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Abstract

The ability of older adults to engage with ICT is crucial in today's digital and connected world. Anxiety about the use of ICT and failure to adopt and engage with ICT is increasingly likely to be a barrier in daily living for older adults and can reduce quality of life, independence, autonomy, and mental health. failure to adopt and engage with ICT may also be a significant factor in social exclusion. Drawing on existing frameworks for technology adoption such as the Theory of Planned Behaviour, Technology Acceptance Model and the Unified Theory of Acceptance and Use of Technology frameworks, this paper examines the concept of anxiety and factors that are associated with anxiety when in engaging with ICT. Our findings showed that anxiety was reduced through a positive attitude towards ICT and through having resources to adopt an engage with IT. Anxiety was increased through subjective norms or when others placed pressure on older people to engage more and when older people perceived increased risked of ICT engagement. The results highlighted the importance of building, renewing, and reinforcing digital literacy in older adults. Understanding factors associated with ICT-related anxiety means that organisations may be better placed to develop campaigns, programmes and policies for older adults that actively reduce ICT anxiety.

Understanding factors influencing seniors' anxiety in using ICT

1 Introduction

This paper pays particular attention to anxiety and the factors that influence information and communication technology (ICT) anxiety in older adults. Anxiety about using technology, including ICT, has been identified as a factor inhibiting the adoption of new technology (Mac Callum et al., 2014; Di Giacomo et al., 2019). Our focus in on anxiety with specific devices and platforms (e.g., computers, eHealth, mobile phones, online shopping) or more generalised technology, and ICT anxiety (Mac Callum et al., 2014; Meng et al., 2021). ICT has been found to generate high levels of anxiety in older adults when using or confronted with the prospect of having to adopt, learn, and use ICT (Barbeite and Weiss, 2004).

Older adults are an increasingly important group of ICT consumers (Vroman et al. 2015). Older adutls can benefit significantly from ICT education for several reasons including: the promotion of life-long learning, social participation and connection, the ability to keep up with the times and to adapt to today's digital society, spending less time doing passive activities and, in general, and enjoying an improved quality of life (Chopik et al., 2017; Hur, 2016; Macedo, 2017; Gonzalez et al., 2012; Alvarez-Dardet et al., 2020; Broady et al., 2010; Selwyn et al., 2003). Older adults have also been identified as having concerns and anxieties around the adoption and use of ICT (Figueiredo et al., 2020). Social distancing and physical isolation brought about by the COVID-19 pandemic has further increased the impetus to better understand older adults and their engagement with ICT.

Despite many benefits, older adults can often find it difficult and stressful to realise the potential of ICT engagement (Alvarez-Dardet et al., 2020). Rapidly changing technology and the need to keep up to date with changes in ICT potentially excludes many seniors from engaging with ICT in ways that add value to their lives, and may undermine overall societal social cohesion (Alvarez-Dardet et al., 2020; Blades-Hamilton, 2015). The unprecedented rates of technological change have resulted in

many seniors feeling disempowered, socially excluded, and anxious about using ICT (Hajkowicz, 2015). These seniors (the term is used here interchangeably with older adults) report feelings of disempowerment and fear of social exclusion when they lack capabilities to engage with ICT (Hill et al., 2015).

Several studies have shown that anxiety about ICT influences adoption and future use of ICT by seniors (Guner and Acarturk, 2020; Kim et al., 2021; Vroman et al., 2015). Anxiety by seniors in relation to ICT can result in self-imposed barriers and low level of engagement (Marquié et al., 2002; Turner et al., 2007). Self-reported differences between older and younger users of ICT was often not associated with one's actual knowledge, but rather in one's confidence or anxiety, and the effects of those feelings led to the tendency of older adults to underestimate their knowledge and abilities (Guner and Acarturk, 2020; Mitzner et al., 2010). Other research has suggested that older users have significantly higher technology anxiety than the younger users due to the perceived cognitive and physiological declines associated with age such as declining sight, dexterity, cognitive processing and learning challenges (Czaja, et al., 2006; Charness and Boot, 2009; Vaportzis, et al., 2017).

While anxiety generally refers to an emotional state, personality trait, or condition, characterized by tension, apprehension, and worry (Thatcher and Perrewé, 2002), individuals experience it when they perceive conditions in their environment, or things and systems they interact with to be threatening (Thatcher et al., 2007). From a computer or ICT perspective, researchers have argued that as opposed to trait anxiety, computer or ICT anxiety is a form of 'state anxiety' which is amenable to change (Heinssen et al., 1987; Chua et al., 1999). Little research has investigated state-based ICT anxiety and its antecedents.

While anxiety often features in research as a mediator or a predictor of ICT engagement, it has yet to be fully analysed as a dependant variable or end state; that is, what is associated with anxiety related to ICT adoption and use.

The present study examines the effects of digital literacy, psychological characteristics, and perceived risks, on anxiety felt by older adults regarding engagement and use of ICT. The findings of the study provide a valuable contribution to raise awareness on drivers of ICT related anxiety and on pathways to reduce anxiety. Contributions include the importance of understanding and addressing perceived risks faced by older adults. The need to understand how social norms or pressure from friends, family and others may cause anxiety rather than be helpful of motivating to use ICT, and the need to foster digital literacy in ways that best suit older adults.

The remainder of the article is organised as follows. The next section presents the conceptual model and hypotheses. In the subsequent sections the methodology is described and the results presented. The paper ends with a discussion and conclusions that summarises the study's findings, identifies contributions, and suggests several potential future research directions.

2 Conceptual framework and hypotheses

2.1 The adoption and use of ICT

Researchers have utilised several models to examine the acceptance and engagement with ICT, including the Technology Acceptance Model (TAM) proposed by Davis et al. (1989), and the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. (2003) and Ajzen's Theory of Planned Behaviour (1991). This research applies an expanded TAM drawing upon elements of the Theory of Planned Behaviour and the UTAUT.

TAM has been used extensively in ICT-related research to assess technology acceptance by individuals (Guner and Acarturk 2020; Legris et al., 2003). TAM has its foundations in both the theory of reasoned action (TRA) and theory of planned behaviour (TPB) (Lee, 2009). Generally, TAM assesses how attitude and behavioural intentions are influenced by perceived usefulness and perceived ease of use together with other external factors. The relationship between perceived usefulness and perceived ease of use and acceptance of technology has been supported by numerous

studies and modified versions including TAM2, TAM3 and UTAUT (Venkatesh and Davis, 2000; Venkatesh, et al., 2003). TAM is often extended by adding some other external factors which are theorised to have impact on the acceptance of technology (Guner and Acarturk 2020; Cheng, 2019). Common external factors that influence perceived usefulness and perceived ease of use include variables such as social influence, anxiety, facilitating conditions, self-satisfaction, self-efficacy, cost tolerance, perceived enjoyment, experience (Abdullah and Ward, 2016). The model employed and noted interrelationships in this research is shown in Figure 1.

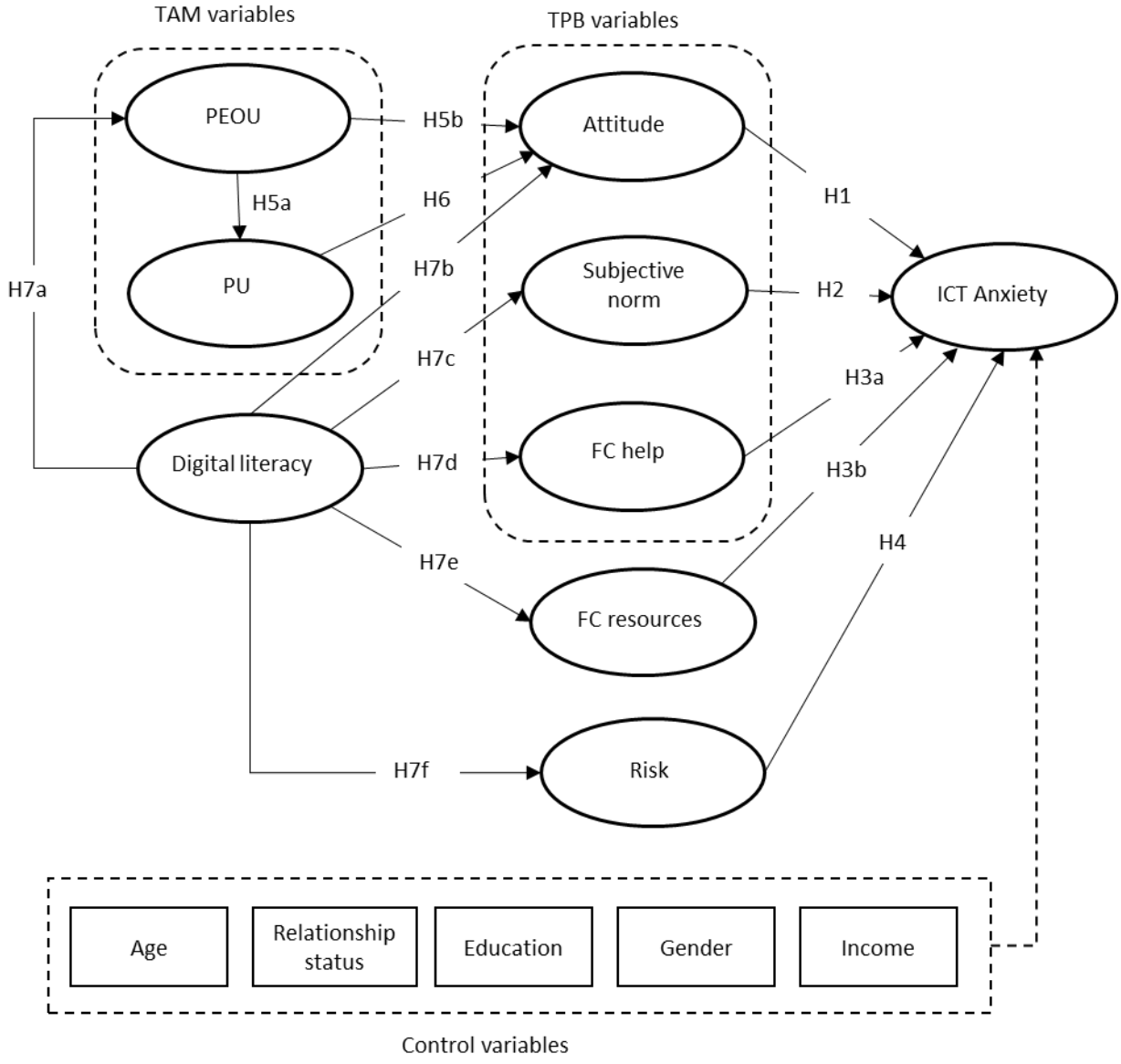

Figure 1. Research model.

2.2 Hypothesis development

Attitude refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour of interest (Ajzen, 2011; Lee, 2009). Guner and Acarturk (2020) note that in both TAM and TPB studies, attitude significantly predicts the intention to adopt and use ICT (e.g., Kim et al. 2009). Moreover, research in technology acceptance by older adults has shown that attitudes, experiences, and self-efficacy interacting with ICT are critical factors for ICT acceptance and adoption (Schomakers et al., 2018; Czaja et al.,2006). Experiences with technologies and other individual differences e.g., ability and knowledge, gender, education, and social background can shape attitudes. In this research we propose that a positive attitude towards the adoption and use of ICT will result in lower perceived anxiety of older adults towards adopting and using ICT. Thus, we hypothesize:

H1: For older adults, a positive attitude to ICT has a negative relationship with anxiety (decreases) towards using ICT.

Social psychologists know that the social context of an individual can change their perceptions about certain behaviours (Michie et al., 2014). Indeed, people often choose to perform an action when one or more important referents say they should, even though they may not like or believe in it (Schepers and Wetzels, 2007). This influence is variously called subjective norm (TPB) and social influence (TAM2, TAM3). Subjective or social norms can also reference the atmosphere of a society or the surroundings that affect an individual's decision-making process in terms of social pressures or collective beliefs (Venkatesh and Bala, 2008). Researchers have found that subjective norms have some influence on the ICT related behaviour of older consumers (Pan and Jordan-Marsh, 2010; Han and Nam, 2021), although the evidence is mixed (Schepers and Wetzels, 2007). From the perspective of anxiety, the perceived pressure from others or society to behaviour in a certain way, e.g., engage with ICT may heighten anxiety, especially if individuals perceive they lack the ability to engage at a level that others expect or want them to. Thus, we hypothesize:

H2: For older adults, subjective norm has a positive relationship with anxiety (increases) towards using ICT.

The ability to engage with ICT and reductions in anxiety about engaging with ICT are likely to relate to the resources available to older adults. These resources and their availability are known as facilitating conditions; defined as the degree to which an individual believes that organizational and technical infrastructure exists to support the use of ICT (Venkatesh et al., 2012). In other words, older adults' perceptions of environmental barriers or availability of resources that may affect engagment with ICT (Macedo, 2017). In the earlier UTAUT version, facilitating conditions were theorised as a driver of use behaviour, meaning that the more the users perceive the availability of resources, knowledge, and support, the more likely it is that they will actually use ICT. For older adults this may take the form of having the necessary resources such as knowledge, time, and money to adopt and use forms of ICT (Choudri et al, 2018). It may also take the form of support, assistance and mentoring that shape engagement with ICT and aid in the reduction of anxiety associated with adoption and use (Arthanat, 2021). In the present study, facilitating conditions are described as the person's beliefs about the costs, including money, knowledge, and assistance older adults need to afford to own and use ICT. We make a distinction between resources to afford and skills to use, and the support available to use e.g., social support, assistance, and mentors (Guner and Arcaturk, 2021; Michailidou et al., 2015). Thus, we hypothesize:

H3: For older adults', (**H3a**) facilitating conditions for ICT (help), and (**H3b**) facilitating conditions for ICT (resources) have a negative relationship with anxiety (decreases) towards using ICT.

Risk perceptions are beliefs about potential harm or the possibility of a loss. It is a subjective judgment that people make about the characteristics and severity of a risk (Arfi et al.,2021). Consumer research has demonstrated that perceived risk influences the adoption and use of products and service, including ICT (Laukkanen et al., 2007; Nunan and Domenico, 2019). Perceived risks can manifest in many ways including financial, performance, social, physical, psychological and time

risks. In this research we utilise a reconceptualization of these risk factors by Figueiredo et al., (2020), incorporating Operational and Functional Risk (e.g. forgetting instructions or passwords, not keeping up, wasting time), Personal and Social Risk (e.g. being made fun of, feeling incompetent, getting frustrated, being overwhelmed), Privacy and Transaction Risk (e.g. losing privacy, identity theft, automatic payments), Purchase Transaction Risk (e.g. making transaction mistakes, not receiving goods, processing errors), Overspending Risk (buying too much online, software upgrade or device costs), Physical Harm Risk (e.g. becoming addicted to ICT, eyesight strain, or repetitive strain injury). Thus, we hypothesize:

H4: For older adults, higher perceived risks in using ICT have a positive relationship (increases) with anxiety towards using ICT.

Perceived Ease of Use has been defined as the level of difficulty or effort needed to use the technology, while Perceived Usefulness is the level of belief an individual has about whether the technology will provide an advantage and lead to better outcomes than not using it (Brown et al., 2010). In the TAM, attitude towards technology, in this case ICT, is influenced by the perceived usefulness and perceived ease of use of ICT together with external factors like digital literacy (Guner and Acarturk, 2020; Mac Callum et al., 2014). The model has also been tested to show a relationship between perceived usefulness and ease of use, with ease of use influencing perceived usefulness. According to TAM, perceived usefulness and perceived ease of use also determine the acceptance of using ICT. If older adults consider ICT as being useful and easy to use, they are more likely to hold positive attitudes towards adoption and use of ICT and subsequently be less anxious about adoption and use. Thus, we hypothesize:

H5: For older adults, perceived ease of use of ICT has (**H5a**) a positive relationship with perceived usefulness of ICT, and (**H5b**) positive attitude towards ICT.

H6: For older adults, perceived usefulness has a positive relationship with positive attitude towards ICT.

Digital literacy and associated skills are fundamental in today's knowledge economy and information society (Bawden, 2001). Digital literacy is variously defined as “the ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse, and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process” (Martin, 2005, p. 135). Improving the inclusion and engagement of older adults in digital technology is becoming increasingly important (Oh et al., 2021; Scheerder et al., 2017) and while numerous studies have measured the digital literacy of younger generations, few have examined the inclusion of older adults in the research and design of digital technologies (Olsson, et al. 2019; Scheerder et al., 2017; Van Deursen, et al., 2016). Research suggests that people with higher digital literacy have less anxiety associated with using ICT in their daily lives (Di Giacomo et al., 2019). Digital literacy and associated skills are also likely to significantly influence attitudes towards using ICT, the level of self-efficacy and facilitating conditions for engaging with ICT, and the degree to which others pressure the individual to use ICT (De Boer et al., 2019). Importantly digital literacy is also associated with the perceived ease use and perceived usefulness of ICT (De Boer et al., 2019). Thus we hypothesise:

> **H7**: For older adults, a higher level of digital literacy has a positive relationship with (**H7a**) perceived ease of use of ICT, (**H7b**) positive attitude to ICT, (**H7c**) subjective norms, (**H7d**) facilitating condition for ICT (help), and (**H7e**) facilitating condition for ICT (resources), and a negative relationship with (**H7f**) perceived risk of ICT.

3 Methodology

To empirically test the proposed research model the current study employed a survey design using self-administered online questionnaires. The questionnaire was hosted on a Qualtrics platform and an invitation to participate was emailed to members of the Victorian University of the Third Age (U3A) Network (www.u3avictoria.org.au). The university ethics committee approved the collection of data from human subjects. Participants were informed that by completing the survey they were providing

their informed consent and assured that their answers were anonymous, confidential and would be used for research purposes only. Participation was voluntary and some returned surveys were incomplete.

3.1 Procedure

This research is part of a larger research project investigating how technology use supports older adults' connectedness and enhances social inclusion and participation. This project is multi-disciplinary and brings together researchers and stakeholders with expertise in consumer behaviour, social marketing, consumer culture theory, and design innovation management.

The U3A Network is an international movement that provides lifelong learning opportunities through courses and activities to people who are retired or semiretired and over the age of 50. There are 104 U3As throughout Victoria, Australia offering courses to members who make up the U3A Network Victoria. U3As provide opportunities for retired or semiretired people to engage in later life learning, meet new people and share their knowledge and skills with others.

The survey questionnaire was carefully designed to be applied to this group. Survey development included a review of the literature and an analysis of 22 recorded and transcribed exploratory interviews conducted from November 2020 to January 2021. Thirteen interview participants were women and eight were men. Four participants self-reported as culturally and linguistically diverse (CALD) persons. The participants were between 59 and 85 years old, with a mean age of 71.8 and a median of 71. Several of vignettes were created from the interview data, to help the researchers understand older consumers and their engagement with ICT.

Ten qualified researchers familiar with the topics under research reviewed the survey questionnaire to assure its content validity. To eliminate possible ambiguities and, following established recommendations (Hunt et. al., 1982), the survey was pre-tested with administrators of U3A and with

25 older adults enrolled in U3A courses. Pre-test participants were encouraged to comment on the questions, survey design, and other survey elements that would influence completion of the survey. Their responses were not included in the final sample used for analysis.

Trusted U3A representatives were asked to distribute the survey instrument to their members, which reduced older adults' risk and anxiety regarding participation in the study. To facilitate the reading and completion of the survey, the U3A and the university's names also appeared on the survey. There was also a brief introduction to the project and research goals. These measures helped to limit resistance to participation and mitigate concerns about scams, cyberbullying, and general security threats and other various perceptions of risk (Aleti et. al., 2019).

Following Macedo's (2017) recommendations, common method bias was addressed using following steps: 1) respondents were assured anonymity; 2) attention was paid to avoid statements relating to the dependent variable not being located close to the independent variables of the questionnaire (Podsakoff et al., 2003). Ex post, Harman's single-factor test was computed based on principal component analysis (PCA) (Podsakoff et al., 2003) and revealed 19 components with eigenvalues greater than 1.0. This result suggests no evidence of common methods bias

3.2 Recruitment

Australian U3A members were contacted via email, newsletter, and nominated courses to voluntarily complete the online survey. Three recruitment bulletin emails were sent to the 104 Member U3As of U3A Network Victoria, and a bulk email was sent to a wider U3A network. In addition, notifications were placed in U3A Network Victoria publications (Network News, Facebook, Network Council papers). The survey was promoted through the Social Seniors programs, and 10 U3As that had members complete the survey in Digital Literacy classes. Incomplete responses lacking completion of the demographics section were not included in the final analysis. Over a 5-month period, 722 surveys

were registered. Removing duplicates and invalid responses where no demographic information was recorded yielded 615 complete and valid surveys.

3.3 Participants

Table 1 shows the complete demographic profile of the sample group. The largest age category of participants was 70-74 years of age (37.6%). There were significantly more female participants (68%) compared to male participants (31%). Education varied amongst the participants with 12% having achieved lower than year 11 or below and 7.3% completing secondary school (year 12). A significant proportion had a graduate diploma (18.4%), a bachelor's degree (21.6%) or postgraduate qualifications (19%). As expected for this age group, most of the participants were retired or no longer working (87.5%). The income of most participants (53.1%) was less than $51,999 however, 10.8% had an income of over $91,000 per year. Most participants were currently in couple relationships (58.5%) compared to single (34.4%) with 7.2% preferring not to answer this question. A greater percentage of participants lived in urban areas (67.8%) compared to rural or regional locations (32.2%).

Table 1. Demographic profile of survey respondents (*N* = 615).

Characteristics	Number	Percentage
Gender		
Female	422	68.0
Male	192	31.0
Other	1	0.2
Age (years)		
less 50	5	0.8
55-59	6	1.0
60-64	54	8.8
65-69	144	23.4
70-74	231	37.6
75-79	103	16.7
80-84	61	9.9
85+	10	1.6
Prefer not to say	1	0.2
Education		
Year 11 or below	74	12.0
Year 12	45	7.3
Certificate I/II	7	1.1
Certificate III/IV	26	4.2
Advanced Diploma and Diploma	88	14.3
Bachelor's Degree	133	21.6
Graduate Diploma	113	18.4
Postgraduate Degree	117	19.0
Prefer not to say	12	2.0
Respondent gross income		
$7,800 - $15,599 per year	47	7.7
$15,600 - $20,799 per year	55	9.0
$20,800 - $25,999 per year	60	9.8
$26,000 - $33,799 per year	58	9.5

$33,800 - $41,599 per year	56	9.1
$41,600 - $51,999 per year	49	8.0
$52,000 - $64,999 per year	41	6.7
$65,000 - $77,999 per year	18	2.9
$78,000 - $90,999 per year	13	2.1
$91,000 - $103,999 per year	11	1.8
$104,000 - $155,999 per year	4	0.7
$156,000 or more per year	51	8.3
Prefer not to say		24.5
Relationship status		
Single	211	34.3
Couple	360	58.5
Prefer not to say	44	7.2
Location		
Rural/regional	197	32.2
Urban	415	67.8
Employment		
Working full-time (on-going)	8	1.3
Working part-time (on-going)	31	5.0
Working casually (intermittent)	30	4.9
Unemployed / seeking work	4	0.7
Fully retired / no longer working	537	87.5
Prefer not to say	4	0.7

With respect to ICT ownership and usage (Table 2), almost all survey respondents had personal access to the internet (92.5%) or owned a smartphone (71.5%). This was followed by a laptop (54.6%) or an iPad or tablet (91.4%) as the most owned pieces of technology. Just over half owned an internet-enabled TV or a desktop computer. Wearable devices and the iPod Touch (digital music player) were not commonly owned items (10.7% and 24.7% respectively).

Table 2. Device ownership (*N* = 615).

Characteristics	Number	Percentage
Types of devices owned		
Internet	569	92.5
Smartphone	562	91.4
iPad/Tablet	426	69.3
Laptop	440	71.5
Internet-enabled TV	359	58.4
Desktop computer	336	54.6
Wearable devices	153	24.9
iPod Touch or similar device	66	10.7
Other	34	5.5

Note. Respondents could select more than one device type.

3.4 Measures

Theoretical constructs including digital literacy, perceived ease of use, perceived usefulness, attitude, subjective norm, and facilitating conditions were operationalised using previously validated multi-item scales. Scales were adapted with slight modifications and rephrasing through a process of consultation and prior qualitative research with older adults. The 4-item dependant measure of ICT Anxiety was based on Guner & Acarturk (2020) and Venkatesh et al. (2003). Each item was measured on 7-point Likert scales, where 1 = strongly disagree to 7 = strongly agree. Items related to Attitude, Subjective Norm, Facilitating conditions, Perceived ease of use, Perceived usefulness were also measured based on Guner and Acarturk (2020) and Venkatesh et al. (2003). Each item was measured on 7-point Likert scales, where 1 = strongly disagree to 7 = strongly agree.

The measure of digital literacy was based on the Internet Skills Scale (ISS) (Van Deursen et al., 2016; Van Deursen and Mossberger, 2018). The scale encompasses not only technical ability but also other technical and cognitive skill types that support engagement with the internet and other ICT. Technical

ability includes operational skills (8 items). Information navigation skills (6 items) relate to finding, selecting, and evaluating information sources on the Internet. Mobile skills (4 items) include downloading and installing applications and monitoring the data costs involved in online mobile use (Van Deursen et al., 2016). Social skills (7 items) enable using online communication and interactions to understand and exchange meaning, involving searching, selecting, evaluating, and acting on online contacts. Creative skills (5 items) are the skills necessary to create content suitable for online display, including text, music and video, photo or image, multimedia, or remixed media (Van Deursen et al., 2016). Each item was measured on 7-point Likert scales, where 1 = strongly disagree to 7 = strongly agree. The scale is treated as a second order factor in the analysis (Rehman et al., 2020).

Risk was measured using a combination of items drawn from consumer behaviour and information systems research (Cocosila and Archer, 2010; Featherman and Pavlou, 2003; Stone and Mason 1995; Stone and Grønhaug, 1993). The measures for risk were further developed through qualitative research with older adults and subsequent quantitative analysis using exploratory and confirmatory factor analysis (Figueiredo et al., 2020). The final Perceived ICT Risk Scale comprised, Operational and Functional Risk (12 items), Personal and Social Risk (10 items), Privacy and Transaction Risk (7 items), Purchase Transaction Risk (5 items), Overspending Risk (4 items), Physical Harm Risk (3 items). Each item was measured on 7-point Likert scales, where 1 = strongly disagree to 7 = strongly agree. The scale is treated as a second order factor in the analysis (Rehman et al., 2020).

4 Analysis and Results

Descriptive statistics were calculated using IBM SPSS Statistics (Version 28), and SmartPLS (Version 3.3.3) was used to conduct the partial least squares structural equation modelling (PLS-SEM) (Ringle et al., 2015). PLS-SEM is a distribution free method of determining the predictive power of complex models (Hair et al., 2019; Hair et al., 2014). PLS-SEM was appropriate for the

analysis of a predictive model that utilised multiple constructs and indicators. PLS-SEM was also deemed suitable given the relatively small sample size (N = 615).

The first stage of the analysis requires establishing the establishment of the validity and reliability of the model (Appendix 1) including assessing indicator loadings, internal consistency and construct reliability (Hair et al., 2019; Hair et al., 2014). The second stage of the analysis tested the relationships and predictive power the model constructs.

4.1 Measurement model

Reliability measures determine whether items are consistently measuring the construct. The internal consistency of each construct and measure (Table 3). was assessed using Cronbach's Alpha (CA). Each was above the acceptable threshold of 0.7. Three constructs had CA and CR values above .95 suggesting some potential item redundancy (Hair et al., 2019) for measures of Perceived Ease of Use (CA = .96, CR = 0.97), Perceived Usefulness (CA = .95, CR = .97), and Anxiety in Using ICT (CA = 0.94; CR = 0.96). Nonetheless, all items were subsequently retained for the analysis. The convergent validity of each construct was assessed using evaluation of average variance extracted (AVE); which were above 0.5 (whereby 50% or more of the variance is explained). In addition, all of the composite reliability scores were above 0.7 (Hair et al., 2019; Hair et al., 2021).

Table 3. Construct reliability.

Construct		Cronbach's Alpha (CA)	Composite Reliability (CR)	Average Variance Extracted (AVE)	Adjusted R Square
ANX	Anxiety in using ICT	0.94	0.96	0.86	0.69
ATT	Attitude toward using ICT	0.85	0.90	0.64	0.61
DL	Digital literacy	0.87	0.90	0.65	---
FCH	Facilitating conditions – mentoring and help	0.71	0.84	0.63	0.01
FCR	Facilitating condition – skills and knowledge	0.86	0.90	0.72	0.55

PEOU	Perceived ease of use of ICT	0.96	0.97	0.89	0.58
PU	Perceived usefulness of ICT	0.95	0.97	0.88	0.28
RSK	Risk	0.90	0.92	0.66	0.45
SUBN	Subjective norm to use ICT	0.85	0.88	0.68	0.02

The next phase in determining the validity and reliability of the constructs, is to determine discriminant validity. Discriminant validity measures indicate the extent to which each construct differs from the others. Two approaches were used to assess discriminant validity – Fornell-Larcker criterion and the heterotrait-monotrait ratio (HTMT) (Hair et al., 2019). In Table 4 the values on the diagonal (in bold) are the square root of the average variance extracted. For each variable the off-diagonals (raw correlations) are lower than the square root of the AVE for each variable, indicating discriminant validity – hence the Fornell-Larcker – criterion was satisfied.

Table 4. Discriminant validity – Fornell-Larcker criterion.

	ANX	ATT	DL	FCH	FCR	INC	PEOU	PU	REL	Risk	SUBN	Age	EDU
ANX	**0.93**												
ATT	-0.63	**0.80**											
DL	-0.70	0.58	**0.81**										
FCH	0.04	0.07	-0.04	**0.79**									
FCR	-0.71	0.68	0.74	0.04	**0.84**								
INC	-0.06	0.08	0.08	-0.06	0.06	**1.00**							
PEOU	-0.71	0.67	0.76	-0.01	0.80	0.09	**0.94**						
PU	-0.45	0.69	0.47	0.02	0.55	0.04	0.53	**0.94**					
REL	-0.07	0.11	0.15	0.08	0.12	0.18	0.06	0.02	**1.00**				
RSK	0.77	-0.59	-0.67	0.05	-0.64	-0.06	-0.63	-0.41	-0.07	**0.81**			
SUBN	0.23	-0.02	-0.14	0.32	-0.08	-0.01	-0.12	0.02	-0.03	0.17	**0.83**		
Age	0.05	-0.04	-0.25	-0.03	-0.16	0.02	-0.17	-0.01	-0.12	0.01	0.03	**1.00**	
EDU	-0.14	0.15	0.18	-0.01	0.21	0.04	0.15	0.16	0.10	-0.15	0.06	-0.11	**1.00**
Gender	-0.11	0.03	0.09	-0.12	0.11	0.06	0.08	0.02	0.31	-0.11	-0.03	0.07	0.11

Note: ANX = Anxiety; ATT = Attitude; DL = Digital literacy; FCH=Facilitating condition - help; FCR=Facilitating condition - resources; INC=Income; PEOU=Perceived ease of use; PU=Perceived usefulness; REL=Relationship status; RSK=Risk; SUBN=Subjective norm; EDU=Education level. Diagonal elements (in bold) are the square-root of the AVEs along the diagonal and the raw correlation on the off-diagonal elements.

The Heterotrait-Monotrait Ratio (HTMT) was used as the second test of discriminant validity. A threshold of 0.85 was used to identify evidence of internal validity. Apart from one ration (FCR and PEOU = 0.85), all inter-variable assessments were adequate (Table 4). There were four ratios that were above 0.8, but not greater than 0.85. Overall, the scales and subscales used in the model demonstrated adequate internal consistency and discriminant validity.

Table 5. Heterotrait-Monotrait Ratio (HTMT).

	ANX	ATT	DL	FCH	FCR	INC	PEOU	PU	REL	Risk	SUBN	Age	EDU
ANX													
ATT	0.70												
DL	0.77	0.67											
FCH	0.06	0.10	0.07										
FCR	0.76	**0.80**	**0.83**	0.08									
INC	0.06	0.09	0.08	0.09	0.07								
PEOU	0.75	0.74	**0.83**	0.03	**0.85**	0.09							
PU	0.47	0.76	0.52	0.03	0.61	0.04	0.55						
REL	0.07	0.12	0.16	0.09	0.15	0.18	0.06	0.02					
Risk	0.81	0.65	0.73	0.07	0.71	0.07	0.65	0.42	0.08				
SUBN	0.22	0.12	0.16	0.37	0.14	0.03	0.12	0.13	0.03	0.16			
Age	0.05	0.07	0.26	0.04	0.16	0.02	0.17	0.01	0.12	0.06	0.03		
EDU	0.14	0.17	0.20	0.02	0.24	0.04	0.16	0.17	0.10	0.16	0.11	0.11	
Gender	0.12	0.05	0.11	0.14	0.13	0.06	0.08	0.03	0.31	0.11	0.04	0.07	0.11

Note: ANX = Anxiety; ATT = Attitude; DL = Digital literacy; FCH = Facilitating condition - help; FCR = Facilitating condition - resources; INC=Income; PEOU = Perceived ease of use; PU = Perceived usefulness; REL = Relationship status; SUBN = Subjective norm; EDU = Education level. Ratios in bold approached the acceptability threshold of 0.85.

4.2 The Structural Model

Table 6 details the significance of the path coefficients and show that 11 of the 14 hypotheses were supported. With respect to UTAUT and TPB variables, the relationships between ICT-related anxiety and attitude (H1) and between ICT-related anxiety and facilitating conditions - resources (H3b) were significant and reduced anxiety felt by older adults. Interestingly, subjective norm had a significant

influence.s. Perceived risks (H4) associated with engaging with ICT were associated with higher anxiety scores. Contrary to what was hypothesised, facilitating conditions – sources of help (H3a), was not a significant driver (either positive or negative) of ICT anxiety.

Table 6. Predictors of ICT Anxiety (direct effects).

Hypothesis	Relationships	Beta	t-value	p-value
H1	**Attitude > Anxiety**	-0.160	5.185	<0.001
H2	**Subjective norm > Anxiety**	0.118	4.744	<0.001
H3a	Facilitating conditions(help) > Anxiety	0.004	0.103	0.918
H3b	**Facilitating conditions(resources) > Anxiety**	-0.283	7.426	<0.001
H4	**Risk > Anxiety**	0.475	15.598	<0.001
H5a	**Perceived ease of use > Perceived usefulness**	0.526	13.748	<0.001
H5b	**Perceived usefulness > Attitude**	0.448	11.497	<0.001
H6	**Perceived ease of use > Attitude**	0.384	8.654	<0.001
H7a	**Digital literacy > PEOU**	0.764	33.284	<0.001
H7b	Digital literacy > Attitude	0.080	1.835	0.067
H7c	**Digital literacy > Subjective norm**	-0.160	4.136	<0.001
H7d	Digital literacy > Facilitating conditions(help)	-0.044	0.911	0.362
H7e	**Digital literacy > Facilitating conditions(resources)**	0.730	29.671	<0.001
H7f	**Digital literacy > Risk**	-0.705	31.013	<0.001

Note. Hypothesis numbers in bold are supported.

For the TAM-related variables, perceived ease of use (H6) and perceived usefulness (H5b) had a significant positive impact on attitude. The relationship between these variables was also significant in that perceived ease of use had a positive impact on perceived usefulness (H5a).

Our analysis showed that digital literacy is a significant driver of PEOU of ICT (H7a) and facilitating condition (resources) (H7e), but was not associated with attitude toward ICT use (H7a) nor facilitating condition (help) (H7d). Digital literacy was shown to have a significant downward influence on the perceived risk associated with engaging with ICT (H7f), in that the higher the level of digital literacy

the less likely older adults were to perceive ICT use as risky. This is important, as the model demonstrates, high perceived risk scores significantly increase ICT anxiety scores. People who perceive the use of ICT as fraught with risks, or traps or dangers are going to be more anxious about using ICT and hence likely more resistant to engaging with it. Moreover, the analysis suggests that while digital literacy does not have a direct effect on the attitude toward ICT, the impact of digital literacy is indirect through perceived use and perceived ease of use.

Interestingly, digital literacy was shown to have a negative impact on subjective norm (H7c). This suggests that the higher an older adult's digital literacy the less subject they might be to pressure or expectations of significant others regarding their engagement with ICT. The analysis also shows that higher subjective norms are also associated with higher levels of ICT related anxiety. The control variables, age, relationship status, education, gender, and income, were not significantly associated with ICT anxiety (Table 7).

Table 7. Control variables

	Beta	t-value	p Values
Age -> Anxiety	-0.009	0.358	0.720
Educ -> Anxiety	0.018	0.758	0.449
Gender -> Anxiety	-0.034	1.459	0.145
Income -> Anxiety	0.002	0.047	0.962
Relationship status -> Anxiety	0.031	1.241	0.214

Overall, the analysis revealed the significant impact of digital literacy on PEOU, and indirectly on PU and a positive ICT attitude. Digital literacy was also a significant influencer of perceived risk, which has the greatest influence on reducing ICT anxiety.

For older adults it appears that improving digital literacy holds the key to reducing ICT anxiety. A higher level of digital literacy, reduces perceptions of ICT risk, increases the perceived usefulness of ICT and access to resources that facilitate ICT use. Interestingly, given the perception that older adults rely on others, especially younger family members to assist them with their ICT needs, facilitating

conditions (help) was not a significant factor in ICT anxiety. The final research model is depicted in Figure 2.

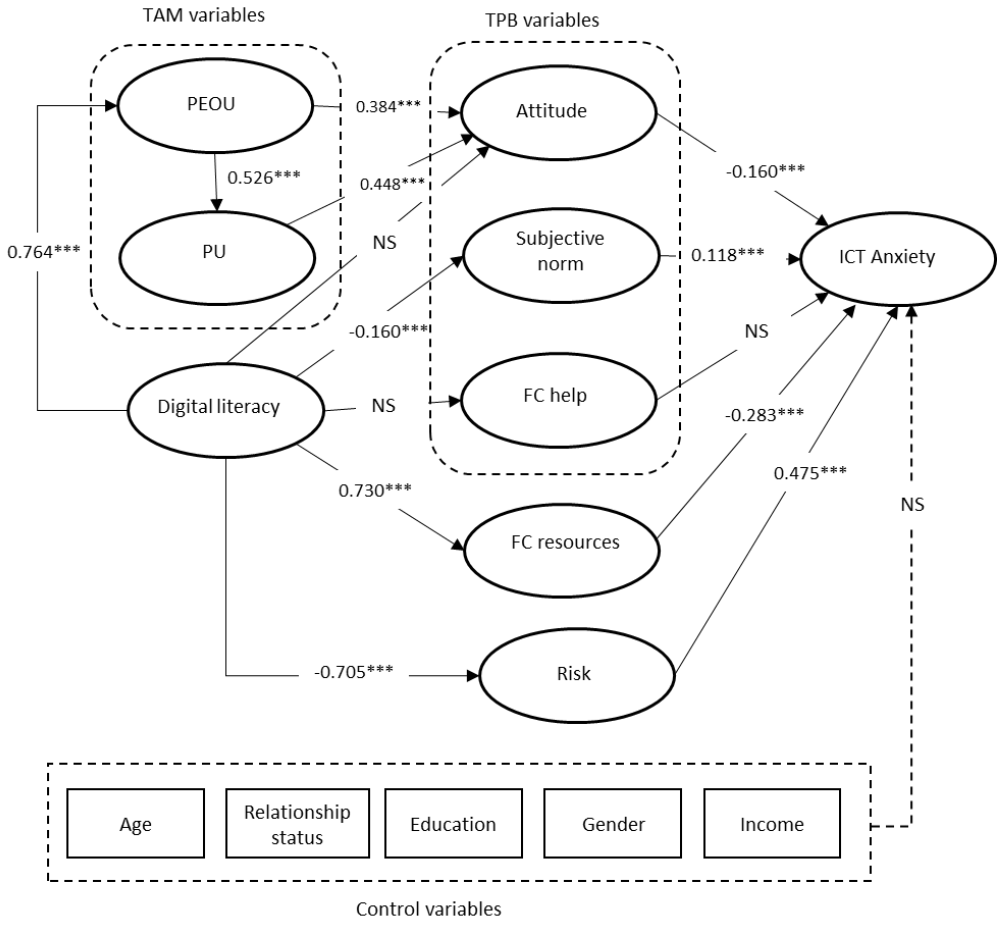

Figure 2. Final research model.

5 Discussion

Older adults face a world that is becoming increasingly digital. Being able to engage in daily activities such as shopping, paying bills, interacting with friends and family, attending medical appointments, and accessing forms of entertainment are becoming more complicated for the less digitally literate. Information and communication technologies (ICT) that enable positive and active ageing by facilitating access to information, entertainment, health and healthcare, socio-economic participation and other life activities are important to adopt. Although many older adults are frequent users of information and communication technologies, many others still lack the access they would like, and

lack the skills needed, and are at risk of being excluded from many parts of society and the economy as the pace of digital innovation and change increases (Lissitsa et al., 2022; Neves, et al., 2018). Understanding how to reduce the anxiety associated with change and ICT adoption and engagement is paramount to effective ICT engagement among older adults.

Our research has examined a several critical barriers and facilitators of older adults' ability to engage with ICT and has done so through the lens of reducing anxiety. Understanding drivers of anxiety will enable policy makers, companies, and agencies dealing with older adults to craft timely and effective strategies and programs that foster capability and engagement. The impetus to do this has only increased with the advent of the COVID-19 pandemic (Van Jaarsveld, 2020).

Anxiety

Anxiety is often relegated to an independent variable, but its importance in shaping ICT engagement and behaviour means it deserves more detailed investigation. Our analysis showed that higher levels of anxiety is influenced by attitudes held by older adults towards IT, the facilitating resources they have available to engage with ICT, and by perceived risks associated with ICT engagement. Addressing and understanding ICT-related anxiety is important because of potential implications to mental health and general wellbeing.

Attitude

Our analysis showed that having a positive attitude towards ICT was associated with a lower level of anxiety towards engaging with and using ICT. A positive attitude towards ICT is built around beliefs that using ICT is a good idea, that is it important to use today's ICT and not be left behind, and that it is enjoyable to use (Seifert & Schelling, 2018). For older adults it is important to foster a positive attitude towards engaging with ICT, especially as individuals age and retire and potentially lose their work-relate connection to ICT and impetus to remain up to date with new forms of ICT (Wang et al.,

2017). Creating a positive attitude towards ICT or changing a negative one can be done through well considered communication strategies (both messaging and media choices), other forms of interpersonal persuasion, and through engaging older consumers in experiences that illustrate the value of today's ICT (Fernández et al., 2017). From a communication perspective it is important to employ sources that are trusted by older adults and ensure the right message characteristics are used to engage and persuade those with negative attitudes (Chen et a., 2018).

PEOU/PU

Our analysis supports extant research and found that both perceived ease of use, and perceived usefulness had a significant and positive impact on attitude towards using todays ICT (Davis, 1989; Venkatesh, 2000; Guner and Acarturk, 2020) and hence a lower level of anxiety. The relationship between these variables was also significant in that perceived ease of use had a positive impact on perceived usefulness. If older adults perceive that ICT as easy to use, then it's likely they will be willing to engage with it and may be more open to using current forms of ICT. Perceived ease of use is often related to design and UX elements of ICT that account for age related issues (e.g., perceived physiological and cognitive decline) (Liu and Yu, 2017). If ICT is perceived as useful then older adults may feel they are able to extract more value from its use, be prepared to engage with it further, and find it less stressful (Pal et al., 2018).

Subjective norm

Our analysis found that subjective norms increased feelings of anxiety about using ICT. Subjective norms can essentially be considered as social norms, including the social pressure imposed by friends, family, and other important to the individual, to adopt a certain behaviour i.e., adopt ICT, increase the repertoire of ICT used, or remain current, knowledgeable, and skilful in using ICT. Whilst extant research has examined the relationships between subjective norm and its effect on ICT related behaviour (Ho et al., 2017), there is little work done on how influential others can best support and encourage older adults. Whilst support from family, friends and others is considered important in supporting ICT adoption and use, care is needed that support is implemented appropriately so that it is

not perceived negatively and subsequently increase the level of anxiety felt by older adults. For example, the children of older adults often want their parents to be able to use the internet, use a smartphone, or to be able to execute online transactions and processes, but they may not be skilled as teachers and may lack patience and sufficient technical skills to help their parents or an older adult. Their attempts and own lack of skill in helping may be perceived as pressure or coercive behaviour by their parents.

Facilitating conditions

Facilitating conditions are described as the person's beliefs about the costs, money, knowledge, and assistance and they need to access and use ICT. Our research examined two aspects of facilitating conditions related to, having help and support (friends, family, informal mentoring), and related to having resources (knowledge, skills, money) to access and use ICT. We found that lower anxiety was associated with having resources but not by having help. In line with previous research, our findings suggest that older adults are less anxious about using todays' ICT if they have the necessary knowledge, skills and money to acquire and use ICT (Guner and Acarturk, 2020; Kavandi & Jaana 2020; Macedo, 2017, Kohnke et al., 2014).

Perceived risks

Risk perceptions are beliefs about potential harm or the possibility of a loss. It is a subjective judgment that people make about the characteristics and severity of a risk (Arfi et al.,2021). Consumer research has demonstrated that perceived risk influences the adoption and use of products and service, including ICT (Mitchell, 1999; Laukkanen et al., 2007; Nunan and Domenico, 2019). Our analysis identified the relationship between perceived risk and anxiety as most significant. Our research used an expanded notion of risk (Figueiredo et al., 2020), where older consumers' willingness to engage with ICT, and to have less fear around using ICT, is related to several different types of risk. Older adults can face operational and functional risks, including challenges associated with forgetting instructions or passwords on devices and platforms, not being able to keep up with current changes to ICT, and wasting time trying to make things work as they would like. They also

face personal and social risk, including being made fun of by others, feeling incompetent, getting frustrated, and being overwhelmed. Privacy and transaction risks also exist for older adults including losing privacy, potential identity theft, and losing control over automatic payments. Similarly, with the increased pressure to use online retail and other services, there are perceived risks around making transaction mistakes, not receiving goods that have been purchased and processing errors by online stores. Increased online retail related activity may also entrail risks associated with overspending e.g., buying too much, cost of software upgrades, and increased device costs. Finally, increased engagement with ICT may bring with it perceptions of physical harm including risks of becoming addicted to devices or games and apps, increased degradation of eyesight, or acquiring other forms of repetitive strain injury.

Digital literacy

Understanding the digital literacy needs of older adults is complex. For older adults to be digitally literate it is important to look beyond just technical competence or exposure and consider a combination of cultural, cognitive, emotional, and technical resources (Schreurs et al., 2017). We used a measure that encompassed an individual's technical ability, operational skills, information navigation skills, mobile skills, social skills, and creative skills (Van Deursen et al., 2016; Van Deursen and Mossberger, 2018). Our analysis found that digital literacy significantly reduced the level of risk perceived by older adults when using or considering ICT. Digital literacy was also associated with perceived availability of resources and with perceived ease of use of ICT. Interestingly, digital literacy was shown to have a negative relationship with subjective norm. This suggests that the higher an older adult's digital literacy the less subject they might be to pressures or expectations by significant others regarding their engagement with ICT.

Research often argues that older adults are digital migrants rather than digital natives and have had to learn how to navigate digital technologies later in life (Schreurs et al., 2017; Magsamen-Conrad & Dillon, 2020; Prensky, 2001). Moreover, even those older adults who use computers at work and have prior experience with information technology (IT) often tend to halt or reduce their engagement once

they retire (Selwyn, 2004; Nimrod, 2013). Those encouraging digital literacy need to consider the motivation, opportunity, and ability of individuals to appropriately use digital tools and facilities (Mohammadyari, & Singh, 2015). Martin (2005) suggests that individuals need to be able to "identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process" (p. 135). Older adults often lack the experience because they are hesitant to try new technologies (Quan-Haase et al., 2014) and this hesitancy may manifest itself in higher levels of anxiety. Developing digital literacy in adults is significantly important but needs to be undertaken in ways that best meets their needs and learning styles.

6 Study limitations, and recommendations for further research

Our research, as with all research, has limitations. The main limitation of the current study is its cross-sectional design, which does not enable proof of a causal effect of psychological variables on actual anxiety reduction. Therefore, we suggest conducting longitudinal research examining how older adults engage with ICT, and how different communication strategies and participatory programs reduce anxiety and foster the desire for engagement with ICT. An additional limitation of the study is the quantitative nature of analysis. It would be useful to undertake qualitative and ethnographic work to reveal in-depth mechanisms associated with anxiety and how the influence of others, including family and friends, shapes anxiety. Qualitative research would also aid in understanding the ICT ecosystem of older adults and what and how ICT adds value to their lives and how the ecosystem influences anxiety associated with adoption and engagement with ICT.

In this study we used a convenience sampling, which as opposed to random sampling, does not allow generalization for the entire population. Moreover, we utilised U3A as our primary source of participants. In general participants in this type of organisation and associated courses tend to be more highly educated that the general population. It would be important to extend the research into lower

SES populations and those with a more diverse cultural and linguistic background. As with Lissitsa et al., (2022) we argue that the findings of this study are supported by the findings of previous studies but that some caution should be exercised about generalizing results. Our survey sample may not be representative due to the noted limitations.

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