ATTITUDES TOWARD
AN INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) INSTRUMENT
APPLICABILITY IN OLDER ADULTS

By

Ha Neul Kim

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Social Work – Doctor of Philosophy

2025

ABSTRACT

Contemporary society is quickly changing with digital and technology advancements. However, due to a lack of former experience and cognitive and physical challenges, older adults often fall into the digital divide, the gap between technology users and non-users. Such a gap exacerbates the already-existing disparities in health, information, financial, and social arenas older adults may experience. Therefore, understanding the factors promoting older adults to better use and understand technology became an important issue. Among different types of technology, this study focuses on information and communication technology (ICT) that plays a vital role in facilitating communication and interaction for older adults. While existing studies have explored factors influencing older adults' ICT use, including barriers, benefits, and usage patterns, limited research has focused specifically on their attitudes toward ICT. Attitudes are crucial in determining behavioral intentions and technology adoption, yet there is a lack of a standardized measurement for assessing older adults' perceptions of ICT. Most existing instruments focus on general technology or specific devices, such as computers, rather than ICT as a whole, and thereby miss the quickly changing digital landscape.

This gap in research highlights the need for a more refined approach to understanding older adults' attitudes toward ICT. Therefore, this study aims to examine the applicability of attitudes toward ICT scale among the older adult population via reliability, confirmatory factor analysis (CFA), convergent validity, and concurrent validity tests. The scale chosen for the reliability and validity testing is 12 attitudinal items from the Media and Technology Usage and Attitudes Scale (MTUAS) developed by Rosen et al. (2013). The scale consist of both affective and cognitive attitudes, was tested for reliability and validity, and was focused on technology, which is broad enough to be modified into ICT.

Respondents to the current survey were 231 older adults in Michigan who are 65 years old or older, and able to read and answer the survey in English. MTUAS attitudes toward ICT scale showed good internal reliability. CFA results showed Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) above and equal to the cut-off line respectively, indicating a good fit, while Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) exceeded the cut-off line, indicating moderate fit. Convergent validity testing between MTUAS attitudes toward ICT scale and attitudes toward ICT semantic questions showed a moderate-to-strong relationship between the two constructs. Concurrent validity testing between MTUAS attitudes toward ICT scale and behavioral intention of using ICT questions showed a moderate relationship between the two constructs.

The findings suggest that while the scale demonstrates a moderately good fit, some items showing low correlations in the correlation analysis highlight areas for improvement. Furthermore, convergent and concurrent validity testing suggests that certain items, particularly those measuring negative attitudes, require revision as they exhibited weak associations with the overall factor structure. This study highlights an additional research gap, as few existing questionnaires assess technology dependence in older adults. The results indicate that older adults can relate to technology dependence, not just in terms of technophobia but also in anxiety stemming from not being able to use technology. This demonstrates the need for further research into the affective and cognitive, as well as positive and negative dimensions of technology attitudes among older adult populations. This study contributes significantly to the understanding of older adults' attitudes toward ICT and emphasizes the need for more targeted research, policy improvements, and social work interventions to support older adults' evolving digital experiences.

This dissertation is dedicated to my family.
Thank you for your prayers.

ACKNOWLEDGEMENTS

Your kingdom come, Your will be done on earth as it is in heaven. Matthew 6:10

First and foremost, I give thanks to my Lord, my God, for sustaining me through every step of this long journey and for blessing me with wonderful, loving people.

I would like to express my deepest gratitude to those who have supported me throughout the Ph.D. program. I am incredibly thankful to my advisor and committee chair, Dr. Paul Freddolino, for your mentorship, guidance, and immense support in both my personal and academic life. Whenever I felt isolated, you were so kind to remind me that I was never alone in this journey. I also deeply appreciate my dissertation committee members, Dr. Anne Hughes, Dr. Amanda Woodward, and Dr. Anastasia Kononova, for your guidance and encouragement throughout the program and dissertation process. Thank you to Dr. Hyunkag Cho for your caring check-ins and for making sure that I felt a sense of belonging within the MSU community. Each of you has contributed uniquely to my academic and personal growth, and I am deeply grateful for your time and mentorship.

My family and friends in Korea and the US – I am so thankful for your positivity and encouragement, which brightened my life in countless ways. To my beloved parents, Mom (Mihyung Kim) and Dad (Seongchun Kim), you taught me how to stay positive and stand firm in God in tough times, and I have learned so much wisdom from you. Thank you for believing in me so that I could grow like a strong tree. To my dear friends – Taylor Geddes, Sammie Roenigk, Christine Jina Chang, Esther Guak, Yuan Xiong, Hyejin Park, Daeun Kim, Sue Lim, Hannah Boyke, Dasom Jang, and Daniel Yechan Ha – thank you for helping me keep my sanity. Your humor, encouragement, and thoughtful conversations helped me stay grounded and motivated, even during the most challenging moments. Whether it was a late-night chat, a much-needed distraction, or a word of reassurance, your presence made this journey more bearable and more meaningful. To my wonderful friends from the MSU School of Social Work – Jen Hirsch, Linda Zhang, and Ayaka Lingard – I am grateful for your friendship and inspiration in gerontological social work studies. You helped me better understand what advocacy looks like in real life and what it means to truly collaborate as a team. I also extend my heartfelt thanks to Pastor Sanghyup Jeong, Kumyoung Kim, Elder Dohun Pyeon, and the other members of New Hope Church for your prayers, care, and support for my spiritual well-being.

This dissertation is not just a culmination of research, but also a reflection of the many people who walked alongside me during this time. Thank you all for being a part of it.

TABLE OF CONTENTS

INTRODUCTION

Technological development has profoundly changed society, bringing both benefits and challenges. Innovations such as robotics and automation have streamlined work processes and altered employment patterns (López Peláez & Kyriakou, 2008). Technology also brought benefits for those who need technology-based care solutions including tools supporting mobility (Carver et al., 2016) and artificial intelligence (AI) to aid conversations (Cortellessa et al., 2021; Gudala et al., 2022). In particular, considerable literature has explored the benefits of Information and Communication Technology (ICT), a subset of technology that facilitates interaction and communication. Those benefits may include a better teaching-learning process, increased performance in education (Becker, 2000; Das, 2019), reduced loneliness and isolation (Blusi et al., 2013), reduced caregiving burden (Tremont et al., 2008), and more.

At the same time, the older adult population has largely been left behind in these innovative changes with technology and digital devices (Faverio, 2022; Wagner et al., 2010). It is clear that older adults are experiencing the digital divide, the gap between those who use technology and those who do not (van Dijk, 2006), getting limited benefits from such digital transformation. Various factors contribute to the digital divide experienced by older adults, such as lack of experience after leaving the workforce, inaccessibility to broadband internet and even digital devices, and fear or anxiety related to digital technology (Han & Nam, 2021; Nimrod, 2018; van Dijk, 2005). These factors are not only the determinants of older adults' experience with the digital divide but also determinants of their decision to use technology. Among those factors, fears and anxiety and their counterpart groups of emotions could be grouped as attitude, which are often discussed as one of the major determinants of the use of technology. Therefore, understanding attitudes is crucial as attitudes influence the behavioral intention to use technology

(Davis, 1989), which affects actual usage and can, in turn, help mitigate the digital divide. Among various technologies that could be selected, the proposed dissertation research concentrates on ICT, with the hope of identifying a good scale for measuring older adults' attitudes toward ICT and thereby laying the groundwork for future research on older adults' use of ICT.

Older Adults in the Digital World

More and more older adults are learning about and getting involved with using ICT (Anderson & Perrin, 2017; OECD, 2017) through various means, such as programs that teach using computers and the internet (Mayhorn et al., 2004) and through informal instructors like family and friends (Khvorostianov, 2016). For instance, in the United States, among older adults who are 65 or older, about 90% answered that they use the Internet, and about 70% responded that they have home broadband in 2024 ("Internet, Broadband Fact Sheet," 2024). Their technology use spans various types of ICT tools such as smartphones, computers, and tablets (Vroman et al., 2015), as well as messengers and social media like Facebook (Sinclair & Grieve, 2017), Instagram (McGrath, 2018; Sheldon et al., 2021), and WhatsApp (Fernández-Ardévol & Rosales, 2017; Rosales & Fernández-Ardèvol, 2016).

Despite the recent increase in the number of older adults using technology, a significant portion remains excluded and isolated from the digital world in terms of easy access or competency in using the features and potential applications of these technologies. Older adults have faced challenges with technology and internet access since the early days of digitalization, due to factors such as physical and cognitive changes, cost, and lack of digital literacy. First, older adults' change in cognitive and physical functioning affects their ability to use complex technological products (Reddy et al., 2010). Aging can affect motor dexterity and cognitive capacity (Wood et al., 2005), and result in other physiological changes such as decrements of sight and hearing, hand-eye co-ordination, etc. (Blake et al., 2008; Virokannas et al., 2000). In addition, technological devices require complex physical and cognitive functioning compared to other activities that may be familiar to older adults (Smith et al., 1999). Research has found that hand functioning measured by grip strength, pinch strength, and dexterity test did not show a correlation with the use of a tablet touchscreen, indicating that the ability to use a touchscreen requires different set of skills compared to typical hand function tested through traditional standards (Elboim-Gabyzon & Danial-Saad, 2021). Second, many older adults may find obtaining technological devices and broadband internet access a pricy decision (Lee & Coughlin, 2015a, 2015b). In particular with the low-income older adult population, the affordability of technology was directly translated to the accessibility of technology, one of the major hindering factors in using technology (D. Y. L. Chan et al., 2023; Latulipe et al., 2015). Third, older adults often lack digital literacy, having had limited exposure to technology throughout their lives (Betts et al., 2019; Heinz et al., 2013; Wu et al., 2015). This unfamiliarity that stems from a lack of experience makes it difficult for them to use modern digital devices (Lawry et al., 2010). Additionally, there is a shortage of educational programs designed to address the specific needs of older adults (Dyck & Smither, 1994; Ellis & Allaire, 1999; Yoon et al., 2021). Digital literacy education must be tailored to older adults' unique needs and abilities (Deng et al., 2014; Yoon et al., 2021). Although there is growing recognition of the importance of such training, and despite the increased availability of free online resources, it remains insufficient for many older adults (Han & Nam, 2021).

The digital divide itself has risen to be a problem for older adults, but it also continues to be a serious issue affecting other aspects of lives (Betts et al., 2019). Many scholars have paid attention to how the digital divide – which is highly correlated with income and socioeconomic status - emphasizes already-existing inequalities in financial status, education, and information access (van Dijk, 2006). Additionally, when it comes to the digital divide in terms of using ICT, the digital divide refers to the gap between those who can interact with people remotely and those who cannot, depicting the digital divide in social engagement. For example, the COVID-19 pandemic and the resulting regulation of social distancing forced many services and social events to be moved to hybrid or online, making the problem of digital access and utilization among older adults more visible (Spears & Zheng, 2020). Despite the benefits older adults could have through technology such as an increase in autonomy and social interactions (Delello & McWhorter, 2017), there are many older adults who were left behind as many services that are rather unfamiliar to them have moved online (Han & Nam, 2021). Therefore, understanding the unique needs and limitations of older adults in adopting technology is crucial for achieving digital inclusion, which aims to close the digital divide and ensure social inclusion by enabling older adults to be more connected with family, friends, their community, and the resources available online (Mori, 2011; Tsai et al., 2015).

Information and Communication Technology (ICT) and Older Adults

Information and communication technology (ICT) refers to the integration of audiovisual broadcasting, telecommunication networks, and computer systems. While often used interchangeably with information technology (IT), ICT emphasizes the function of communication technologies and telecommunications networks (C. Chan & Holosko, 2016). Such a characteristic of ICT makes it one of the most functional technologies for human interaction and communication, facilitating human relationships via technology use (Cotten et al., 2013). The importance of using ICT among older adults has been shared in various fields from policies to research. For instance, the European Union (EU) stated that ICT has the potential to bring social and economic inclusion and quality of life to the older adult population [citation?]. Narrowing the digital divide and letting more people be engaged in technological benefits has been one of the important challenges in US policy development as well (Rhinesmith, 2016). In addition, a growing body of research has examined the relationship between ICT use among older adults and various social and health outcomes such as gaining information, accessing e-services, and engaging in entertainment, etc. (Tyler et al., 2020).

Other streams of research focused on factors related to older adults' reluctance to use ICT (Neves et al., 2013; Selwyn, 2004; Selwyn et al., 2003), benefits of using ICT (Blok et al., 2020; Blusi et al., 2013), frequency of use (Sum et al., 2008), and breadth of use (Schuster & Cotten, 2023; Vroman et al., 2015). Throughout this literature, ICT use among older adults has been measured in various ways. For instance, Sum et al. (2008) measured the frequency of internet use among adults aged 55 and older. They assessed this with survey items that asked about average hours spent online and years of previous internet experience. Vroman et al. (2015) used the Breadth of Internet Use (BIU) questionnaire, developed and validated by Shklovski et al. (2004), to measure ICT use among older adults. The BIU assesses breadth, frequency, history of technology use, and the purposes for which technology is used, providing a comprehensive measure of older adults' ICT engagement.

Despite significant scholarly attention to older adults' use of ICT and its determinants and impacts, limited studies have focused specifically on older adult attitudes toward ICT. Attitudes toward ICT are one of the crucial factors influencing older adults' use of ICT and their behavioral intentions to use it (Klimova et al., 2016; Vulpe & Ilinca, 2020; Zambianchi et al., 2019), but it is rarely focused as a main factor and is generally studied with a limited population such as students or health care providers, or with limited types of technology like computer or email. This underscores the importance of gaining a deeper understanding of older adults' attitudes toward ICT, which will proceed from evaluating the reliability and validity of an instrument designed to measure attitudes toward ICT.

KEY CONCEPTS AND THEORY

Key Concepts

Technology

Technology is difficult to define because even the term comes from the word 'technique,' as Salomon (1984) stated, "Everything is technique, but any technique is not technology" (p. 115). The difficulty lies in both distinguishing and setting up the boundary of what it is and what it is not. Kranzberg and Purcell (1967, as cited in Salomon, 1984) also added that technology exceeds the boundary of tools, artifacts, machines, and processes and it incorporates the idea of satisfying one's wants through human action on physical objects. Therefore, because of its broad context, giving a definition to "technology" is not easy. Scholars have also agreed that the area of technology has remained incompletely defined due to its coverage from materials (devices and hardware) to non-materials (systems and software) that should either be understood with confusion or treated in isolation (Bleed, 1997). However, even though there is no clear definition people can give for technology, it does not hinder us from understanding its impact on our lives, especially when technology is closely related to human connection and socialization. After all, technology is a human-made entity that is socially shaped and determined (Williams & Edge, 1996).

ICT. Information and communication technology (ICT) refers to a set or range of technologies that combine technological devices (e.g. laptop, computer, or smartphone) and communication practices (e.g., emails, text messages, phone calls, or video calls) that can share information and form relationships (e.g. social media or social networking) (Cotten et al., 2013). Other examples include internet search, online gaming, and the use of assistive technologies (Stephens-Reicher et al., 2011). ICT is usually divided into two categories such as communication use and information use, based on its purpose of use (Sims et al., 2017).

According to Selwyn et al. (2003), although older adults were mostly found to use longer-established technologies like television and radio, it does not imply that older adults would avoid any new technologies. Instead, the authors suggested that older adults may not choose to use ICT because the devices and services available do not address the needs or wants in their lives. The clearest reason for the non-use of computers is the perceived irrelevance of ICT in older adults' lives. Therefore, clearly understanding the current relationship between older adults and ICT use would enlighten the way to make ICT more engaging for older adults, potentially leading to older adults being less digitally excluded (Selwyn et al., 2003). This also resonates with Rousseau and Rogers' (1998) view that older adults would participate in the era of information only if there were useful systems and available training to support their technology journey.

Attitude

In one of the foundational works regarding attitude study, Droba (1933) identified that scholars studying attitude fall into three big categories: those who do not give a definition, those who give tentative working definitions in the context of their research, and those who provide a more elaborate definition (Droba, 1933). As Droba (1933) added, attitudes research could be conducted without giving a clear definition, but having a "theoretical analysis" (p. 444) adds more precision and clarity in understanding fundamental concepts of attitude. Attitudes consist of different types. There are attitudes that people are aware of and can report what their attitudes are, which are called explicit attitudes; while there are attitudes that people either deny or do not recognize their stance, which are called implicit attitudes (Petty et al., 2009). When it comes to the content of attitudes, there are two perspectives: a three-component model of affective (feelings), cognitive (beliefs), and behavioral (past behaviors) attitudes and an expectancy-value model (Maio & Haddock, 2007). The three-component model suggests that they could work in synergy and also that they could conflict with each other (Maio & Haddock, 2007). If different attitudes are synergetic, it means someone might have good feelings about performing a certain behavior while thinking that performance could be positively understood. If different attitudes conflict, it means someone might have bad feelings about performing a certain behavior while thinking that performance could be positively understood. On the other hand, the expectancy-value model simplifies the attitude as the sum of all the evaluative beliefs, and this was also how attitude in TRA was explained. The formula below explains how the attitude is conceptualized in a quantitative format (Ajzen & Fishbein, 1980).

$$A = \Sigma b_i e_i$$

A is the total attitude toward the object or behavior, b_i is the subjective belief that the object possesses the attribute i and e_i is the evaluation of the attribute i (see Maio & Haddock, 2007). The problem with this view is that it may seem like it oversimplifies the nature of attitudes.

In this dissertation, the focus is on explicit attitudes that respondents can consciously self-report and researchers can measure. With regard to the contents of attitude, the focus is on both affective and cognitive components.

Theory

Theory of Reasoned Action (TRA)

TRA was born to explain the motivations behind volitional behavior (Ajzen & Fishbein, 1980). There is a strong predictor of behavior, which is the intention to perform the behavior, and subjective norms and attitudes are two motivational factors that influence such behavioral intention. Subjective norms are how people think about whether performing the behavior would be encouraged by people who are important to them (Hale et al., 2002). Attitudes can be described as one's overall evaluations of certain behaviors, in particular, the perceived outcomes or attributes of the behavior. Behavioral intention refers to one's plan or decision to enact the behavior. In explaining the impact of behavioral intention on actual behavior, the time frame is also considered. It is important that the interval between the intention and the action is short to ensure that the intention does not change. As TRA limits the type of behavior to volitional behaviors, which are the specific behaviors under the control of intention, TRA suggests behavioral intention as the most impactful variable that influences the actual behavior (Conner & Armitage, 1998). Fishbein (1993, as cited in Conner & Armitage, 1998) also noted that the TRA does not effectively predict behaviors that depend on external factors such as skills, resources, and opportunities. Due to this limitation, the theory of planned behavior (TPB), which is described in the next section, was created with an attempt to predict less volitional behaviors by incorporating perceptions of control over the performance of the behavior as an additional predictor (Ajzen, 1991; Ajzen & Fishbein, 1988) (see Conner & Armitage, 1998; Hale et al., 2002).

Theory of Planned Behavior (TPB)

TPB, as an extension of TRA, is an expectancy-value model of attitude-behavior relationships that explains a variety of behaviors (Ajzen & Fishbein, 1980). As TRA was limited to volitional behaviors with engaging control, Ajzen added a third element, perceived behavioral control, to explain the motivations and determinants of those behaviors with incomplete volitional control (Godin & Kok, 1996). In this context, perceived behavioral control is shaped by beliefs about opportunities and resources necessary to engage in the behavior (Ajzen, 1991).

The other two determinants, attitudes and social norms, stayed the same. In fact, in regard to attitude, Fishbein and Ajzen (1975) already noted that attitude in TRA is specifically about the attitude toward a behavior rather than an attitude toward an object. Therefore, in TRA, the attitude refers to a positive or negative evaluation of performing the behavior (Ajzen, 1985). Since TPB is proposed as a general theory, it does not specify any particular beliefs with certain behaviors, so determining the relationship between beliefs and behavior is the researcher's determination (George, 2004).

Technology Acceptance Model (TAM)

Both TRA and TPB became the fundamental theoretical bases of other technology-related models. The Technology Acceptance Model (TAM) is a theoretical model that identifies factors that influence users' acceptance of new technology. It is considered the most commonly used and well-verified theory when explaining the use of new technology (Benbasat & Barki, 2007; Y. Lee et al., 2003). It is a theoretical framework developed by Fred Davis (1989). Attitude toward using technology is again influenced by perceived usefulness and perceived ease of use. Perceived usefulness refers to the degree to which an individual believes that using new technology will benefit the user and enhance performance or productivity (Compeau & Higgins, 1991; Davis, 1989). Perceived ease of use refers to the degree to which an individual believes that using a new technology will be easy and less physically and mentally burdensome (Compeau & Higgins, 1991; Davis, 1989; Moore & Benbasat, 1991). These two factors, perceived usefulness and perceived ease of use, are the two major elements of TAM supporting the attitude toward using technology.

LITERATURE REVIEW

Attitudes Toward Technology

In the context of attitudes toward technology, the attitude was originally considered in a narrow definition borrowed from TRA and TAM, then broadened to both affective and cognitive attitudes toward technology (object) and using technology (behavior). In Davis' (1993) early work, the focus was on identifying the impact of attitudes toward technology on the actual use of technology through semantic questions asking respondents' attitudes toward using technology However, according to Yang and Yoo (2004), other later studies adapted and used attitude measurements containing both affective and cognitive aspects in a single attitude construct.

In fact, only a few studies of technology provide a clear definition of attitude. Ardies et al. (2015) provided sub-factors or a list of contents of attitudes that were studied before (e.g., enthusiasm, enjoyment, boredom, interest, career aspirations, the difficulty of science and technology, and beliefs regarding the consequences of science and technology). Cussó-Calabuig et al. (2018) also listed the different dimensions like anxiety, enjoyment, self-confidence, utility of computers, and self-efficacy that were shown in previous literature. Elias et al. (2012) provided both a general definition of attitude, as an "evaluative judgment either favorable or unfavorable, that an individual possesses and directs towards some attitude object" (p. 454), but also a tentative definition of "attitude towards technology" as a whole, as "one's positive or negative evaluation towards the introduction of new kinds of technology in the workplace" (p. 454), consistent with the prior conceptualization of attitude towards technology.

Davis (1989) referred to the different distinctions of attitude suggesting that attitude described in TAM would use attitude or evaluation toward *using* the technology defined as: "the degree of evaluative affect that an individual associates with using the target system in his or her job" (Davis, 1993, p. 476). This aligns with the original TRA and TPB's conceptualization of attitude. Therefore, in measuring attitude, Davis also followed Ajzen and Fishbein's recommendations on using attitude measurements in a way that focuses on operationalizing attitude toward using as opposed to attitudes toward technology itself (see Ajzen & Fishbein, 1980). TAM has been widely used in research and practice to understand user acceptance and adoption of new technologies across a variety of domains.

Older Adults' Attitudes Toward Technology or ICT

Studies of older adults' attitudes toward technology or ICT have explored both positive and negative dimensions. Quan-Hasse et al. (2018) found that older adults reported both positive attitudes and negative attitudes toward using ICT. In their study, older adults reported that they enjoyed staying connected and learning new skills while they were still concerned about how overwhelming using ICT could be (Quan-Hasse et al., 2018). In addition, Vroman et al. (2015) identified the differences between ICT users and non-users regarding their attitudes toward using ICT. Compared to non-users who reported that they feel intimidated and anxious about ICT, ICT users reported that they rather have positive affection towards it.

Instruments and scales

Attitudes toward technology

A review of the literature found 15 instruments that measure attitudes to technology. These are reported in Table 1 together with details about their reliability, validity, and other relevant information. (see Table 1).

Table 1

Summary of attitudes toward technology scales

Citation	Scale	Reliability (Cronbach's alpha)	Validity	Factors
Anderberg et al. (2019)	TechPH	tech enthusiasm = 0.72 tech anxiety = 0.68	Factorial validity tested (CFI = .97, AGFI=.95, RMSEA=.067, SRMR=.036)	Tech enthusiasm Tech anxiety
	No. Items	**Scores**	**Item Examples**	**Sample**
	6	5-point Likert scale (Fully disagree - fully agree)	I think it's fun with new technological gadgets", "I like to acquire the latest models or updates", "I am sometimes afraid of not being able to use the new technical things", etc.	Sample from Swedish National Study of Aging and Care (SNAC) - 374 people who were ICT users (65 or older)
Berkowsky et al. (2013)	**Scale**	**Reliability (Cronbach's alpha)**	**Validity**	**Factors**
	Attitudes towards computers	0.847	not presented	not identified
	No. Items	**Scores**	**Item Examples**	**Sample**
	11	4-point scale (4 = strongly agree, 0 = strongly disagree)	Computers make me uncomfortable, I feel intimidated by computers, I don't understand how some people can spend so much time on computers, etc.	Five assisted and independent living communities (AICs) without cognitive impairments - 101 people in total (mean age = 83.5 years)

Table 1 (cont'd)

	Scale	Reliability (Cronbach's alpha)	Validity	Factors
Blackwell et al. (2014)	Attitudes	0.89	EFA	Teachers' help to develop children's critical thinking skills - 5 items, Technology for administration - 3 items
	No. Items	**Scores**	**Item Examples**	**Sample**
	8	5-point Likert scale (Strongly disagree - strongly agree)	Technology can improve individualized learning, Technology is useful for social interactions among children, Technology can improve documentation of children's learning, etc.	National Association for the Education of Young Children (NAEYC) teachers, n = 1,234
Davis (1993)	**Scale**	**Reliability (Cronbach's alpha)**	**Validity**	**Factors**
	Attitude toward using - semantic differential rating scales	0.96	not presented	not identified
	No. Items	**Scores**	**Item Examples**	**Sample**
	5	7-point semantic differential rating	Good - Bad, Wise - Foolish, Favorable - Unfavorable, Beneficial - Harmful, Positive - Negative	112 professional and managerial employees of a large North American corporation

Table 1 (cont'd)

	Scale	Reliability (Cronbach's alpha)	Validity	Factors
Gonzalez et al. (2015)	Senior Citizens' Attitudes toward Computers (SAC)	0.68	EFA	Single factor scale
	No. Items	**Scores**	**Item Examples**	**Sample**
	25	four-point scale (a lot = 4, quite a lot = 3, not much = 2, not at all = 1)	Using computers makes me nervous, I like using the computer, Using the computer makes me feel valuable, I think computers are too important in the world, etc.	191 older adults (60 +) through the "Cuenc@enRed" network of computers and an Internet course
	Scale	**Reliability (Cronbach's alpha)**	**Validity**	**Factors**
Hernandez-Ramos et al. (2013)	University teacher attitude scale towards the use of ICT	0.862	content validity, construct validity (correlation matrix all greater than .08), CFA	Single factor scale
	No. Items	**Scores**	**Item Examples**	**Sample**
	15	five-point Likert scale (Completely disagree, disagree, neither agree nor disagree, agree, completely agree)	ICT results in a higher education with a greater degree of interdisciplinarity, ICT save the teacher repeating work, The use of technology in the classroom facilitates teaching for university teachers, etc.	161 teachers in all department of the University of Salamanca.

Table 1 (cont'd)

	Scale	Reliability (Cronbach's alpha)	Validity	Factors
Kernan & Howard (1990)	Computer anxiety/attitudes scale	Factor 1 = 0.91, Factor 2 = 0.82, Factor 3 = 0.75, Factor 4 = 0.70, Factor 5 = 0.63	EFA	Five factors: fear of computers, concern for the impact of computers on society, desire to own a computer, ability or capacity to learn about computers, and incomprehensibility of computers
	No. Items	**Scores**	**Item Examples**	**Sample**
	35	five-point Likert scale or seven point Likert scale	Computers intimidate and threaten me, I am confident that I could learn computer skills, Our country relies too much on computers, etc.	335 subjects enrolled in an introductory computer course
	Scale	**Reliability (Cronbach's alpha)**	**Validity**	**Factors**
Mannheim et al. (2021)	Attitudes toward older adults using technology (ATOAUT)-10	0.82	not presented	Two factors: stereotypes and prejudice toward older adults' abilities to use digital technology, attitudes toward older adults' access to digital technology and online digital services
	No. Items	**Scores**	**Item Examples**	**Sample**
	10	Likert-type scale from 1 (totally disagree) to 6 (totally agree)	Using digital technology is harder for most older adults, One needs a lot of patience to explain to an older adult how to use digital technologies, etc.	93 health care professionals and fourth year health care students in the Netherlands

Table 1 (cont'd)

	Scale	Reliability (Cronbach's alpha)	Validity	Factors
Meelissen & Drent (2007)	computer attitude scale	0.80	not presented	Two factors: attitude toward computer use at school, attitude toward computers in general
	No. Items	**Scores**	**Item Examples**	**Sample**
	11	four-point scale (Agree a lot, agree, disagree, disagree a lot)	I enjoy lessons in which computers are used, Computers can help me to learn things more easily, I want to know a lot about computers, You benefit a lot from knowing how to use computers, etc.	4,361 students in primary education
	Scale	**Reliability (Cronbach's alpha)**	**Validity**	**Factors**
Morahan-Martin & Schumacher (2007)	Internet and computer attitudes scale (ICAS)	not presented	not presented	Five factors: importance of internet and computer knowledge, computer phobia, internet and computer comfort/competency, internet and computer overuse, dislike of technology
	No. Items	**Scores**	**Item Examples**	**Sample**
	23	four-point scale (strongly disagree to strongly agree)	Computer literacy is important in order to function in the world, I feel I have no control over what I do when I use a computer, I feel comfortable using the Internet, People have told me I use the computer too much, I am fascinated by new technology, etc.	258 incoming university students in the United States

Table 1 (cont'd)

	Scale	Reliability (Cronbach's alpha)	Validity	Factors
Reece & Gable (1982)	General attitudes toward computers	0.87	constructed validity, EFA	Three factors: Affective, behavioral, and cognitive
	No. Items	**Scores**	**Item Examples**	**Sample**
	10	four-point scale (strongly disagree to strongly agree)	Computer literacy is important in order to function in the world, I feel I have no control over what I do when I use a computer, I feel comfortable using the Internet, People have told me I use the computer too much, I am fascinated by new technology, etc.	258 incoming university students in the United States
	Scale	**Reliability (Cronbach's alpha)**	**Validity**	**Factors**
Rosen et al. (2013)	Media and Technology Usage and Attitudes Scale (MTUAS) - Attitudinal factors	0.88	EFA	Four factors: positive attitudes, anxiety and dependence, negative attitudes, and multitasking preference
	No. Items	**Scores**	**Item Examples**	**Sample**
	16	five-point Likert response (strongly agree to strongly disagree)	I will use a computer as soon as possible, I enjoy computer work, Computers can be used to save lives, etc.	61 seventh-grade students and 172 eighth-grade students from white middle-class junior high school

Table 1 (cont'd)

	Scale	Reliability (Cronbach's alpha)	Validity	Factors
van Braak & Goeman (2003)	Computer Attitudes Scale	0.90	EFA, predictive validity was tested	perceived computer attitudes, computer attitudes
	No. Items	**Scores**	**Item Examples**	**Sample**
	17	Likert scale rescaled into 0 to 100 range	Goals at work can be better achieved with computers, I experience positive effects of computing at work, I will never be able to use computers, I'm afraid to break something, etc.	381 employees working in different sectors in Dutch-speaking region in Belgium
	Scale	**Reliability (Cronbach's alpha)**	**Validity**	**Factors**
Webb & Doman (2020)	adapted from computer attitude questionnaire (CAQ)	0.873	content validity	four factors: instrumentality, anxiety, comfort, digital literacy
	No. Items	**Scores**	**Item Examples**	**Sample**
	16	5-point Likert scale	I will be able to get a good job if I learn how to use a computer, A classroom that uses technology can help me with my academic and career goals, I am comfortable using technology, etc.	128 students students from English Language Learning institutions in Macau, Colombia, and the US.

Table 1 (cont'd)

	Scale	Reliability (Cronbach's alpha)	Validity	Factors
Yang & Yoo (2003)	Attitude	0.918	CFA, convergent validity	Affective, cognitive
	No. Items	**Scores**	**Item Examples**	**Sample**
	6	7-point semantic scale	Happy - annoyed, positive - negative, good - bad, wise -- foolish, beneficial - harmful, valuable - worthless, etc.	211 undergraduate students major in management information systems at a college of management in the New England, US

Anderberg et al. (2019) developed the TechPH (Technophilia) scale, which measures both technology enthusiasm and technology anxiety. Technophilia, though not universally defined, refers to a "strong enthusiasm and love for modern technology" (Anderberg et al., 2019, p. 2). The questions included items such as “I think it’s fun with new technological gadgets”, “I like to acquire the latest models or updates”, “I am sometimes afraid of not being able to use the new technical things”, etc. Items were scored with a 5-point Likert scale ranging from fully disagree (1) to fully agree (5). The reliability of the scale, in terms of internal consistency, was calculated using Cronbach’s alpha, with satisfactory results given the small number of items (tech enthusiasm = .72, tech anxiety = .68). Through validity testing, the authors confirmed relatively good fit indexes for the two-factor model. The questions mainly covered affective attitudes but less so cognitive attitudes. Therefore, it is difficult to measure both dimensions of attitudes using this scale.

Some attitude scales are focused on education settings (Blackwell et al., 2014; Hernández-Ramos et al., 2014; Webb & Doman, 2020) and specific types of technology such as computers (Berkowsky et al., 2013; Kernan & Howard, 1990; Meelissen & Drent, 2008; Reece & Gable, 1982; van Braak & Goeman, 2003), the internet (Morahan-Martin & Schumacher, 2007), email (Davis, 1993b), and spreadsheets (Yang & Yoo, 2004).

The following scales were designed for educational settings making them difficult to adapt to the older adult population. Blackwell (2014) developed a survey “Teacher’s attitudes toward value of technology scale”. In total, eight items were developed. They revealed two factors by conducting factor analysis with varimax rotation: teachers’ attitudes toward children’s learning and technology for administration. The first factor includes questions like “Technology can help to develop children’s critical thinking skills” and “Technology can help to develop children’s content knowledge”, while the second factor includes questions like “Technology can improve documentation of children’s learning” and “Technology is useful for online professional development”. It is measured with a 5-point Likert scale ranging from strongly disagree to strongly agree.

Webb and Doman (2020) developed a technology survey consisting of four constructs: instrumentality, anxiety, comfort, and digital literacy. The technology survey took three constructs (instrumentality, anxiety, and comfort) adapted from the computer attitude questionnaire (CAQ) that was developed by the University of North Texas Institute for Integration of Technology in Teaching and Learning and used over ten years to understand learner dispositions towards technology. Digital literacy was developed by the authors adding items to the CAQ to incorporate the students’ attitudes about achievement through technologies. The items include: “I am comfortable using technology”, “Using technology is fun and exciting”, “Knowing how to upload assignments and participating on our online class page can help me succeed in other areas of my life”, “I can easily understand how to learn and communicate on an online class page”, “I am worried when my teacher uses an online class page”, etc. The questions were answered on a 5-point Likert scale from strongly agree (1) to strongly disagree (5). In terms of reliability, Cronbach’s alpha scores for the constructs were .873, which is acceptable reliability overall. Content validity was determined based on the researchers evaluating the survey items. However, again, these are questions that are too focused on educational settings, so it is hard to apply to the older adult population.

Hernández-Ramos et al. (2014), also targeting educational settings, developed the University Teacher Attitude Towards Use of ICT Scale. The examples of items are: “The use of ICT in university teaching implies the development of new student competences”, “Due to the incorporation of ICT in my teaching, my students are more motivated to work at my subject", "Adequate use of ICT in teaching implies professional online training for teachers", etc. The scale is scored with 5-point Likert scale from completely disagree (1) to completely agree (5). Although the focus of this scale was on ICT, the general theme was focused on the use of ICT in university teaching, which would not translate well to older adult populations.

Several measurements also focused on specific types of technology such as computers. Berkowsky et al. (2013) developed an "attitudes towards computers" measurement that is widely used. The questions include items like "Computers make me uncomfortable", "Computers are difficult to understand", "I usually need help to use a computer", "I have better ways to spend my time than with a computer", etc. The scale is scored in a 5-point Likert scale from strongly disagree (0) to strongly agree (4). Cronbach's alpha of the summed scale was .847, and no validity testing was reported. Kernan and Howard (1990) recreated a computer anxiety and attitude measure inspired by many previous scales along with four computer alienation questions developed by the authors. These scales include:

a. Computer Attitude Scale (CATT) - 20 items, scored with a 5-point Likert Scale from strongly agree (1) to strongly disagree (5) (Dambrot et al., 1985)
b. Attitudes Toward Computer Usage Scale (ATCUS)- 20 items, scored with a 7-point Likert Scale (Popovich et al., 1987)
c. Attitudes Toward Computers (ATC) scale – computer anxiety (10 items), the impact of computers on society (8 items), scored with a 5-point Likert scale (Raub, 1981)
d. Attitudes Toward Computers Scale – 4 items, scored with a 5-point Likert Scale (Morrison, 1983)

Some of the items included: "Computers intimidate and threaten me," "I am confident that I could learn computer skills," "There's a computer revolution going on, and I don't feel like I'm part of it," "Our country relies too much on computers," and "A computer could make learning fun for me." They are measured by either a 5-point or 7-point Likert scales. A total of 335 subjects enrolled in an introductory computer course participated in this study. Principal components factor analysis with varimax rotation was conducted in a total of 66 anxiety and attitude items, identifying 35 items that were retained after factor loadings.

Meelissen and Drent (2008) developed a computer attitude scale that consists of two factors: affective attitude and cognitive attitude. In here, they developed 11 statements with regard to their computer attitudes (affective component, Cronbach's alpha = .73, cognitive component, Cronbach's alpha = .69). Internal consistency of all items is .80. Sample items include: I enjoy lessons in which computers are used, Computers can help me to learn things more easily, I want to know a lot about computers, If you can use computers, you will get a better job in the future, etc. It is scored on a four-point scale, then, transferred to a score between 0 (totally agree) and 100 (totally disagree). Reece and Gable (1982) developed a scale to measure general attitudes toward computers, adapting the idea of different types of affective, behavioral, and cognitive attitudes. Some of the items included: "I will use a computer as soon as possible," "Learning about computers is boring to me," "Computers can be used to save lives," "I would never take a job where I had to work with computers," and "Having computers in the classroom would be fun for me." These items are scored on a 5-point scale from strongly disagree to strongly agree. A factor analysis of the intercorrelations of responses to 30 items from a sample of 233 seventh and eighth grade students in a white middle-class school revealed one identifiable factor dimension entitled General Attitudes Toward Computers, with an estimated alpha internal consistency reliability of .87. However, the scale is too focused on computers and is not contextually appropriate for older adults, as it includes questions related to the classroom and work. van Braak and Goeman (2003) developed a general computer attitude and perceived computer attribute scale focusing on the work environment. Collecting data from 381 employees in Belgium, they asked 28 items to measure an individual's disposition toward the use of computers in general and the perceived value of computer use in professional situations. Fourteen questions were borrowed from computer attitude items from Loyd and Gressard (1984) and Loyd and Loyd (1985). The original scale was developed to assess secondary school students' computer liking, perceived computer usefulness, computer interest, and computer anxiety but it was never validated for a sample of adult employees. The other fourteen questions were borrowed from Dearing and Meyer's (1994) innovation attribute matrix. The model with a two-factor solution (Computer attributes and perceived computer attitudes) was proposed and among 28 items, 17 items were retained with high loadings. Some of the items covered are "Computer use in the work environment is a necessity", "I experience positive effects of computing at work", "Computers don't frighten me", "I'm afraid to break something", etc. The index scores for the three scales transferred from 0 to 100 to increase comparability between scales. The index scores were calculated by summing the raw scores obtained for each statement. Internal reliability suggested that the total scale was acceptable (Factor 1 = .89, Factor 2 = .81, Total = .90).

González and Viadel (2015) developed a senior citizen's attitudes toward computers (SAC) scale. The scale contains a total of 26 items, including questions such as "Using computers makes me nervous", "I like using the computer", "I think learning to use the computer is something worthy", "Computers make me feel like I'm not up to date", "Using the computer helps dealing with paperwork”, etc. Four answer choices were given to respondents: Not at all (1), Not much (2), Quite a lot (3), and A lot (4). In terms of reliability, Cronbach’s alpha scored .68. Concurrent validity was tested, showing a positive correlation between SAC and computer use ($r = .22$) and SAC and internet access ($r = .25$). However, the scale was specifically developed to measure attitudes toward computers, which is narrower in scope than a general attitudes scale for technology or ICT.

Another type of technology that appeared in measurements was the Internet. Morahan-Martin and Schumacher (2007) developed an Internet and Computer Attitude Scale consisting of the importance of internet and computer knowledge, computer phobia, internet and computer comfort or competency, internet and computer overuse, and dislike of technology. Some examples of questions are: "Knowing how to use the internet will make it easier to get a job," "All business college students should be taught to use the internet," "Computer skills are essential in the modern business world," "Computers are so complicated that I would rather work manually," "I feel competent in my ability to use the internet," "People have told me I use the computer too much," and "I would prefer to do math/statistics by hand rather than use a computer," etc. The scale is scored on a 4-point scale from 1 (strongly disagree) to 4 (strongly agree). Five factors were identified for the 23 questions: importance of internet and computer knowledge, computer phobia, internet and computer comfort/competency, Internet and computer overuse, and dislike of technology. Morahan-Martin and Schumacher (2007) did not report the reliability testing result. Although the scale incorporated both Internet and computer, it limits the types of ICT that older adults can be asked about.

Other scales were built upon specific functions of technology such as emailing or using spreadsheets. Davis (1993), when developing attitude toward technology questionnaires, originally suggested adapting from Ajzen and Fishbein's questionnaire which incorporated the evaluative dimension of the semantic differential (see Osgood et al., 1957). Davis (1993) proposed five semantic differential questions for measuring electronic mail as an example: Good – bad, Wise – foolish, Favorable – unfavorable, Beneficial – harmful, and Positive – negative. These semantic choices were presented after the statement, "All things considered, my using electronic mail in my job is…". Adapting these semantic differential questions, Yang and Yoo (2004) divided them into two factors: affective attitude (Happy – annoyed, Positive – negative, Good – bad) and cognitive attitude (Wise – foolish, Beneficial – harmful, Valuable – worthless). The question given was, "Using spreadsheet software makes me feel…". These were measured with 7-point semantic differential rating scales.

There was also a measurement that involved the idea of older adults using technology. However, the focus was not on older adults' attitude itself but attitude towards older adults' use of technology. Mannheim et al. (2021) developed and used both direct and indirect measurement to measure attitudes toward older adults using technology. Their direct measurement included 'attitudes toward older adults using technology (ATOAUT) scale'. Items were developed based on the literature regarding stereotypes of older adults and technology, such as ease of use, perceived benefit, fear, anxiety, and self-efficacy, as well as their experience from interviewing technology designers and focus groups with older adults, and feedback from experts drawn from previous studies. They initially had 15 items, and participants were told to rate their agreement with statements about older adults and digital technology. The items included questions like "It's hard to explain to older adults how to use digital technology", "Most older adults are not interested in learning about using new digital technology", "Most older adults can use digital technology just as well as younger adults", etc. It was scored with Likert-type scale from totally disagree (1) to totally agree (6). However, with the factor analysis, they identified those questions that focused on stereotypes or prejudice toward older adults regarding their use of digital technology – which then became ATOAUT-10 scale. Cronbach alpha coefficient of the new 10-item scale was .82. As their indirect measure, they modified a vignette technique that was used to assess health care-related ageism. Participants were presented with three descriptions of health care-related digital technology such as health care application, smartwatches, and rehabilitation video games. They were asked to answer either yes or no if they believed different age groups could use this digital technology. However, the focus was not on older adults' attitudes toward using technology, but rather health care workers' attitudes towards older adults using technology.

There is one additional measurement that engaged both cognitive and affective attitudes toward using technology but which has yet to be tested for older adult populations. Rosen et al. (2013) developed a scale called Media and Technology Usage and Attitudes scale (MTUAS). MTUAS has total of 60 items and it consists of 15 subscales: 11 measuring usage of technology and media (i.e., smartphone, Internet, e-mailing, media sharing, text messaging, video gaming, phone calling, television viewing, Facebook usage, Facebook friendships, and online friendships) and four measuring attitudes (e.g., positive attitude, negative attitude, anxiety and dependence, and multitasking preference). Each subscale is internally reliable and externally valid so that it could be combined or separated when used. The attitudes subscales (positive attitude, negative attitude, anxiety and dependence and multitasking preference) respectively achieved Cronbach's alpha score of .87, .80, .83, and .85. However, among the four subscales, multitasking preference does not ask the respondents' attitudes toward 'technology' but only their preference in multitasking.

Unresolved Issues

A review of the literature reveals a number of important issues that have not been addressed. One of the issues found is the lack of consistency within and across the papers regarding the key terms: attitude and technology. Considering multiple types and ways of categorizing attitudes, it was difficult to find studies that initially defined or gave a working definition of attitude. This posited a question if it is certain that the same definition or types of attitudes were applied between different studies that developed or measured attitudes towards technology or ICT. While Reece et al. (1982) and Yang and Yoo (2004) differentiated affective and cognitive attitudes in scale development, they focused on specific devices like computers or software like spreadsheets, making the instrument difficult to extend to general technology terms. This, in fact, raises another issue of the consistency of the concept, technology, within the study. As technology encapsulates a variety of kinds and meanings, it faces a problem of consistency within the study. If specific types of technology are given in the scale, generalization and application are difficult, and if it is just given as 'technology' or 'ICT', identifying respondents' understanding of technology is almost impossible. Finally, it was very difficult to find studies that targeted older adults in the context of attitudes toward technology or ICT. Rather than putting older adults as the main population of the study, they were introduced as part of adult groups. With this in mind, this dissertation research tried to resolve such issues found in previous literature.

Purpose Statement

Given the importance of measuring older adults' attitudes toward ICT, the purpose of the proposed study is to assess the utility of a widely used attitude toward technology scale with this population. A scale that can measure attitudes toward ICT, with reliability and validity, can provide important information for designing interventions to increase the use of ICT and improve digital literacy among older adults. Therefore, the research question is, "Does the attitudes toward technology or ICT scale that are chosen with inclusion and exclusion criteria for this study provide a valid and reliable measure of attitudes toward ICT in older adults, as assessed through confirmatory factor analysis, convergent validity, and concurrent validity tests?"

METHODS

Sample Eligibility

Eligibility for participation in the current study was based on two criteria: the participant must be aged 65 or older and feel comfortable reading and answering the survey in English.

Sample Size

When it comes to structured equation model (SEM) and factor analyses like exploratory factor analysis (EFA) and CFA, determining the sample size based on rule of thumb had been most of the cases that some scholars tried to find alternatives for so long (Kyriazos, 2018). The rule of thumb is that the minimum sample size is to exceed 200 which would offer adequate statistical power (Hoe, 2008). Comrey and Lee (2013) noted that in factor analysis, a sample of 50 or lower is considered very poor, about 100 is poor, about 200 is fair, about 300 is good, about 500 is very good, and if the number exceeds 1,000, it is excellent. Another way of estimating with rule of thumb could be using the ratio of items (*q*). N;*q* is commonly used, and the ratio is from10:1 to 20:1 (Jackson, 2003). Following this approach, because the measurement of interest in this dissertation contains 12 items in total, the minimum size of the sample was estimated to be around 120 to 240.

Instead, according to Velicer and Fava (1998), the size of factor loadings and the number of variables are important factors in determining sample size in CFA. Previous literature has identified several features that also influence the sample size of SEM and CFA, such as model complexity, number of model parameters estimated, existing interactions between data, estimation methods, missing data, etc. (Kline, 2016, as cited in Kyriazos, 2018). Another way of estimating the appropriate sample size is a priori power analysis (Kyonka, 2018). In calculating the sample size, the alpha level (probability of rejecting the null hypothesis) would be set to 0.05, the power level (probability of correctly rejecting the null hypothesis) to 0.80, and the effect size to 0.05. Degrees of freedom (*df*) will be calculated by subtracting the sum of factor loadings, factor variances, factor covariance, and error variance from total number of variances and covariances. Testing for the three-factor CFA model, as the original MTUAS proposed, *df* is calculated as 48, resulting in sample size of 249 (Moshagen & Bader, 2023). Therefore, the appropriate sample size for this research was between 120 to 249.

Survey Design

Measures (see Appendix)

Eligibility questions. Age and proficiency in English were collected.

Demographics. Gender identity, highest education, race, living status (living alone or not), income level, and residence characteristics (urban, suburban, small city, rural) were collected.

Technology-related items. Respondents were asked to identify one specific ICT as a focus for the survey, such as smartphone, computer, email, etc. They were also asked to answer duration of using this ICT, former use or experience with this ICT in and out of the workplace, training experience of using this ICT, and frequency of ICT use.

Attitudes Toward ICT. Rosen et al.' (2013) attitude toward technology subscale from the Media and Technology Usage and Attitudes Scale (MTUAS) was chosen as a main measurement for the attitudes toward ICT (see Table 2). The criteria for choosing the scale to be included in the survey is that the survey 1) measures both affective and cognitive attitude, 2) has done reliability or validity testing, and 3) targets 'technology' or 'ICT' but not computer, smartphone, or any of the specific type of technology.

Table 2

MTUAS attitudinal factors (original)

Factor	Questions
Positive Attitude	1. I feel it is important to be able to find any information
Positive Attitude	2. I feel it is important to be able to access the internet any time I
Positive Attitude	3. I think it is important to keep up with the latest trends in
Anxiety/ Dependence	4. I get anxious when I don't have my cell phone.
Anxiety/ Dependence	5. I get anxious when I don't have the internet available to me.
Anxiety/ Dependence	6. I am dependent on my technology.
Positive Attitude	7. Technology will provide solutions to many of our problems.
Positive Attitude	8. With technology anything is possible.
Positive Attitude	9. I feel that I get more accomplished because of technology.
Negative Attitude	10. New technology makes people waste too much time.
Negative Attitude	11. New technology makes life more complicated.
Negative Attitude	12. New technology makes people more isolated.
Multitasking Preference	13. I prefer to work on several projects in a day, rather than
Multitasking Preference	14. When doing a number of assignments, I like to switch back
Multitasking Preference	15. I like to finish one task completely before focusing on
Multitasking Preference	16. When I have a task to complete, I like to break it up by

First, knowing both affective and cognitive attitudes is important in identifying one's attitudes toward technology (Yang & Yoo, 2004). When it comes to the impact of attitudes toward technology or technology use, the impact might differ between affective attitude and cognitive attitude. Yang and Yoo (2004) found that affective attitude does not show significant influence on the behavior of using technology compared to cognitive attitudes which in fact showed significant influence. This can be easily interpreted as a comparison of an individual feeling bad or worried about using technology personally (affective attitude), but if that individual agrees or understands that the technology could be welcomed in society and the person knows it is considered beneficial (cognitive attitude), that person would try using that technology. It is yet unknown if this result would also be the same for the older adult population.

Second, among many self-developed questionnaires that were used in research involving attitudes toward technology or ICT, reliability testing and/or validity testing were reported. This builds a better foundation to apply such measurement for the older adult population. Third, given the lack of a well-established scale specifically designed to measure attitudes toward ICT, it was deemed more appropriate to adopt an existing comprehensive measure of attitudes toward technology and adapt its focus from technology to ICT rather than modifying a computer-specific scale to encompass ICT. This decision was based on the premise that the broader level of measurement represented by 'technology' could be narrowed to 'ICT' easily while increasing the narrower level of measurement such as 'computer' is difficult as the expanded terms may not overlap in some way (DeVellis, 2017). Consequently, utilizing a technology-based attitude scale ensured a more holistic and inclusive assessment of ICT-related attitudes without the limitations imposed by a device-specific framework

Following those criteria, Rosen et al.'s (2013) attitudinal subscale of MTUAS was selected (see Table 4). Their study included some older adults, but they did not report how many older adults were considered as 'older people' and they did not specify the number or criteria of older people. They presented that older people showed less positive attitudes toward technology and were less anxious about not checking in with technology, but age was not correlated with preference for task switching or negative attitudes toward technology. Rosen et al. (2013) stated that each subscale of attitudinal factors such as positive attitude, negative attitude, technology anxiety or dependence, and multitasking preference could also be used as an independent scale as subscales were internally reliable and externally valid on their own. Therefore, in the modified version of MTUAS attitudes toward ICT scale, the multitasking preference subscale which did not include the key concept technology or ICT was removed to prevent confusion among respondents, and "technology" was replaced with "this ICT" indicating the ICT respondents previously chose in the earlier part of the survey, unless a specific technology was mentioned in the item (see Table 3).

Table 3

MTUAS attitudes toward ICT (modified)

Item code	Factor	Questions
Q23_1	Positive Attitude	I feel it is important to be able to find any information whenever I want online.
Q23_2	Positive Attitude	I feel it is important to be able to access the internet any time I want.
Q23_3	Positive Attitude	I think it is important to keep up with the latest trends in technology.
Q23_4	Anxiety/ Dependence	I get anxious when I don't have my cell phone.
Q23_5	Anxiety/ Dependence	I get anxious when I don't have the internet available to me.
Q23_6	Anxiety/ Dependence	I am dependent on this ICT.
Q23_7	Positive Attitude	This ICT will provide solutions to many of our problems.
Q23_8	Positive Attitude	With this ICT anything is possible.
Q23_9	Positive Attitude	I feel that I get more accomplished because of this ICT.
Q23_10	Negative Attitude	New ICT makes people waste too much time.
Q23_11	Negative Attitude	New ICT makes life more complicated.
Q23_12	Negative Attitude	New ICT makes people more isolated.

For convergent validity testing, attitudes toward ICT semantic questions were included in the survey. The semantic questions are scored with 7-point scale from positive nuanced words to neutral to negative nuanced words. The original questions were from Davis (1993) and Yang and Yoo (2004), and the modification was made to include "this ICT" in the statement given (see Table 4).

Table 4

Attitudes toward ICT semantic questions (modified)

Item code	Questions
Q27_1	Good – Neutral – Bad
Q27_2	Wise – Neutral – Foolish
Q27_3	Favorable – Neutral – Unfavorable
Q27_4	Beneficial – Neutral – Harmful
Q27_5	Positive – Neutral – Negative
Q27_6	Happy – Neutral – Annoyed
Q27_7	Valuable – Neutral – Worthless

Note. Respondents were asked to complete the given sentence: "All things considered, my using this ICT is".

For concurrent validity testing, behavioral intention of using ICT (see Table 5) was used. Behavioral intention of using ICT was scored with 5-point Likert scale ranging from strongly agree to strongly disagree. The instrument was modified from the original version developed by Martín-García et al. (2022).

Table 5

Behavioral intention of using ICT (modified)

Item code	Questions
Q24_1	I plan to use this ICT.
Q24_2	In general, I will use this ICT frequently.
Q24_3	I am interested in finding out about new versions of this ICT to use.

Data Collection

For the recruitment of participants, the strategy was to leverage existing partnerships or connections with senior centers formed during previous research projects. Through research projects, there was a good connection built with the Tri-County Office on Aging (TCOA), Otsego County Commission on Aging (OCCOA), Antrim County Commission on Aging (ACCOA), Bay County Department on Aging (BCDOA), St. Patrick's Senior Center in Detroit, Oakland-Livingston Human Service Agency (OLHSA) in Pontiac, and Alpena Senior Center. As an example, at TCOA, the congregate meal program is reported to have reached 678 older adults in 2023 (Tri-County Office on Aging, 2023). In addition, a personal connection with Asian churches added more diversity to participant recruitment.

All procedures that involved human subjects in the dissertation were submitted to the Michigan State University Institutional Review Board (MSU IRB) for approval and the study was exempted as the survey was conducted anonymously. The data were collected either through MSU Qualtrics, an online survey tool, or printed copies, and for the analyses and data management, data was coded in MSU Qualtrics with anonymity. Participants were given all required informed consent information before beginning the survey. The anonymous data are stored in a password-protected file and only the principal investigator has access.

Data collection for this study was conducted between October and December 2024. Surveys, along with relevant study information, were distributed through senior centers in Michigan and shared via word-of-mouth to reach a broader participant base. The survey was primarily administered in hard-copy format via mail, but upon request, an online version was made available to select senior centers and individuals. In total, 414 responses were collected. Due to the nature of convenience sampling, and distribution strategy that encompassed both online and in-person contacts, it was difficult to estimate response rate. After deleting the ineligible cases from 414 responses, it was identified that 337 participants fully completed the MTUAS attitudes toward ICT Scale. Given that the study examined not only the MTUAS attitudes toward ICT scale but also attitudes toward ICT semantic questions and behavioral intention of using ICT questions, the study took a conservative approach to inclusion. Ultimately, 231 fully completed responses (online responses =142, hard copy responses = 89), including all three scales and demographic information, were retained for analysis to ensure data completeness and consistency across variables.

Data Analyses Plan

Reverse Coding

In order to match the direction for confirmatory factor analysis (CFA) and other validity tests, all items except for items 10, 11, and 12 from attitudes toward ICT items from MTUAS (Q23_10, Q23_11, and Q23_12) were reversed so that higher scores would indicate positive attitudes toward ICT and more willingness in using ICT. Rosen et al. (2013) did not provide the correlation between the items, and it is difficult to identify the direction of each item pair. Other items from attitudes toward ICT semantic questions and behavioral intention of using ICT questions were also reversed so that higher score would indicate a more positive attitude towards and more willingness of using ICT.

Reliability

The Cronbach's Alpha coefficient is the most commonly used measure of internal consistency and is regarded as particularly suitable for reliability assessments involving Likert scales (Cronbach, 1951; Vaske et al., 2017). Although there are no strict rules for what constitutes adequate internal consistency, a coefficient of .70 is generally accepted as the minimum threshold (Robinson, 2010). While reliability is crucial for a study, it must be accompanied by validity to ensure the measure's overall utility and effectiveness.

Confirmatory Factor Analysis (CFA)

A commonly used method to investigate construct validity is confirmatory factor analysis (CFA) (Fournier-Vicente et al., 2008). CFA is a tool that a researcher can use to attempt to reduce the overall number of observed variables into latent factors based on commonalities within the data. CFA assists in the reduction of measurement error and allows for the comparison of alternatively proposed a priori models at the latent factor level (McArdle, 1996). Model evaluations would be made using a variety of fit indices, including the comparative fit index (CFI), standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). Indication of a good fit with the data varies a little by scholars depending on how rigorous the cut-off values could be. Hoyle (1995) suggested values of CFI > 0.9, SRMR < 0.08, and RMSEA < 0.08 to be a good fit. Hu and Bentler (1999) suggested that CFI $\geq .95$, RMSEA $\leq .06$, and SRMR $\leq .08$ are the values for a good fit. Vandenberg and Lance (2000) suggested values of CFI $\geq .90$, RMSEA $\leq .08$, and SRMR $\leq .10$. In this study, the determination of good fit followed Hu and Bentler (1999) as it suggests a rigorous cutoff standard.

Convergent Validity

Convergent validity refers to the degree to which two measures that are theoretically related demonstrate a strong correlation, indicating that they assess the same construct (Campbell & Fiske, 1959). It is an essential aspect of construct validity, ensuring that a measurement tool effectively captures the intended concept. In this study, Spearman’s rank correlation coefficient (ρ) was used to assess the convergent validity, as it is suitable to measure correlations between ordinal variables A high positive Spearman's correlation (e.g., $\rho > 0.50$) suggests strong convergent validity, whereas a weak or non-significant correlation may indicate issues with the measurement (Hinkle et al., 2003). If the correlation is statistically significant and meets the expected threshold, the new measure is considered to have adequate convergent validity. In this dissertation, MTUAS attitudes towards ICT scale (Q23) and Attitudes toward ICT semantic questions (Q27) were used in convergent validity testing.

Concurrent Validity

Concurrent validity refers to the extent to which a new measure correlates with an established measure of the same construct when both are assessed at the same time (Anastasi & Urbina, 1997). It is a subtype of criterion validity, indicating that the new instrument produces results consistent with a well-validated benchmark. Spearman's rank correlation coefficient (ρ) was also used to assess the concurrent validity, as it is suitable to measure correlations between ordinal variables. A strong positive Spearman's correlation (e.g., $\rho > 0.50$) suggests that the new measure aligns well with the established one, supporting its concurrent validity (Hinkle et al., 2003). In this study, MTUAS attitudes towards ICT scale (Q23) and behavioral intention of using ICT questions (Q24) were used in concurrent validity testing.

Prior to conducting the primary analyses, descriptive statistics were presented, followed by assumption testing and the results of CFA, convergent validity testing, and concurrent validity testing. All statistical analyses were conducted using the R software (ver. 4.4.2) environment for statistical computing, and analysis procedures were confirmed by the MSU Center for Statistical Training and Consulting (CSTAT).

RESULTS

This study aimed to evaluate the factorial, convergent, and concurrent validity of the 12-item MTUAS measures assessing attitudes toward ICT in an older adult sample. Specifically, it sought to replicate findings from a previous study on the general adult population, which identified evidence supporting three-factor model of attitudes toward ICT using confirmatory factor analysis (CFA). Demographic information of 231 responses is presented in Table 6. The majority of the respondents were female (N = 171, 74.03%), White or Caucasian (N = 145, 62.77%). More than half of respondents answered that their annual household income of the previous year was over $40,001 (N = 116, 50.22%) and they currently live alone (N = 120, 51.95%). The remainder of the variables showed relatively balanced answers. Respondents answered their highest education as a college graduate (N = 67, 29%) or graduate degree (N = 65, 28.14%), and their community types were urban (N = 85, 36.8%) and rural (N = 61, 26.41%).

Table 6

Descriptive Analyses for Demographics (N = 231)

Variables	***N***	**%**
Gender		
Male/Man	59	25.54
Female/Woman	171	74.03
Other	1	0.43
Education		0.00
Elementary school	0	0.00
Some high school	3	1.30
High school graduate or GED	24	10.39
Some college or technical school	72	31.17
College graduate	67	29.00
Graduate degree	65	28.14
Race		0.00
White or Caucasian	145	62.77
Black or African American	72	31.17
Native American or Indigenous	2	0.87
Asian and Pacific islanders	5	2.16
Other	7	3.03

Table 6 (cont'd)

Variables	*N*	%
Live Alone		0.00
Yes	111	48.05
No	120	51.95
Annual Household Income		0.00
Less than $15,000	14	6.06
$15,001 - $25,000	25	10.82
$25,001 - $40,000	38	16.45
$40,001 or more	116	50.22
Don't know/Not sure	8	3.46
Prefer not to answer	30	12.99
Community types		0.00
Urban	85	36.80
Suburban	33	14.29
Small city	52	22.51
Rural	61	26.41

Note. N=231. Participants were on average 73.5 years old (SD=5.75).

Respondents were asked to circle all the devices or services they would identify as ICT among the options given (see Table 7). The list of ICT people could circle included: smartphone, laptop, desktop, table PC, internet, texting, email, video chat, online game, online club activities, social media, smart speakers, and "others" with text entry. The data suggested that participants identified both devices (e.g., smartphone, laptop) as well as services (e.g., texting, email) as ICT. The devices and software that had high votes were smartphone (N = 218, 94.4%), internet (N = 198, 85.71%), texting (N = 187, 80.95%), and email (N = 187, 80.95%), followed by laptop (N = 183, 79.22%).

Table 7

Identification of ICT (N = 231)

Devices and services	*N*	%
Smartphone	218	94.37
Internet	198	85.71
Texting	187	80.95

Table 7 (cont'd)

Devices and services	***N***	**%**
Email	187	80.95
Laptop	183	79.22
Tablet PC	174	75.32
Desktop	160	69.26
Social media	157	67.97
Video chat	150	64.94
Online game	120	51.95
Smart speakers	103	44.59
Online club activities	84	36.36
Others	15	6.49

Respondents were also asked to select one ICT that their answers to the survey would be based on (see Table 8). This question was asked in order to improve consistency of their responses. About half of the respondents chose phone (N = 115, 49.75%) which included text entry for phone, cell phone, and smartphone. The next most frequent choice was internet (N = 37,16.02%), followed by computer (N = 31,13.42%) which included computer and desktop computer.

Table 8

Frequency report of ICT identification (text entry) (N = 231)

Items	***N***	**%**
Phone[a]	115	49.75
Internet	37	16.02
Computer[b]	31	13.42
Tablet[c]	19	8.23
Laptop	8	3.46
Social Media[d]	6	2.60
Email	5	2.16
Online	1	0.43
Video conference	1	0.43

Table 8 (cont'd)

Items	***N***	**%**
VR	1	0.43
Website	1	0.43
Others[e]	4	1.73
Missing value	2	0.87

Note. [a]Phone includes cellphone, phone, and smartphone.

[b]Computer includes computer and desktop computer.

[c]Tablet includes iPad and tablet.

[d]Social media includes Facebook and social media.

[e]Others include those who wrote more than one item such as 'internet, iPhone', 'phone, computer', 'smartphone, tablet', and 'texting, computer.'

Respondents also answered their previous experience with the specific ICT they selected (see Table 9). The majority of people identified that they have used the ICT of their choice before (N = 222, 96.1%) and they used in their workplace before (N = 136, 58.87%). However, more than half of the respondents answered that they did not have training experience of the ICT they chose (N = 141, 61.04%). Again, the majority of respondents claimed that they are using this ICT almost every day (N = 212, 91.77%) while there were four people (1.73%) who answered that they never use this ICT.

Table 9

ICT-related experiences (N = 231)

Variables	***N***	**%**
Formal Use Experience		
Have used	222	96.10
Never used	9	3.90

Table 9 (cont'd)

Variables	***N***	**%**
Formal Use Experience at Work		
Yes	136	58.87
No	94	40.69
Never employed	1	0.43
Training Experience		
Yes	88	38.10
No	141	61.04
Unsure	2	0.87
Frequency of Use		
Almost everyday	212	91.77
At least once a week	10	4.33
At least once a month	5	2.16
At least once a year	0	0
Never	4	1.73

Reliability and Validity Testing

The following table is presents a summary of all the testing results of reliability and validity testing (see Table 10).

Table 10

Summary of Test Results

Testing	Results	Comments
Reliability	Cronbach's alpha = 0.87	Reliable
Factorial Validity	$\chi^2(51) = 161.83$, $p < .001$	Good discrepancy
	Comparative Fit Index (CFI) = 0.961	Good fit
	Tucker-Lewis Index (TLI) = 0.950	Good fit
	Standardized Root Mean Square Residual (SRMR) = 0.067	Acceptable range
	Root Mean Square Error of Approximation (RMSEA) = 0.097	Moderate fit
Convergent Validity	$\rho = .56$, $p < .001$	Moderate-to-strong positive relationship
Concurrent Validity	$\rho = .56$, $p < .001$	Moderate positive relationship

Reliability Testing

A reliability analysis was conducted to assess the internal consistency of the twelve-item measure using Cronbach's alpha (see Table 11). The results indicated a high level of reliability, with a Cronbach's alpha of 0.87, suggesting strong internal consistency among the items. The 95% confidence interval for Cronbach's alpha ranged from 0.85 to 0.89, indicating stability in reliability estimates. An analysis of item reliability showed that removing any single item did not significantly improve the overall reliability, with Cronbach's alpha ranging between 0.85 and 0.87 if an item was dropped.

Table 11

Correlation Matrix for attitudes toward ICT items from MTUAS (N = 231)

Items	2	3	4	5	6	7	8	9	10	11	12
1	0.70***	0.52***	0.35***	0.43***	0.37***	0.42***	0.38***	0.43***	0.18**	0.24***	0.15*
2		0.50***	0.35***	0.44***	0.38***	0.34***	0.34***	0.38***	0.19**	0.30***	0.18**
3			0.30***	0.40***	0.32***	0.33***	0.39***	0.41***	0.25***	0.24***	0.23***
4				0.71***	0.61***	0.52***	0.37***	0.42***	0.25***	0.16*	0.15*
5					0.66***	0.46***	0.43***	0.46***	0.19**	0.19**	0.22***
6						0.53***	0.38***	0.55***	0.14*	0.15*	0.13
7							0.60***	0.64***	0.28***	0.21**	0.28***
8								0.50***	0.17*	0.12	0.20**
9									0.29***	0.21**	0.33***
10										0.57***	0.59***
11											0.47***
12											

Note. * p < .05, ** p < .01, *** p < .001

Factorial Validity Testing

Assumptions of CFA

CFA assumes multivariate normality, the absence of multivariate outliers, linear relationships among items, and complete data. In summary, linearity and normality of residuals among MUTAS attitudes toward ICT items were found in these responses. Furthermore, no multivariate outliers were found in the sample. However, violations of normality (skewness and kurtosis) were present.

Normality. A normality assessment was conducted to determine whether the data met the assumptions required for Confirmatory Factor Analysis (CFA). The results indicated that the assumption of multivariate normality was not met. Mardia's skewness test yielded a statistic of 818.37, with a highly significant p-value ($p < .001$), and Mardia's kurtosis test resulted in a statistic of 10.24, also significant ($p < .001$), suggesting violations of multivariate normality (Mardia, 1970). For univariate normality, the Anderson-Darling test was conducted for each item, and all yielded significant results ($p < .001$), indicating deviations from normality across all observed variables. Skewness and kurtosis values further supported this finding, with several items displaying skewness exceeding ±1 and kurtosis values deviating from the expected range of normal distribution (West et al., 1995) (see Table 12). Descriptive statistics showed that item means ranged from 2.61 to 4.53, with standard deviations between 0.73 and 1.22, suggesting variations in response distributions. Some items, such as Q23_1 and Q23_2, exhibited higher negative skewness (-1.65 and -2.12, respectively), indicating that responses were clustered toward the higher end of the Likert scale. Given these findings, due to the violation of normality assumptions, the weighted least squares mean and variance adjusted (WLSMV) estimator, which is the method that is robust to non-normality, should be considered for accurate parameter estimation (Muthén & Muthén, 2017).

Table 12

Means, SDs, and Distribution Statistics of Attitudes toward ICT (MTUAS) items

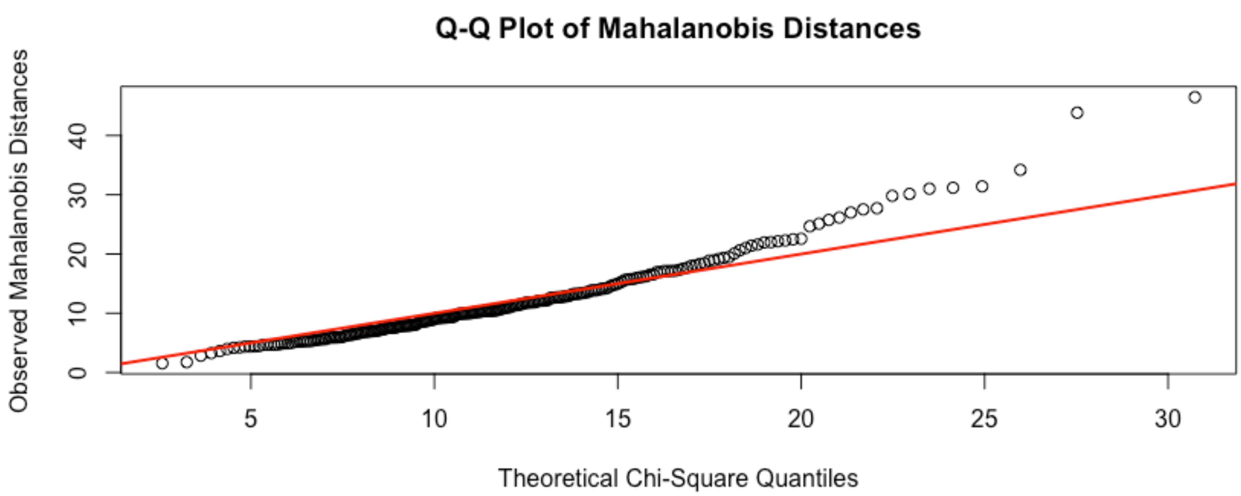
	Mean	SD	Skewness	Kurtosis	Shapiro-Wilk
1. I feel it is important to be able to find any information whenever I want online.	4.51	0.73	-1.66	3.16	0.68***
2. I feel it is important to be able to access the internet any time I want.	4.53	0.79	-2.13	5.39	0.63***
3. I think it is important to keep up with the latest trends in technology.	4.03	0.90	-0.52	-0.49	0.84***
4. I get anxious when I don't have my cell phone.	3.42	1.22	-0.35	-0.81	0.90***
5. I get anxious when I don't have the internet available to me.	3.42	1.17	-0.20	-0.93	0.90***
6. I am dependent on this ICT.	3.55	1.19	-0.48	-0.60	0.89***
7. This ICT will provide solutions to many of our problems.	3.58	1.06	-0.37	-0.37	0.89***
8. With this ICT anything is possible.	3.31	1.05	-0.05	-0.45	0.90***
9. I feel that I get more accomplished because of this ICT.	3.75	1.05	-0.41	-0.74	0.88***
10. New ICT makes people waste too much time.	2.65	1.04	0.15	-0.61	0.91***
11. New ICT makes life more complicated.	2.77	1.01	0.05	-0.58	0.91***
12. New ICT makes people more isolated.	2.61	1.11	0.33	-0.75	0.90***

Note. Items were measured with a 5-point Likert scale (1: Strongly agree, 2: Agree, 3: Neutral, 4: Disagree, 5: Strongly disagree). For analyses, Items 1-9 were reverse coded so that higher scores would indicate positive attitudes toward ICT.

Multivariate outliers. In this study, Mahalanobis distance (D^2), a measure that accounts for the multidimensional distribution of the data (Tabachnick & Fidell, 2019), was computed using participants' responses to the twelve ordinal Likert-scale items of attitudes toward ICT. A Q-Q plot was used to visually assess Mahalanobis distances against expected chi-square quantiles. Points that significantly deviated from the reference line suggested potential multivariate outliers (see Figure 1). Three outliers were found, and with a close investigation of each of those responses, there was no evidence of careless responding or straight lining, which is to select the same answer for every question, that could be harmful enough to remove the data.

Figure 1

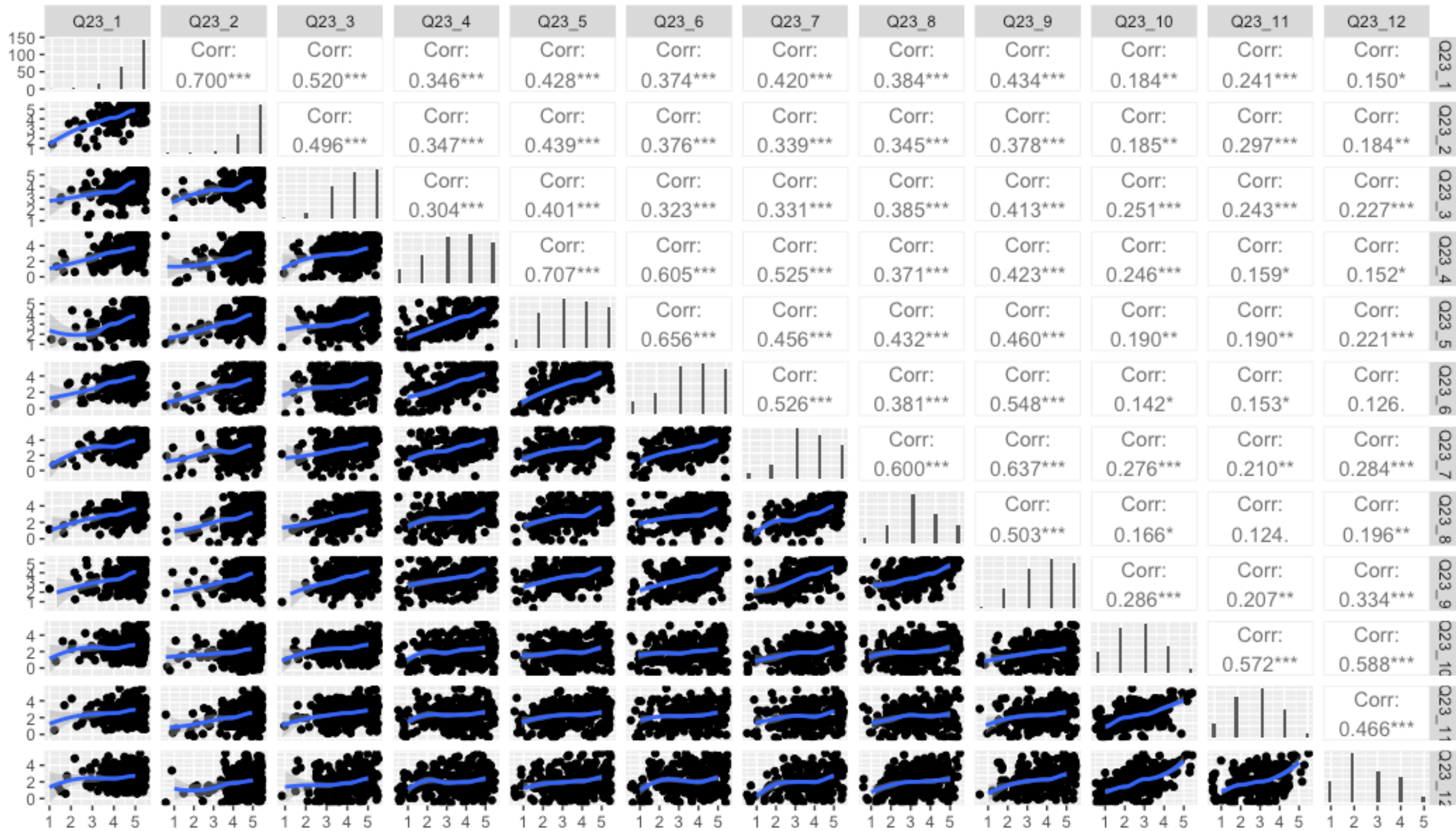
Q-Q Plot of Mahalanobis Distances



Linearity. To evaluate the linearity assumption of Confirmatory Factor Analysis (CFA), scatterplots were visually inspected for each combination of items from the MTUAS attitudes toward ICT scale. However, since the data were collected using a 5-point Likert scale, the scatterplots appeared somewhat difficult to interpret, making it challenging to assess linearity through visual inspection alone. To address this limitation, Locally Estimated Scatterplot Smoothing (LOESS) lines were applied to the scatterplots to provide a more nuanced assessment of the relationships among items. LOESS smoothing is a nonparametric method that fits a flexible curve to the data, making it particularly useful when linear relationships are difficult to discern visually (Jacoby, 2000). This approach has been widely recommended for assessing linearity assumptions in multivariate analyses, particularly in cases where relationships between variables may exhibit slight deviations from strict linearity, as is often observed in single-factor, multi-item Likert scale data (Austin & Steyerberg, 2014). By applying LOESS smoothing, researchers can identify potential nonlinear trends that might otherwise be overlooked, ensuring a more robust evaluation of whether the assumption of linearity is met. In Figure 2, the blue line in the lower half of each graph indicates the linearity of the item pairs. A straight line indicates the linearity between the items while a horizontal line indicates no correlation, and a curved line indicates a violation of linearity. Bar charts in the diagonal cells indicate the histogram of each item indicating the frequency and skewness of the data. "Corr" in the upper half of the figure indicates the correlation coefficient and p-value in asterisks (see Figure 2).

Figure 2

Correlation, linearity, and histogram of MTUAS Attitudes toward ICT scale



Note.

* p < .05, ** p < .01, *** p < .001

CFA

A Confirmatory Factor Analysis (CFA) was conducted using the weighted least square mean and variance adjusted (WLSMV) estimator, an estimation method suitable for ordinal data. The analysis was performed on 231 observations, with a three-factor model representing attitudes toward ICT, including positive attitude, anxiety/dependence, and negative attitude. The CFA model demonstrated acceptable model fit, though some indices suggested areas for potential improvement. The chi-square test was statistically significant, $\chi^2(51) = 161.83$, $p < .001$, indicating a discrepancy between the hypothesized model and the observed data. However, given the sensitivity of chi-square to sample size, alternative fit indices were considered. The Comparative Fit Index (CFI) = 0.961 and Tucker-Lewis Index (TLI) = 0.950, both approaching the commonly accepted threshold of 0.95 for a well-fitting model (Hu & Bentler, 1999). The Standardized Root Mean Square Residual (SRMR) = 0.067, which falls within an acceptable range (≤ 0.08) (Kline, 2015). The Root Mean Square Error of Approximation (RMSEA) = 0.097 (90% CI [0.081, 0.114]), exceeded the recommended cutoff of 0.08, suggesting moderate model fit. All observed variables loaded significantly onto their respective latent constructs ($p < .001$), supporting the three-factor structure. For the positive attitude factor, standardized factor loadings ranged from 0.653 (Q23_3) to 0.831 (Q23_1). For anxiety/dependence, factor loadings ranged from 0.829 (Q23_4) to 0.905 (Q23_5). The negative attitude factor had loadings between 0.756 (Q23_11) and 0.853 (Q23_10). These results suggest strong relationships between the items and their respective latent constructs, supporting construct validity. Significant correlations were found between the three latent factors. Positive attitude and anxiety/dependence were moderately correlated ($r = 0.770$, $p < .001$), while positive attitude and negative attitude had a weaker correlation ($r = 0.465$, $p < .001$). The correlation between anxiety/dependence and negative attitude was $r = 0.321$, $p < .001$, suggesting that while these constructs are related, they are distinct factors. The thresholds for each item were significant ($p < .001$ for most items), confirming that the observed ordinal responses align well with the underlying continuous latent construct. The residual variances for the items ranged from 0.181 (Q23_5) to 0.573 (Q23_3), indicating varying levels of unexplained variance. Overall, the three-factor model demonstrated an acceptable fit, with strong standardized factor loadings, indicating that the scale effectively captures attitudes toward ICT. However, the RMSEA suggests some model misfit, which may warrant further refinement of the scale or exploration of alternative factor structures. Despite this, the significant factor loadings and correlations between factors support the validity of the model for measuring attitudes toward ICT in the study population.

Convergent Validity Testing

A Spearman's rank correlation analysis was conducted to assess convergent validity between the MTUAS attitudes toward ICT scale (Q23) and the Attitudes toward ICT semantic questions (Q27) (see Table 13). Convergent validity refers to the extent to which two theoretically related measures demonstrate a significant correlation, indicating that they assess the same underlying construct (Campbell & Fiske, 1959). Given that the data were collected using Likert-scale items, Spearman's correlation was chosen as an appropriate nonparametric method to handle ordinal-level data and potential non-normality in distributions. The results showed a significant positive correlation between the mean scores of the two scales, $\rho = .59$, $p < .001$, suggesting a moderate-to-strong relationship between the two constructs (Cohen, 1988). This indicates that individuals who scored higher on the MTUAS attitudes toward ICT scale (Q23) also tended to report more favorable attitudes toward using ICT on the semantic questions (Q27), supporting the convergent validity of the MTUAS measure. Additionally, item-level correlations within MTUAS attitudes toward ICT scale demonstrated strong inter-item relationships, with coefficients ranging from 0.50 to 0.74, further reinforcing internal consistency within the scale. Overall, these findings provide empirical support for the convergent validity of the MTUAS attitudes toward ICT scale, confirming that it measures attitudes toward ICT in a manner consistent with an established measure of the same construct.

Table 13

Correlation Matrix for Q23 (MTUAS Attitudes toward ICT) and Q27 (Attitudes toward technology - semantic) (N = 231)

		Q23											
		2	3	4	5	6	7	8	9	10	11	12	M_{Q23}
	1	0.70***	0.52***	0.35***	0.43***	0.37***	0.42***	0.38***	0.43***	0.18	0.24**	0.15	0.64***
	2		0.50***	0.35***	0.44***	0.38***	0.34***	0.34***	0.38***	0.19	0.3***	0.18	0.61***
	3			0.30***	0.40***	0.32***	0.33***	0.39***	0.41***	0.25**	0.24**	0.23*	0.62***
	4				0.71***	0.61***	0.52***	0.37***	0.42***	0.25**	0.16	0.15	0.65***
	5					0.66***	0.46***	0.43***	0.46***	0.19	0.19	0.22*	0.70***
Q	6						0.53***	0.38***	0.55***	0.14	0.15	0.13	0.65***
2	7							0.6***	0.64***	0.28***	0.21**	0.28***	0.94***
3	8								0.5***	0.17***	0.12	0.20	0.63***
	9									0.29***	0.21*	0.33***	0.73***
	10										0.57	0.59***	0.54***
	11											0.47***	0.50***
	12												0.52***
	M_{Q23}												

Note. M_{Q23} indicates the mean value of 12 items in Q23.

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 13 (cont'd)

		Q27							
		1	2	3	4	5	6	7	M_{Q24}
Q23	1	0.33***	0.42***	0.35***	0.44***	0.40***	0.35***	0.41***	0.43***
	2	0.30***	0.38***	0.35***	0.38***	0.36***	0.31***	0.38***	0.4***
	3	0.35***	0.42***	0.46***	0.37***	0.36***	0.30***	0.37***	0.43***
	4	0.27***	0.27***	0.25***	0.23*	0.28***	0.28***	0.26***	0.31***
	5	0.28***	0.34***	0.28***	0.31***	0.32***	0.32***	0.29***	0.35***
	6	0.37***	0.45***	0.37***	0.45***	0.42***	0.36***	0.43***	0.47***
	7	0.37***	0.49***	0.37***	0.40***	0.42***	0.43***	0.46***	0.49***
	8	0.30***	0.41***	0.31***	0.31***	0.36***	0.43***	0.31***	0.42***
	9	0.48***	0.53***	0.47***	0.48***	0.47***	0.49***	0.49***	0.56***
	10	0.21*	0.15	0.25**	0.18	0.22*	0.23*	0.20	0.24**
	11	0.26***	0.20	0.26***	0.18	0.26***	0.28***	0.25**	0.28***
	12	0.24**	0.23*	0.23*	0.21*	0.21*	0.27***	0.24**	0.27***
	M_{Q23}	0.48***	0.54***	0.50***	0.50***	0.52***	0.52***	0.52***	0.59***
Q27	1		0.67***	0.76***	0.73***	0.79***	0.58***	0.66***	0.83***
	2			0.74***	0.73***	0.72***	0.68***	0.75***	0.87***
	3				0.80***	0.77***	0.67***	0.71***	0.88***
	4					0.83***	0.61***	0.83***	0.87***
	5						0.69***	0.77***	0.91***
	6							0.64***	0.82***
	7								0.85***
	M_{Q27}								

Note. M_{Q23} indicates the mean value of 12 items in Q23.

M_{Q24} indicates the mean value of three items in Q24.

* p < .05, ** p < .01, *** p < .001

Concurrent Validity Testing

Again, Spearman's rank correlation analysis was conducted to evaluate concurrent validity between the MTUAS attitudes toward ICT scale (Q23) and the behavioral intention of using ICT questions (Q24) (see Table 14). Concurrent validity examines the extent to which two measures, assessed simultaneously, yield similar results when measuring the same or a closely related construct (Anastasi & Urbina, 1997). Again, given the ordinal nature of the data collected via Likert-scale responses, Spearman's correlation was used as it provides a nonparametric approach suitable for assessing the relationship between ranked data. The results indicated a moderate positive correlation between the overall scores of MTUAS attitudes toward ICT scale (Q23) and behavioral intention of using ICT questions (Q24), $\rho = .56$, $p < .001$, suggesting that individuals with more favorable attitudes toward ICT also demonstrated higher technology affinity. At the item level, correlations between corresponding items from MTUAS attitudes toward ICT scale (Q23) and behavioral intention of using ICT questions (Q24) ranged from $\rho = .30$ to $\rho = .51$, with all relationships reaching statistical significance ($p < .001$). These findings suggest that while the two scales assess related constructs, they do not measure identical dimensions of ICT attitudes. Furthermore, internal correlations among MTUAS attitudes toward ICT scale items ranged from $\rho = .50$ to $\rho = .74$, indicating strong internal consistency within the MTUAS attitudes toward ICT scale. Similarly, inter-item correlations within Q24 were high ($\rho = .81$ to $\rho = .86$), reinforcing the reliability of the behavioral intention of using ICT. Notably, lower correlations were observed between some items, such as Q23_10 ("New ICT makes people waste too much time.") and Q24_1 ("I plan to use this ICT.") ($\rho = .09$. Overall, these results provide empirical support for the concurrent validity of the MTUAS attitudes toward ICT scale, as it correlates significantly with an independent measure of behavioral intention of using ICT.

Table 14

Correlation Matrix for Q23 (MTUAS Attitudes toward ICT) and Q24 (Behavioral intention to use ICT) (N = 231)

		Q24			
		1	2	3	M_{Q24}
Q23	1	0.40***	0.44***	0.35***	0.46***
	2	0.43***	0.45***	0.37***	0.48***
	3	0.30***	0.31***	0.48***	0.46***
	4	0.30***	0.28***	0.32***	0.37***
	5	0.34***	0.35***	0.38***	0.43***
	6	0.42***	0.44***	0.35***	0.47***
	7	0.33***	0.38***	0.31***	0.40***
	8	0.21*	0.26***	0.36***	0.35***
	9	0.42***	0.45***	0.44	0.52***
	10	0.09	0.08	0.21*	0.16
	11	0.19	0.15	0.22*	0.22*
	12	0.21*	0.20	0.25**	0.25**
	M_{Q23}	0.44***	0.46***	0.51***	0.56***
Q24	1		0.86***	0.38***	0.81***
	2			0.41***	0.84***
	3				0.81***
	M_{Q24}				

Note. Correlations within Q23 are presented in Table 14.

M_{Q23} indicates the mean value of 12 items in Q23.

M_{Q24} indicates the mean value of three items in Q24.

* $p < .05$, ** $p < .01$, *** $p < .001$

DISCUSSION

The purpose of this study was to examine the reliability and validity of MTUAS attitudes toward ICT scale for an English-speaking older adult population by testing internal reliability, confirmatory factor analysis (CFA), convergent validity, and concurrent validity tests. The results of this study suggested that the MTUAS attitudes toward ICT scale demonstrates a moderately good fit when applied to an older adult population. However, the results of validity tests indicate areas for improvement.

First, in regard to the demographics of the survey respondents, it showed diversity in the sample. Compared to Michigan census data in 2020 (US Census Bureau, 2023), there are about 1.93 million older adults who are 65 years or older living in Michigan. About 57.2% of the older adults are female, and 86% of older adults are White or Caucasian, followed by 9% of Black or African American population. This study had 74.04% female participants, 62.77% White or Caucasian, followed by 31.17% Black or African American population, showing less representation of White or Caucasian population but more representation of female population and Black or African American population. Overall, such comparison suggests that the survey participants have greater diversity in demographics considering that of Michigan older adults.

Through factorial validity testing using CFA, it was shown that both the comparative fit index (CFI) and Tucker-Lewis Index (TLI) showed good fit while Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) showed moderate fit. Such a result implies that the general factor structure has a good fit while some correlations between individual items are not well explained within this model. This indicates that the overall structure of MTUAS attitudes toward ICT scale offers promise in being applied to an older adult population, but improvements in items or factors are needed to increase the usefulness and applicability of this scale.

Furthermore, convergent and concurrent validity testing results indicate that certain items and factors require modification. Specifically, items related to negative attitudes (Q23_10, Q23_11, Q23_12) showed weaker associations with the overall factor structure, suggesting that these items may not be adequately measuring the intended construct among older adults. Interestingly, the current study highlights a significant gap in research and assessment tools: there are very few older-adult-targeted questionnaires that include technology dependence as a factor. The findings suggest that technology dependence is a relevant construct for older adults, emphasizing not only concerns related to technology use (e.g., technophobia) but also the anxiety associated with not being able to use technology. This indicates the need for future research to explore older adults' technology dependence from both an affective and cognitive standpoint as well as positive and negative attitudes.

Stemming from the current research, future studies could incorporate some ideas that were not explored in this study, such as running the model using all items from the original 16-item attitudinal factors from MTUAS, comparing the results of all responses including incomplete surveys (N = 414) and those that only completed the MTUAS attitudes toward ICT scale (N = 337), or comparing the results across people who selected different ICT (e.g. smartphones versus laptops) as their ICT of focus.

The findings from this study also have important implications for research, policy, and social work practice. From a research perspective, this study underscores the need for a more comprehensive understanding of technology attitudes among older adults. Even though MTUAS attitudes toward technology scale combines cognitive and affective attitudes, like other traditional scales, they may not fully capture the nuances of older adults' experiences with technology. Future research should move beyond a unidimensional assessment and consider a holistic approach that differentiates between cognitive and affective attitudes as well as positive and negative attitudes. Additionally, while much of the literature on older adults and technology focuses on technophobia or resistance to technology (Anderberg et al., 2019), this study highlights the relevance of technology dependence in older populations. The fact that older adults in this study were able to relate to questions about dependence suggests that digital reliance is not exclusive to younger generations. As technology becomes increasingly integrated into essential services, such as telehealth, online banking, and social networking, it is crucial to investigate how older adults navigate their own levels of dependence and how this impacts their well-being.

From a policy standpoint, the study reveals a gap in current digital inclusion and literacy initiatives, which often prioritize skill-building without fully considering attitudes toward technology. Many state and federal programs focus on bridging the digital divide by providing internet access and provision of affordable devices (Rep. DeFazio, 2021), but they seldom address the psychological and emotional dimensions of technology use. There is a need for policy frameworks that incorporate attitudinal factors into digital literacy programs, ensuring that older adults receive support in managing both technology-related anxieties and dependencies. Furthermore, the study suggests that policymakers should develop initiatives that go beyond basic digital training and include guidance on the healthy integration of technology into daily life. Given that digital tools are now essential for healthcare access, social connection, and financial management, policies should emphasize not only how to use technology effectively but also how to balance its role in daily life to prevent over-reliance or avoidance.

In terms of social work practice, the findings suggest that local communities and aging services should offer programs that address both digital literacy and healthy technology use. Many older adults use technology to maintain social connections and access essential services (Han & Nam, 2021), yet there is little structured guidance on how to manage digital utilization in a way that fosters well-being. Community organizations, senior centers, and aging services should consider integrating digital well-being education into their programming, teaching older adults how to balance technology use with offline social engagement such as in games and activities. Additionally, support groups could serve as valuable spaces for older adults to discuss their experiences with technology, including both anxieties and dependencies. By facilitating peer discussions and mentorship programs, social workers and community organizations can help older adults navigate their digital interactions in a way that promotes both autonomy and confidence.

Limitations

While this study provides valuable insights into older adults' attitudes toward technology, several limitations should be acknowledged. First, the convenience sampling might have caused a bias in samples. As the survey was distributed both online and offline through senior centers and other partnered agencies, it is not only difficult to track the response rate, but also difficult to control the sample bias. For instance, the title of the survey indicating the survey is related to technology could have attracted those people who are already interested in technology, or the fact that it was mainly advertised throughout senior centers could have attracted more socially engaged participants. Another limitation is that MTUAS attitudes toward ICT scale was a modified version of attitudinal items from MTUAS, indicating that there could be questions raised regarding how attitudes toward technology might have been different from attitudes toward ICT, how older adults being consistent with one ICT might have created different results, and how including all 16 items could lead to different results. However, even though there were modifications in changing the term to ICT and deleting four items that are not related to technology, the factor structure of the MTUAS attitudes toward ICT scale followed the original three-factor model, which may not be entirely applicable to older adults. The original scale combines affective and cognitive attitudes into broad categories, yet the findings from this study suggest that these attitudes may function differently among older adults. A more nuanced factor structure, perhaps distinguishing between positive cognitive, positive affective, negative cognitive, and negative affective attitudes, may better reflect how older adults engage with technology. Future research should explore alternative factor models that more accurately represent the attitudinal dimensions unique to older populations.

Additionally, the lack of a negative affective attitude component in the original scale limits the ability to fully capture older adults' emotional responses to technology. While the study identified negative cognitive attitudes, it did not explicitly assess negative emotions such as frustration, anxiety, or fear related to technology use. These emotional dimensions could be particularly relevant for older adults, who may experience stress when using unfamiliar digital tools or navigating online security risks. Future research should consider expanding the scale to include negative affective attitudes, ensuring that both cognitive resistance and emotional barriers to technology adoption are adequately measured.

Despite these limitations, this study makes a significant contribution by highlighting the applicability of MTUAS attitudes toward the ICT scale to older adults and emphasizing the need for a more refined and targeted approach to assessing technology attitudes in aging populations. The findings open doors for future research, policy adjustments, and social work interventions that better address the evolving digital experiences of older adults.

REFERENCES

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In J. Kuhl & J. Beckmann (Eds.), *Action Control* (pp. 11–39). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-69746-3_2

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Prentice-Hall.

Ajzen, I., & Fishbein, M. (1988). Theory of reasoned action-Theory of planned behavior. *University of South Florida*, *2007*, 67–98.

Anderberg, P., Eivazzadeh, S., & Berglund, J. S. (2019). A Novel Instrument for Measuring Older People's Attitudes Toward Technology (TechPH): Development and Validation. *Journal of Medical Internet Research*, *21*(5), e13951. https://doi.org/10.2196/13951

Anderson, M., & Perrin. (2017, May 17). *Tech Adoption Climbs Among Older Americans | Pew Research Center*. https://www.pewresearch.org/internet/2017/05/17/tech-adoption-climbs-among-older-adults/

Ardies, J., De Maeyer, S., Gijbels, D., & Van Keulen, H. (2015). Students attitudes towards technology. *International Journal of Technology and Design Education*, *25*(1), 43–65. https://doi.org/10.1007/s10798-014-9268-x

Austin, P. C., & Steyerberg, E. W. (2014). Graphical assessment of internal and external calibration of logistic regression models by using loess smoothers. *Statistics in Medicine*, *33*(3), 517–535. https://doi.org/10.1002/sim.5941

Becker, H. J. (2000). Pedagogical Motivations for Student Computer Use That Lead to Student Engagement. *Educational Technology*, *40*(5), 5–17.

Benbasat, I., & Barki, H. (2007). Quo vadis TAM? *Journal of the Association for Information Systems*, *8*(4), 7. https://doi.org/10.17705/1jais.00126

Berkowsky, RonaldW., Cotton, SheliaR., Yost, ElizabethA., & Winstead, VickiP. (2013). Attitudes Towards and Limitations to ICT Use in Assisted and Independent Living Communities: Findings from a Specially-Designed Technological Intervention. *Educational Gerontology*, *39*(11), 797–811. https://doi.org/10.1080/03601277.2012.734162

Betts, L. R., Hill, R., & Gardner, S. E. (2019). "There's Not Enough Knowledge Out There": Examining Older Adults' Perceptions of Digital Technology Use and Digital Inclusion Classes. *Journal of Applied Gerontology*, *38*(8), 1147–1166.

https://doi.org/10.1177/0733464817737621

Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2014). Factors influencing digital technology use in early childhood education. *Computers & Education*, *77*, 82–90. https://doi.org/10.1016/j.compedu.2014.04.013

Blake, R., Rizzo, M., & McEvoy, S. (2008). Aging and Perception of Visual Form From Temporal Structure. *Psychology and Aging*, *23*(1), 181–189. https://doi.org/10.1037/0882-7974.23.1.181

Bleed, P. (1997). Content as Variability, Result as Selection: Toward a Behavioral Definition of Technology. *Archaeological Papers of the American Anthropological Association*, *7*(1), 95–104. https://doi.org/10.1525/ap3a.1997.7.1.95

Blok, M., van Ingen, E., de Boer, A. H., & Slootman, M. (2020). The use of information and communication technologies by older people with cognitive impairments: From barriers to benefits. *Computers in Human Behavior*, *104*, 106173. https://doi.org/10.1016/j.chb.2019.106173

Blusi, M., Asplund, K., & Jong, M. (2013). Older family carers in rural areas: Experiences from using caregiver support services based on Information and Communication Technology (ICT). *European Journal of Ageing*, *10*(3), 191–199. https://doi.org/10.1007/s10433-013-0260-1

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin*, *56*(2), 81. https://doi.org/10.1037/h0046016

Carver, J., Ganus, A., Ivey, J. M., Plummer, T., & Eubank, A. (2016). The impact of mobility assistive technology devices on participation for individuals with disabilities. *Disability and Rehabilitation: Assistive Technology*. https://doi.org/10.3109/17483107.2015.1027295

Chan, C., & Holosko, M. J. (2016). A Review of Information and Communication Technology Enhanced Social Work Interventions. *Research on Social Work Practice*, *26*(1), 88–100. https://doi.org/10.1177/1049731515578884

Chan, D. Y. L., Lee, S. W. H., & Teh, P.-L. (2023). Factors influencing technology use among low-income older adults: A systematic review. *Heliyon*, *9*(9). https://doi.org/10.1016/j.heliyon.2023.e20111

Compeau, D. R., & Higgins, C. A. (1991). *A social cognitive theory perspective on individual reactions to computing technology*. https://aisel.aisnet.org/icis1991/55/

Comrey, A. L., & Lee, H. B. (2013). *A first course in factor analysis*. Psychology press. https://doi.org/10.4324/9781315827506

Conner, M., & Armitage, C. J. (1998). Extending the Theory of Planned Behavior: A Review and Avenues for Further Research. *Journal of Applied Social Psychology*, *28*(15), 1429–1464. https://doi.org/10.1111/j.1559-1816.1998.tb01685.x

Cortellessa, G., De Benedictis, R., Fracasso, F., Orlandini, A., Umbrico, A., & Cesta, A. (2021). AI and robotics to help older adults: Revisiting projects in search of lessons learned. *Paladyn, Journal of Behavioral Robotics*, *12*(1), 356–378. https://doi.org/10.1515/pjbr-2021-0025

Cotten, S. R., Anderson, W. A., & McCullough, B. M. (2013). Impact of Internet Use on Loneliness and Contact with Others Among Older Adults: Cross-Sectional Analysis. *Journal of Medical Internet Research*, *15*(2), e2306. https://doi.org/10.2196/jmir.2306

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334.

Cussó-Calabuig, R., Farran, X. C., & Bosch-Capblanch, X. (2018). Effects of intensive use of computers in secondary school on gender differences in attitudes towards ICT: A systematic review. *Education and Information Technologies*, *23*(5), 2111–2139. https://doi.org/10.1007/s10639-018-9706-6

Das, K. (2019). *The Role and Impact of ICT in Improving the Quality of Education: An Overview*. *4*(6).

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319–340. https://doi.org/10.2307/249008

Davis, F. D. (1993a). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, *38*(3), 475–487. https://doi.org/10.1006/imms.1993.1022

Davis, F. D. (1993b). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, *38*(3), 475–487. https://doi.org/10.1006/imms.1993.1022

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Management Science*, *35*(8), 982–1003. https://doi.org/10.1287/mnsc.35.8.982

Delello, J. A., & McWhorter, R. R. (2017). Reducing the Digital Divide: Connecting Older Adults to iPad Technology. *Journal of Applied Gerontology*, *36*(1), 3–28. https://doi.org/10.1177/0733464815589985

Deng, Z., Xiuting, M., & Liu, S. (2014). Comparison of the middle-aged and older users' adoption of mobile health services in China. *International Journal of Medical*

Informatics, *83*. https://doi.org/10.1016/j.ijmedinf.2013.12.002

Droba, D. D. (1933). The Nature of Attitude. *The Journal of Social Psychology*, *4*(4), 444–463. https://doi.org/10.1080/00224545.1933.9919338

Dyck, J. L., & Smither, J. A.-A. (1994). Age Differences in Computer Anxiety: The Role of Computer Experience, Gender and Education. *Journal of Educational Computing Research*, *10*(3), 239–248. https://doi.org/10.2190/E79U-VCRC-EL4E-HRYV

Elboim-Gabyzon, M., & Danial-Saad, A. (2021). Correlation between the ability to manipulate a touchscreen device and hand strength and manual dexterity among community-living older individuals. *International Journal of Environmental Research and Public Health*, *18*(17), 9408. https://doi.org/10.3390/ijerph18179408

Elias, S. M., Smith, W. L., & Barney, C. E. (2012). Age as a moderator of attitude towards technology in the workplace: Work motivation and overall job satisfaction. *Behaviour & Information Technology*, *31*(5), 453–467. https://doi.org/10.1080/0144929X.2010.513419

Ellis, R. D., & Allaire, J. C. (1999). Modeling Computer Interest in Older Adults: The Role of Age, Education, Computer Knowledge, and Computer Anxiety. *Human Factors*, *41*(3), 345–355. https://doi.org/10.1518/001872099779610996

Faverio, M. (2022, January 13). Share of those 65 and older who are tech users has grown in the past decade. *Pew Research Center*. https://www.pewresearch.org/short-reads/2022/01/13/share-of-those-65-and-older-who-are-tech-users-has-grown-in-the-past-decade/

Fernández-Ardévol, M., & Rosales, A. (2017). Older people, smartphones and WhatsApp. In *Smartphone cultures* (pp. 55–68). Routledge. https://doi.org/10.4324/9781315307077-5

Fishbein, & Ajzen. (1975). *Belief, Attitude, Intention, and Behavior*. https://www.google.com/books/edition/Belief_Attitude_Intention_and_Behavior/8o0QAQAAIAAJ?hl=ko&gbpv=0&bsq=belief%20attitude%20intention%20and%20behavior

Fournier-Vicente, S., Larigauderie, P., & Gaonac'h, D. (2008). More dissociations and interactions within central executive functioning: A comprehensive latent-variable analysis. *Acta Psychologica*, *129*(1), 32–48. https://doi.org/10.1016/j.actpsy.2008.04.004

George, J. F. (2004). The theory of planned behavior and Internet purchasing. *Internet Research*, *14*(3), 198–212. https://doi.org/10.1108/10662240410542634

Godin, G., & Kok, G. (1996). The Theory of Planned Behavior: A Review of its Applications to Health-Related Behaviors. *American Journal of Health Promotion*, *11*(2), 87–98. https://doi.org/10.4278/0890-1171-11.2.87

Gudala, M., Ross, M. E. T., Mogalla, S., Lyons, M., Ramaswamy, P., & Roberts, K. (2022). Benefits of, barriers to, and needs for an artificial intelligence–powered medication information voice chatbot for older adults: Interview study with geriatrics experts. *JMIR Aging*, *5*(2), e32169. https://doi.org/10.2196/32169

Hale, J. L., Householder, B. J., & Greene, K. L. (2002). The theory of reasoned action. *The Persuasion Handbook: Developments in Theory and Practice*, *14*(2002), 259–286. https://doi.org/10.4135/9781412976046.n14

Han, S., & Nam, S. I. (2021). Creating supportive environments and enhancing personal perception to bridge the digital divide among older adults. *Educational Gerontology*, *47*(8), 339–352. https://doi.org/10.1080/03601277.2021.1988448

Heinz, M., Martin, P., Margrett, J. A., Yearns, M., Franke, W., Yang, H.-I., Wong, J., & Chang, C. K. (2013). Perceptions of Technology among Older Adults. *Journal of Gerontological Nursing*, *39*(1), 42–51. https://doi.org/10.3928/00989134-20121204-04

Hernández-Ramos, J. P., Martínez-Abad, F., García Peñalvo, F. J., Esperanza Herrera García, M., & Rodríguez-Conde, M. J. (2014). Teachers' attitude regarding the use of ICT. A factor reliability and validity study. *Computers in Human Behavior*, *31*, 509–516. https://doi.org/10.1016/j.chb.2013.04.039

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (2003). *Applied statistics for the behavioral sciences* (Vol. 663). Houghton Mifflin Boston. https://library.wur.nl/WebQuery/titel/1944963

Hoe, S. L. (2008). Issues and procedures in adopting structural equation modelling technique. *Journal of Quantitative Methods*, *3*(1), 76.

Hoyle, R. H. (1995). *Structural equation modeling: Concepts, issues, and applications*. Sage. https://books.google.com/books?hl=ko&lr=&id=zFMYJqVeQUEC&oi=fnd&pg=PR17&dq=hyole+1995&ots=dNzjLGOfX0&sig=P2VnseCXtonLKVp9V2Nh0LXKJXQ

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Internet, Broadband Fact Sheet. (2024, November 13). *Pew Research Center*. https://www.pewresearch.org/internet/fact-sheet/internet-broadband/

Jacoby, W. G. (2000). Loess: A nonparametric, graphical tool for depicting relationships between variables. *Electoral Studies*, *19*(4), 577–613. https://doi.org/10.1016/S0261-3794(99)00028-1

Kernan, M. C., & Howard, G. S. (1990). Computer Anxiety and Computer Attitudes: An Investigation of Construct and Predictive Validity Issues. *Educational and Psychological Measurement*, *50*(3), 681–690. https://doi.org/10.1177/0013164490503026

Khvorostianov, N. (2016). “Thanks to the Internet, We Remain a Family”: ICT Domestication by Elderly Immigrants and their Families in Israel. *Journal of Family Communication*, *16*, 1–14. https://doi.org/10.1080/15267431.2016.1211131

Klimova, A., Rondeau, E., Andersson, K., Porras, J., Rybin, A., & Zaslavsky, A. (2016). An international Master’s program in green ICT as a contribution to sustainable development. *Journal of Cleaner Production*, *135*, 223–239. https://doi.org/10.1016/j.jclepro.2016.06.032

Kyonka, E. G. E. (2018). Tutorial: Small-N Power Analysis. *Perspectives on Behavior Science*, *42*(1), 133–152. https://doi.org/10.1007/s40614-018-0167-4

Kyriazos, T. A. (2018). Applied Psychometrics: Sample Size and Sample Power Considerations in Factor Analysis (EFA, CFA) and SEM in General. *Psychology*, *09*(08), 2207–2230. https://doi.org/10.4236/psych.2018.98126

Latulipe, C., Gatto, A., Nguyen, H. T., Miller, D. P., Quandt, S. A., Bertoni, A. G., Smith, A., & Arcury, T. A. (2015). Design Considerations for Patient Portal Adoption by Low-Income, Older Adults. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 3859–3868. https://doi.org/10.1145/2702123.2702392

Lawry, S., Popovic, V., & Blackler, A. (2010). *Identifying Familiarity in Older and Younger Adults*.

Lee, C., & Coughlin, J. F. (2015a). Generational Differences in Adoption and Use of Information and Communications Technology. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *59*(1), 892–896. https://doi.org/10.1177/1541931215591264

Lee, C., & Coughlin, J. F. (2015b). PERSPECTIVE: Older Adults’ Adoption of Technology: An Integrated Approach to Identifying Determinants and Barriers. *Journal of Product Innovation Management*, *32*(5), 747–759. https://doi.org/10.1111/jpim.12176

Lee, Y., Kozar, K. A., & Larsen, K. R. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems*, *12*(1), 50. https://doi.org/10.17705/1CAIS.01250

López Peláez, A., & Kyriakou, D. (2008). Robots, genes and bytes: Technology development and social changes towards the year 2020. *Technological Forecasting and Social Change*, *75*(8), 1176–1201. https://doi.org/10.1016/j.techfore.2008.01.002

Maio, G. R., & Haddock, G. (2007). Attitude change. *Social Psychology: Handbook of Basic Principles*, *2*, 565–586.

Mayhorn, C. B., Stronge, A. J., McLaughlin, A. C., & Rogers, W. A. (2004). OLDER ADULTS, COMPUTER TRAINING, AND THE SYSTEMS APPROACH: A FORMULA FOR SUCCESS. *Educational Gerontology*, *30*(3), 185–203.

https://doi.org/10.1080/03601270490272124

McArdle, J. J. (1996). Current Directions in Structural Factor Analysis. *Current Directions in Psychological Science*, *5*(1), 11–18. https://doi.org/10.1111/1467-8721.ep10772681

McGrath, L. (2018). Achieving visibility: Midlife and older women's literate practices on instagram and blogs. *Literacy in Composition Studies*, *6*(2). https://doi.org/10.21623/1.6.2.7

Meelissen, M. R., & Drent, M. (2008). Gender differences in computer attitudes: Does the school matter? *Computers in Human Behavior*, *24*(3), 969–985. https://doi.org/10.1016/j.chb.2007.03.001

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. https://doi.org/10.1287/isre.2.3.192

Morahan-Martin, J., & Schumacher, P. (2007). Attitudinal and experiential predictors of technological expertise. *Computers in Human Behavior*, *23*(5), 2230–2239. https://doi.org/10.1016/j.chb.2006.03.003

Mori, C. K. (2011). 'Digital inclusion': Are we all talking about the same thing? In *ICTs and sustainable solutions for the digital divide: Theory and perspectives* (pp. 45–64). IGI Global. https://doi.org/10.4018/978-1-61520-799-2.ch003

Moshagen, M., & Bader, M. (2023). semPower: General power analysis for structural equation models. *Behavior Research Methods*, *56*(4), 2901–2922. https://doi.org/10.3758/s13428-023-02254-7

Muthén, L., & Muthén, B. (2017). *Mplus Statistical Analysis With Latent Variables User's Guide*. https://www.statmodel.com/download/usersguide/MplusUserGuideVer_8.pdf

Neves, B. B., Amaro, F., & Fonseca, J. R. S. (2013). Coming of (Old) Age in the Digital Age: ICT Usage and Non-Usage among Older Adults. *Sociological Research Online*, *18*(2), 22–35. https://doi.org/10.5153/sro.2998

Nimrod, G. (2018). Technophobia among older Internet users. *Educational Gerontology*, *44*(2–3), 148–162. https://doi.org/10.1080/03601277.2018.1428145

OECD. (2017). *OECD Digital Economy Outlook 2017*. Organisation for Economic Co-operation and Development. https://doi.org/10.1787/9789264276284-en

Petty, R. E., Briñol, P., & Priester, J. R. (2009). Mass media attitude change: Implications of the elaboration likelihood model of persuasion. In *Media effects* (pp. 141–180). Routledge. https://doi.org/10.4324/9780203877111-13

Quan-Haase, A., Williams, C., Kicevski, M., Elueze, I., & Wellman, B. (2018). Dividing the Grey Divide: Deconstructing Myths About Older Adults' Online Activities, Skills, and Attitudes. *American Behavioral Scientist*, *62*(9), 1207–1228. https://doi.org/10.1177/0002764218777572

Reddy, G. R., Blackler, A., Mahar, D., & Popovic, V. (2010). The effects of cognitive ageing on use of complex interfaces. *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction*, 180–183. https://doi.org/10.1145/1952222.1952259

Reece, M. J., & Gable, R. K. (1982). The Development and Validation of a Measure of General Attitudes toward Computers. *Educational and Psychological Measurement*, *42*(3), 913–916. https://doi.org/10.1177/001316448204200327

Rep. DeFazio, P. A. [D-O.-4. (2021, November 15). *H.R.3684 - 117th Congress (2021-2022): Infrastructure Investment and Jobs Act* (2021-06-04) [Legislation]. https://www.congress.gov/bill/117th-congress/house-bill/3684

Rhinesmith, C. (2016). Digital inclusion and meaningful broadband adoption initiatives. *Evanston, IL: Benton Foundation, January*. https://pbdd.org/wp-content/uploads/2015/06/Benton-Foundation-DI-Report.pdf

Robinson, J. (2010). *Triandis' theory of interpersonal behaviour in understanding software piracy behaviour in the South African context* [PhD Thesis, University of the Witwatersrand Johannesburg]. https://wiredspace.wits.ac.za/bitstreams/413b1902-029d-4d1d-89c2-a5ac0d9d7b27/download

Rosales, A., & Fernández-Ardèvol, M. (2016). Beyond WhatsApp: Older people and smartphones. *Romanian Journal of Communication and Public Relations*, *18*(1), 27–47. https://doi.org/10.21018/rjcpr.2016.1.200

Rosen, L. D., Whaling, K., Carrier, L. M., Cheever, N. A., & Rokkum, J. (2013). The media and technology usage and attitudes scale: An empirical investigation. *Computers in Human Behavior*, *29*(6), 2501–2511. https://doi.org/10.1016/j.chb.2013.06.006

Rousseau, G. K., & Rogers, W. A. (1998). Computer usage patterns of university faculty members across the life span. *Computers in Human Behavior*, *14*(3), 417–428. https://doi.org/10.1016/S0747-5632(98)00014-4

Salomon, J. (1984). What is technology? The issue of its origins and definitions∗. *History and Technology*, *1*(2), 113–156. https://doi.org/10.1080/07341518408581618

Schuster, A. M., & Cotten, S. R. (2023). Examining aspects of digital inclusion among national samples of US older adults. *Social Inclusion*, *11*(3), 251–270. https://doi.org/10.17645/si.v11i3.6890

Selwyn, N. (2004). The information aged: A qualitative study of older adults' use of information and communications technology. *Journal of Aging Studies*, *18*(4), 369–384. https://doi.org/10.1016/j.jaging.2004.06.008

Selwyn, N., Gorard, S., Furlong, J., & Madden, L. (2003). Older adults' use of information and communications technology in everyday life. *Ageing and Society*, *23*(5), 561–582. https://doi.org/10.1017/S0144686X03001302

Sheldon, P., Antony, M. G., & Ware, L. J. (2021). Baby Boomers' use of Facebook and Instagram: Uses and gratifications theory and contextual age indicators. *Heliyon*, *7*(4). https://doi.org/10.1016/j.heliyon.2021.e06670

Shklovski, I., Kraut, R., & Rainie, L. (2004). The Internet and social participation: Contrasting cross-sectional and longitudinal analyses. *Journal of Computer-Mediated Communication*, *10*(1), JCMC1018. https://doi.org/10.1111/j.1083-6101.2004.tb00226.x

Sims, T., Reed, A. E., & Carr, D. C. (2017). Information and communication technology use is related to higher well-being among the oldest-old. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *72*(5), 761–770. https://doi.org/10.1093/geronb/gbw130

Sinclair, T. J., & Grieve, R. (2017). Facebook as a source of social connectedness in older adults. *Computers in Human Behavior*, *66*, 363–369. https://doi.org/10.1016/j.chb.2016.10.003

Smith, M. W., Sharit, J., & Czaja, S. J. (1999). Aging, Motor Control, and the Performance of Computer Mouse Tasks. *Human Factors*, *41*(3), 389–396. https://doi.org/10.1518/001872099779611102

Spears, J., & Zheng, R. (2020). Older adults' self-efficacy in computer use and the factors that impact their self-efficacy: A path analysis. *Educational Gerontology*, *46*(12), 757–767. https://doi.org/10.1080/03601277.2020.1815976

Stephens-Reicher, J., Metcalf, A., Blanchard, M., Mangan, C., & Burns, J. (2011). Reaching the Hard-To-Reach: How Information Communication Technologies Can Reach Young People at Greater Risk of Mental Health Difficulties. *Australasian Psychiatry*, *19*(1_suppl), S58–S61. https://doi.org/10.3109/10398562.2011.583077

Sum, S., Mathews, R. M., Hughes, I., & Campbell, A. (2008). Internet Use and Loneliness in Older Adults. *CyberPsychology & Behavior*, *11*(2), 208–211. https://doi.org/10.1089/cpb.2007.0010

Tabachnick, B., & Fidell, L. (2019). *Using Multivariate Statistics* (7th edition). Pearson.

Tremont, G., Duncan Davis, J., Bishop, D. S., & Fortinsky, R. H. (2008). Telephone-delivered psychosocial intervention reduces burden in dementia caregivers. *Dementia*, *7*(4), 503–520. https://doi.org/10.1177/1471301208096632

Tri-County Office on Aging. (2023). *Annual Report 2023*. https://www.tcoa.org/wp-content/uploads/2024/05/FY23-TCOA-Annual-Report.pdf

Tsai, H. S., Shillair, R., Cotten, S. R., Winstead, V., & Yost, E. (2015). Getting Grandma Online: Are Tablets the Answer for Increasing Digital Inclusion for Older Adults in the U.S.? *Educational Gerontology*, *41*(10), 695–709. https://doi.org/10.1080/03601277.2015.1048165

Tyler, M., De George-Walker, L., & Simic, V. (2020). Motivation matters: Older adults and information communication technologies. *Studies in the Education of Adults*, *52*(2), 175–194. https://doi.org/10.1080/02660830.2020.1731058

US Census Bureau. (2023). *Exploring Age Groups in the 2020 Census*. Census.Gov. https://www.census.gov/library/visualizations/interactive/exploring-age-groups-in-the-2020-census.html

van Braak, J. P., & Goeman, K. (2003). *Differences between General Computer Attitudes and Perceived Computer Attributes: Development and Validation of a Scale*. https://doi.org/10.1037/t69942-000

van Dijk. (2005). *The Deepening Divide: Inequality in the Information Society. Thousand Oaks, CA, USA: Sage Publications*. https://doi.org/10.4135/9781452229812

van Dijk. (2006). Digital divide research, achievements and shortcomings. *Poetics*, *34*(4–5), 221–235. https://doi.org/10.1016/j.poetic.2006.05.004

Vandenberg, R. J., & Lance, C. E. (2000). A Review and Synthesis of the Measurement Invariance Literature: Suggestions, Practices, and Recommendations for Organizational Research. *Organizational Research Methods*, *3*(1), 4–70. https://doi.org/10.1177/109442810031002

Vaske, J. J., Beaman, J., & Sponarski, C. C. (2017). Rethinking Internal Consistency in Cronbach’s Alpha. *Leisure Sciences*, *39*(2), 163–173. https://doi.org/10.1080/01490400.2015.1127189

Velicer, W. F., & Fava, J. L. (1998). Affects of variable and subject sampling on factor pattern recovery. *Psychological Methods*, *3*(2), 231. https://doi.org/10.1037/1082-989X.3.2.231

Virokannas, H., Rahkonen, M., Luoma, I., & Sorvari, M. (2000). The 60-year-old female worker as user of new technology. *International Journal of Industrial Ergonomics*, *25*(5), 491–495. https://doi.org/10.1016/S0169-8141(99)00034-7

Vroman, K. G., Arthanat, S., & Lysack, C. (2015). “Who over 65 is online?” Older adults’ dispositions toward information communication technology. *Computers in Human Behavior*, *43*, 156–166. https://doi.org/10.1016/j.chb.2014.10.018

Vulpe, S.-N., & Ilinca, C. (2020). Age and usage of technology: A structural equation model based on the theory of planned behavior. *Revista Universitară de Sociologie*, *16*(2). https://www.ceeol.com/search/article-detail?id=944305

Wagner, N., Hassanein, K., & Head, M. (2010). Computer use by older adults: A multi-disciplinary review. *Computers in Human Behavior*, *26*(5), 870–882. https://doi.org/10.1016/j.chb.2010.03.029

Webb, M., & Doman, E. (2020). Impacts of flipped classrooms on learner attitudes towards technology-enhanced language learning. *Computer Assisted Language Learning*, *33*(3), 240–274. https://doi.org/10.1080/09588221.2018.1557692

West, S. G., Finch, J. F., & Curran, P. J. (1995). *Structural equation models with nonnormal variables: Problems and remedies.* https://psycnet.apa.org/record/1995-97753-004

Williams, R., & Edge, D. (1996). The social shaping of technology. *Research Policy*. https://doi.org/10.1016/0048-7333(96)00885-2

Wood, K., Edwards, J., Clay, O., Wadley, V., Roenker, D., & Ball, K. (2005). Sensory and Cognitive Factors Influencing Functional Ability in Older Adults. *Gerontology*, *51*, 131–141. https://doi.org/10.1159/000082199

Wu, Y.-H., Damnée, S., Kerhervé, H., Ware, C., & Rigaud, A.-S. (2015). Bridging the digital divide in older adults: A study from an initiative to inform older adults about new technologies. *Clinical Interventions in Aging*, *10*, 193–201. https://doi.org/10.2147/CIA.S72399

Yoon, H., Jang, Y., Kim, S., Speasmaker, A., & Nam, I. (2021). Trends in Internet Use Among Older Adults in the United States, 2011–2016. *Journal of Applied Gerontology*, *40*(5), 466–470. https://doi.org/10.1177/0733464820908427

Zambianchi, M., Rönnlund, M., & Carelli, M. G. (2019). Attitudes Towards and Use of Information and Communication Technologies (ICTs) Among Older Adults in Italy and Sweden: The Influence of Cultural Context, Socio-Demographic Factors, and Time Perspective. *Journal of Cross-Cultural Gerontology*, *34*(3), 291–306. https://doi.org/10.1007/s10823-019-09370-y

APPENDIX

Attitudes Toward ICT Among Older Adults

This questionnaire <u>is anonymous</u>. Your survey answers will not be linked to any identifying information and your responses will be used only for research purposes. We encourage you to answer all the questions, but you may skip any question you choose to. Thank you in advance for your participation.
For each question, please circle or check the answer that fits your situation.

A. Eligibility questions
Please fill in the blanks or circle the answer that fits you. Please answer each question to the best of your knowledge.

1. What is your age today? ___________________

2. Are you comfortable reading and answering the questions in English?

    a. Yes

    b. No ➔ Thank you for your interest, but there is no need to finish the rest of the survey.

B. Background questions about you
Please answer each question to the best of your knowledge.

3. What is your gender?

    a. Male/Man

    b. Female/Woman

    c. Other (please specify: __________)

    d. Prefer not to answer

4. What is the highest grade or year of school you completed?
    a. Elementary School
    b. Some high school
    c. High school graduate or GED
    d. Some college or technical school
    e. College graduate
    f. Graduate degree (e.g., MSW, MA, MS, Ph.D., JD, MD, etc.)
5. What is your race?
    a. White or Caucasian
    b. Black or African American
    c. Native American or Indigenous
    d. Asian and Pacific islanders
    e. Other (Please specify ________)
6. Do you live alone?
    a. Yes b. No
7. What is your annual household income from all sources:
    a. Less than $15,000
    b. $15,001 - $25,000
    c. $25,001 -$40,000
    d. $40,001 or more
    e. Don't know/Not sure
    f. Prefer not to answer

8. Would you consider where you live to be:

    a. Urban (metropolitan areas; cities of over 100,000 people (e.g., Detroit, Grand Rapids, Lansing)
    b. Suburban (neighborhoods on the outskirts of near larger cities (e.g., Dearborn Heights, Troy, Forest Hills))
    c. Small City (cities of 10,000 to 100,000 (e.g., Jackson, Port Huron, Saginaw))
    d. Rural (villages, hamlets, towns, cities under 10,000 people)

Thank you for answering these background questions.

Following section asks your experience and opinion regarding Information and Communication Technology (ICT). ICT is type of technology that focuses on information transaction and communication purposes.

C. When you hear the phrase Information and Communication Technology or ICT, what devices or services do you think of? (circle all that apply from the box below)

Smartphone (iPhone, Samsung Galaxy, Motorola, etc.)	Laptop	Desktop	Tablet PC (iPad, Galaxy Tab, etc.)
Internet	Texting	Email	Video chat (Facetime, Zoom, Google Meet, etc.)
Online game (Solitaire, Word game, etc.)	Online (Virtual) club activities	Social Media (Facebook, Instagram, Twitter, etc.)	Smart speakers (Amazon Echo – Alexa, Apple – Seri, Samsung – Bixby, etc.)

Others (please specify ____)

Now we have a set of questions about specific ICT.

D. Please think of ONE technology that stands out the most to you or that you will be thinking about most while answering these questions. (Please, select ONE and write it down)

For example, it can be a 'smartphone', 'iPad', 'internet', 'Face Book', 'e-mail', 'computer', etc. When I think of ICT in answering these questions, the one I am thinking about the most is______________________.

E. How long have you been using the ICT you selected above?

I have been using this ICT for ______ Years and ______ Months

__________ I have not used this ICT, but this is what I am thinking about in answering these questions.

F. Did you use this ICT previously at your work (before retirement)?

a. Yes b. No c. Not applicable, I was never employed.

G. Did you attend any education or training about using this ICT?

a. Yes b. No c. Unsure

H. How frequently do you use this ICT now?

a. Almost everyday

b. At least once a week

c. At least once a month

d. At least once a year

e. Never

I. Following are questions regarding your attitudes toward this ICT you mentioned above and a few other technology devices. Please read each statement and mark how much you agree or disagree with each statement by checking the number between the number 1 (Strongly agree) to 5 (Strongly disagree).

	1 Strongly agree	2 Agree	3 Neutral	4 Disagree	5 Strongly disagree
1. I feel it is important to be able to find any information whenever I want online.					
2. I feel it is important to be able to access the internet any time I want.					
3. I think it is important to keep up with the latest trends in technology.					
4. I get anxious when I don't have my cell phone.					
5. I get anxious when I don't have the internet available to me.					
6. I am dependent on this ICT.					
7. This ICT will provide solutions to many of our problems.					
8. With this ICT anything is possible.					
9. I feel that I get more accomplished because of this ICT.					
10. New ICT makes people waste too much time.					
11. New ICT makes life more complicated.					
12. New ICT makes people more isolated.					

J. Following are questions regarding your intention to use this ICT. Please read the statement and answer each question by checking the number between the number 1 (Strongly agree) to 5 (Strongly disagree).

	1 Strongly agree	2 Agree	3 Neutral	4 Disagree	5 Strongly disagree
1. I plan to use this ICT.					
2. In general, I will use this ICT frequently.					
3. I am interested in finding out about new versions of this ICT to use.					

K. Following are questions regarding how useful you think this ICT is. Please read the statement and answer each question by checking the number between the number 1 (Strongly agree) to 5 (Strongly disagree).

	1 Strongly agree	2 Agree	3 Neutral	4 Disagree	5 Strongly disagree
1. The use of this ICT helps me make important decisions.					
2. The use of this ICT helps me manage my daily life.					
3. The use of this ICT reinforces or increases my independence.					
4. The use of this ICT helps me to be more efficient in my daily life.					
5. Using this ICT increases my chances of achieving things that are important to me.					
6. Using this ICT will make my life more comfortable.					

L. Following are questions regarding how easy you think this ICT is to use. Please read the statement and answer each question by checking the number between the number 1 (Strongly agree) to 5 (Strongly disagree).

	1 Strongly agree	2 Agree	3 Neutral	4 Disagree	5 Strongly disagree
1. It's easy for me to use this ICT.					
2. Learning how to use such ICT is easy for me.					
3. I would find it easy to get this ICT to do what I want it to do.					
4. My interaction with this ICT would be clear and understandable.					
5. It would be easy for me to become skillful at using this ICT.					
6. I would find this ICT to be flexible to interact with.					

M. The last set of questions asks how you think about this ICT. Please rate each item on a 7-point scale ranging from positive to negative attributes (e.g., good to bad, wise to foolish). All things considered, my using this ICT is:
(Please select the number that best fits your answer)

1	Good (1)	(2)	(3)	Neutral (4)	(5)	(6)	Bad (7)
2	Wise (1)	(2)	(3)	Neutral (4)	(5)	(6)	Foolish (7)
3	Favorable (1)	(2)	(3)	Neutral (4)	(5)	(6)	Unfavorable (7)
4	Beneficial (1)	(2)	(3)	Neutral (4)	(5)	(6)	Harmful (7)
5	Positive (1)	(2)	(3)	Neutral (4)	(5)	(6)	Negative (7)
6	Happy (1)	(2)	(3)	Neutral (4)	(5)	(6)	Annoyed (7)
7	Valuable (1)	(2)	(3)	Neutral (4)	(5)	(6)	Worthless (7)

Thank you for completing the survey.