e192. https://doi.org/10.2196/jmir.3469.

Mackinnon, S. P., Kehayes, I. L. L., Leonard, K. E., Fraser, R., & Stewart, S. H. (2017). Perfectionistic concerns, social negativity, and subjective well-being: A test of the social disconnection model. *Journal of Personality, 85*(3), 326–340. https://doi.org/10.1111/jopy.12243.

Mahar, M. T., Maeda, H., Sung, H., & Mahar, T. F. (2014). Accuracy of the nike fuelband and fitbit one activity monitors. *Medicine and Science in Sports and Exercise, 46*(5).

Marakhimov, A., & Joo, J. (2017). Consumer adaptation and infusion of wearable devices for healthcare. *Computers in Human Behavior, 76*, 135–148. https://doi.org/10.1016/j.chb.2017.07.016.

Marshall, T. E., & Byrd, T. A. (1998). Perceived task complexity as a criterion for information support. *Information & Management, 34*(5), 251–263. https://doi.org/10.1016/S0378-7206(98)00057-3.

Meisner, B. A. (2012). A meta-analysis of positive and negative age stereotype priming effects on behavior among older adults. *The Journals of Gerontology Series B, Psychological Sciences and Social Sciences, 67B*(1), 13–17. https://doi.org/10.1093/geronb/gbr062.

Mercer, K., Li, M., Giangregorio, L., Burns, C., & Grindrod, K. (2016). Behavior change techniques present in wearable activity trackers: A critical analysis. *JMIR MHealth and UHealth, 4*(2), e40. https://doi.org/10.2196/mhealth.4461.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192–222.

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods, 1*(2), 13–22. https://doi.org/10.1177/160940690200100202.

Myers, H., & Lumbers, M. (2008). Understanding older shoppers: A phenomenological investigation. *The Journal of Consumer Marketing, 25*(5), 294–301. https://doi.org/10.1108/07363760810890525.

Nasir, S., & Yurder, Y. (2015). Consumers' and physicians' perceptions about high tech wearable health products. *Procedia - Social and Behavioral Sciences, 195*, 1261–1267. https://doi.org/10.1016/j.sbspro.2015.06.279.

Neupert, S. D., & Bellingtier, J. A. (2017). Aging attitudes and daily awareness of age-related change interact to predict negative affect. *Gerontologist, 57*, S187–S192. https://doi.org/10.1093/geront/gnx055.

Niehaves, B., & Plattfaut, R. (2014). Internet adoption by the elderly: Employing IS technology acceptance theories for understanding the age-related digital divide. *European Journal of Information Systems, 23*(6), 708–726. https://doi.org/10.1057/ejis.2013.19.

O'Brien, T., Troutman-Jordan, M., Hathaway, D., Armstrong, S., & Moore, M. (2015). Acceptability of wristband activity trackers among community dwelling older adults. *Geriatric Nursing, 36*(2), S21–S25. https://doi.org/10.1016/J.GERINURSE.2015.02.019.

O'Cathain, A., Murphy, E., & Nicholl, J. (2010). Three techniques for integrating data in mixed methods studies. *British Medical Journal: BMJ,* 341–4587.

Oviatt, S. (2006). Human-centered design meets cognitive load theory: Designing interfaces that help people think. *Proceedings of the 14th Annual ACM International Conference on Multimedia, MM 2006* (pp. 871–880). . https://doi.org/10.1145/1180639.1180831.

Page, T. (2014). Touchscreen mobile devices and older adults: A usability study. *International Journal of Human Factors and Ergonomics, 3*(1), 65–85.

Page, K. L., & Uncles, M. D. (2014). The complexity of surveying web participation. *Journal of Business Research, 67*(11), 2356–2367. https://doi.org/10.1016/j.jbusres.2014.02.001.

Pan, S. L., Cui, M., & Qian, J. (2020). Information resource orchestration during the COVID-19 pandemic: A study of community lockdowns in China. *International Journal of Information Management, 54*, Article 102143. https://doi.org/10.1016/J.IJINFOMGT.2020.102143.

Park, S., & Jayaraman, S. (2003). Enhancing the quality of life through wearable technology. *IEEE Engineering in Medicine and Biology Magazine, 22*(3), 41–48. https://doi.org/10.1109/MEMB.2003.1213625.

Patel, M. S., Asch, D. A., & Volpp, K. G. (2015). Wearable devices as facilitators, not drivers, of health behavior change. February 3 *JAMA - Journal of the American Medical Association*. https://doi.org/10.1001/jama.2014.14781 American Medical Association.

Pattison, M., & Stedmon, A. (2006). Inclusive design and human factors: Designing mobile phones for older users. *PsychNology Journal, 4*(3), 267–284.

PEW (2020). *Older Americans follow coronavirus news more closely than younger adults | Pew Research Center.* Retrieved June 15, 2020, fromhttps://www.journalism.org/2020/04/22/older-americans-continue-to-follow-covid-19-news-more-closely-than-younger-adults/.

Pinquart, M. (2002). Creating and maintaining purpose in life in old age: A meta-analysis. *Ageing International, 27*(2), 90–114. https://doi.org/10.1007/s12126-002-1004-2.

Pinquart, M., & Sörensen, S. (2000). Influences of socioeconomic status, social network, and competence on subjective well-being in later life: A meta-analysis. *Psychology and Aging, 15*(2), 187–224. https://doi.org/10.1037/0882-7974.15.2.187.

Popescu, G. H. (2014). Economic aspects influencing the rising costs of health care in the United States. *American Journal of Medical Research*. https://doi.org/10.1177/1062860610389020 Addleton Academic Publishers.

Potnis, D., Demissie, D., & Deosthali, K. (2017). Students' intention to adopt Internet-based personal safety wearable devices: Extending UTAUT with trusting belief. *First Monday, 22*(9), https://doi.org/10.5210/fm.v22i9.7808.

PRB (2019). *Fact sheet: Aging in the United States – Population Reference Bureau.* Retrieved September 7, 2019, fromhttps://www.prb.org/aging-unitedstates-fact-sheet/.

Ram, S. (1987). A model of innovation resistance. *Association for Consumer Research, 14*, 208–212.

Ridgers, N. D., Timperio, A., Brown, H., Ball, K., Macfarlane, S., Lai, S. K., ... Salmon, J. (2018). Wearable activity tracker use among australian adolescents: Usability and acceptability study. *JMIR MHealth and UHealth, 6*(4), e86. https://doi.org/10.2196/mhealth.9199.

Ringle, C. M., Wende, S., & Becker, J. M. (2015). *SmartPLS 3.* Retrieved June 1, 2016, fromhttp://www.smartpls.com.

Rogers, E. M., & Shoemaker, F. F. (1971). *Communication of innovations; a cross-cultural approach.* New York: The Free Press.

Ron, P. (2007). Elderly people's attitudes and perceptions of aging and old age: the role of cognitive dissonance? *International Journal of Geriatric Psychiatry, 22*(7), 656–662. https://doi.org/10.1002/gps.1726.

Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103*(3), 403.

Scherer, M. J., Craddock, G., & Mackeogh, T. (2011). The relationship of personal factors and subjective well-being to the use of assistive technology devices. *Disability and Rehabilitation, 33*(10), 811–817. https://doi.org/10.3109/09638288.2010.511418.

Schmitz, K. W., Teng, J. T. C., & Webb, K. J. (2016). Capturing the complexity of malleable IT use: Adaptive structuration theory for individuals. *MIS Quarterly: Management Information Systems, 40*(3), 663–686. https://doi.org/10.25300/MISQ/2016/40.3.07.

Shmotkin, D., & Hadari, G. (1996). An outlook on subjective well-being in older Israeli adults: A unified formulation. *International Journal of Aging & Human Development, 42*(4), 271–289. https://doi.org/10.2190/JKMB-2TH6-YB74-L8PL.

Şimşek, Ö. F. (2009). Happiness revisited: Ontological well-being as a theory-based construct of subjective well-being. *Journal of Happiness Studies, 10*(5), 505–522. https://doi.org/10.1007/s10902-008-9105-6.

Statista (2018). *Senior population of the U.S. by state 2018 | Statista.* Retrieved June 15, 2020, fromhttps://www.statista.com/statistics/736211/senior-population-of-the-us-by-state/.

Steptoe, A., De Oliveira, C., Demakakos, P., & Zaninotto, P. (2014). Enjoyment of life and declining physical function at older ages: A longitudinal cohort study. *Cmaj, 186*(4), 150–156. https://doi.org/10.1503/cmaj.131155.

Sudbury-Riley, L., Kohlbacher, F., & Hofmeister, A. (2015). Baby Boomers of different nations. *International Marketing Review, 32*(3/4), 245–278. https://doi.org/10.1108/IMR-09-2013-0221.

Sullivan, Y. W., & Koh, C. E. (2019). Social media enablers and inhibitors: Understanding their relationships in a social networking site context. *International Journal of Information Management, 49*(October 2017), 170–189. https://doi.org/10.1016/j.ijinfomgt.2019.03.014.

Sultan, N. (2015). Reflective thoughts on the potential and challenges of wearable technology for healthcare provision and medical education. *International Journal of Information Management, 35*(5), 521–526. https://doi.org/10.1016/j.ijinfomgt.2015.04.010.

Tams, S., Grover, V., & Thatcher, J. (2014). Modern information technology in an old workforce: Toward a strategic research agenda. *The Journal of Strategic Information Systems, 23*(4), 284–304. https://doi.org/10.1016/j.jsis.2014.10.001.

Tarafdar, M., Pullins, E. B., & Ragu-Nathan, T. S. (2015). Technostress: Negative effect on performance and possible mitigations. *Information Systems Journal, 25*(2), 103–132. https://doi.org/10.1111/isj.12042.

Tay, L., Kuykendall, L., & Diener, E. (2015). *Satisfaction and happiness – The bright side of quality of life. Global handbook of quality of life: Exploration of well-being of nations and continents*. Dordrecht: Springer Netherlands839–853. https://doi.org/10.1007/978-94-017-9178-6_39.

Taylor, S., & Todd, P. (1995). Decomposition and crossover effects in the theory of planned behavior: A study of consumer adoption intentions. *International Journal of Research in Marketing, 12*(2), 137–155. https://doi.org/10.1016/0167-8116(94)00019-K.

Teller, C., Gittenberger, E., & Schnedlitz, P. (2013). Cognitive age and grocery-store patronage by elderly shoppers. *Journal of Marketing Management, 29*(3–4), 317–337. https://doi.org/10.1080/0267257X.2013.766627.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal computing: Toward a conceptual model of utilization. *MIS Quarterly, 15*(1), 125. https://doi.org/10.2307/249443.

Thong, J. Y. L. (1999). An integrated model of information systems adoption in small businesses. *Journal of Management Information Systems, 15*(4), 187–214. https://doi.org/10.1080/07421222.1999.11518227.

Van Gerven, P. W. M., Paas, F. G. W. C., Van Merriënboer, J. J. G., & Schmidt, H. G. (2000). Cognitive load theory and the acquisition of complex cognitive skills in the elderly: Towards an integrative framework. *Educational Gerontology, 26*(6), 503–521. https://doi.org/10.1080/03601270050133874.

Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *MIS Quarterly: Management Information Systems, 37*(1), 21–54. https://doi.org/10.25300/

MISQ/2013/37.1.02.
Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478.
Vuori, S., & Holmlund-Rytkönen, M. (2005). 55 + people as internet users. *Marketing Intelligence & Planning, 23*(1), 58–76. https://doi.org/10.1108/02634500510577474.
Wacker, J. G. (1998). A definition of theory: Research guidelines for different theory-building research methods in operations management. *Journal of Operations Management, 16*(4), 361–385. https://doi.org/10.1016/S0272-6963(98)00019-9.
Wenzke, P. (2014). *Antecedents and consequence of lead userness and the moderating effect of self-perceived age: An empirical study among elderly air travellers.* Retrieved fromUniversity of Twentehttp://essay.utwente.nl/66113/.
Westerhof, G. J., Miche, M., Brothers, A. F., Barrett, A. E., Diehl, M., Montepare, J. M., ... Wurm, S. (2014). The influence of subjective aging on health and longevity: A meta-analysis of longitudinal data. *Psychology and Aging, 29*(4), 793–802. https://doi.org/10.1037/a0038016.
WHO (2013). *Proposed working definition of an older person in Africa for the MDS Project*.
Wilkes, R. E. (1992). A structural modeling approach to the measurement and meaning of cognitive age. *The Journal of Consumer Research, 19*(2), 292. https://doi.org/10.1086/209303.
Wurmser, Y. (2019). *Wearables 2019 - eMarketer trends, forecasts & statistics.* Retrieved September 7, 2019, fromhttps://www.emarketer.com/content/wearables-2019.
Ying, B., & Yao, R. (2010). Self-perceived age and attitudes toward marketing of older consumers in China. *Journal of Family and Economic Issues, 31*(3), 318–327. https://doi.org/10.1007/s10834-010-9199-y.
Ziefle, M., & Bay, S. (2005). How older adults meet complexity: Aging effects on the usability of different mobile phones. *Behaviour & Information Technology, 24*(5), 375–389. https://doi.org/10.1080/0144929042000320009.
Zimmer, Z., Brayley, R. E., & Searle, M. S. (1995). Whether to go and where to go: Identification of important influences on seniors' decisions to travel. *Journal of Travel Research, 33*(3), 3–10. https://doi.org/10.1177/004728759503300302.
Ziółkowski, A., Błachnio, A., & Pąchalska, M. (2015). An evaluation of life satisfaction and health – Quality of life of senior citizens. *Annals of Agricultural and Environmental Medicine, 22*(1), 147–151. https://doi.org/10.5604/12321966.1141385.