



Article

Factors Influencing Seniors' Anxiety in Using ICT

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Abstract: The ability of older adults to engage with information and communication technologies (ICT) is crucial in today's more digital and connected world. Anxiety about and failure to adopt and engage with ICT is increasingly likely to be a barrier in daily living for older adults, potentially reducing their freedom as consumers, quality of life, independence, and wellbeing. It may also be a significant factor in social and economic exclusion. Drawing on consumer behaviour, ICT theories and frameworks, and a quantitative survey of 706 older Australian adults, this paper examines factors influencing anxiety in engaging with ICT. Our findings show that perceived anxiety was associated with increased subjective norms or when others placed pressure on older people to engage more with ICT and when older adults perceived increased risks associated with ICT engagement. Conversely, reduced levels of perceived anxiety were correlated with a positive attitude towards ICT and when older people had the technical and cognitive resources to adopt and engage with ICT. The results highlight the importance of building, renewing, and reinforcing digital competencies in older consumers. Understanding factors associated with ICT-related anxiety means that organisations will be better placed to develop campaigns, products, programmes, and policies for older consumers that actively reduce anxiety, increase their use of ICT, and reduce the digital divide.

Keywords: ICT; anxiety; digital inclusion; competencies; seniors; SmartPLS



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1. Introduction

Within our increasingly digitally connected and dependent society, digital inclusion remains closely linked to age, as the COVID-19 pandemic and its continuing effects have accelerated the need to adopt and use a wide range of information and communication technologies (ICT) among older adults (Chen et al. 2021). Recent work measuring Australia's digital divide has documented gains in digital ability and inclusion for those over 75 years of age; however, overall uptake is lower amongst those over 65 when compared to the wider population (Thomas et al. 2023). These findings mirror research that finds that while older adults' use of technology has increased, many remain unwillingly excluded in our increasingly digitalised society (Litchfield et al. 2021). Such work found that many older adults experience technology-related anxiety, resistance, fear, and even technophobia when using digital devices, applications, or systems (Kim et al. 2023; Meng et al. 2021).

Given these challenges, policymakers and seniors organisations have sought ways to reduce anxieties and address technophobia to enable beneficial engagement with digital society. Research has indicated the role of ICT education and programmes to improve capabilities as well as to promote life-long learning, social participation, and connection

(Vroman et al. 2015). As a number of studies have found, supporting individuals to keep up with the times and to adapt to today's digital society can lead to less time doing passive activities, and, in general, having an improved quality of life (Álvarez-Dardet et al. 2020; Broady et al. 2010; Chopik et al. 2017; González et al. 2012; Hur 2016; Macedo 2017; Selwyn et al. 2003). Nevertheless, it is important to also acknowledge the concerns and anxieties about adopting and continuing to use various types of ICT that often form as individual perceived risks and subjective judgments that can inhibit the adoption and usage of products and services (Figueiredo et al. 2021).

To ensure that all older Australians can access and use digital technologies effectively, alongside issues of access and affordability, we need to engage with these factors that inform individuals' perceptions and concerns with ICT. Considering that we need to understand how older adults experience a broad array of ICT and especially the negative psychological responses to ICT that may reduce adoption or continued use, this study seeks to realise the relationships between ICT anxiety and digital inclusion. First, we detail the factors that can inform adoption and use, towards a conceptual framework that interrogates several hypotheses. This predictive model is then investigated through a quantitative survey of older Australians, using descriptive statistics and partial least squares structural equation modelling to analyse multiple constructs and indicators. In line with prior research (e.g., Guner and Acarturk 2020; Vroman et al. 2015) we focus on the breadth of ICT engagement rather than any one specific information or communication technology.

Older Adults, ICT Use, and Anxiety

Anxiety generally refers to an emotional state or condition (state anxiety) or personality trait (trait anxiety) characterised by tension, apprehension, and worry (Thatcher and Perrewé 2002). Individuals experience anxiety when they perceive conditions in their environment, or things and systems, they interact with as threatening (Thatcher et al. 2007). From a computer or ICT perspective, researchers have argued that as opposed to trait anxiety, an enduring personality trait, computer, technology, or ICT anxiety is a form of 'state anxiety' which is amenable to change (Chua et al. 1999; Heinssen et al. 1987). However, state-based ICT anxiety and its antecedents have been under-researched, especially among older adults (Kim et al. 2023).

Anxiety about using ICT has been identified as a significant factor in digital exclusion and maintenance of the digital divide (Kim et al. 2023). Anxiety about adopting and using ICT can result in exclusion from online consumption and digital activities, including the use of new technologies, devices and platforms, use of eHealth, online financial services, and online shopping and entertainment (Di Giacomo et al. 2019; Geybels 2023; Mac Callum and Jeffrey 2014). Whilst ICT-related anxiety has been investigated as a background factor or distal factor, there is a distinct lack of understanding about what influences anxiety regarding ICT adoption and use (Kim et al. 2023; Meng et al. 2021). This paper pays particular attention to anxiety and the factors influencing (ICT) anxiety in older consumers.

Despite the potential benefits of ICT, older adults often find it difficult and stressful to realise these advantages (Álvarez-Dardet et al. 2020). Moreover, rapidly changing technology potentially excludes many seniors from engaging with ICT in ways that add value to their lives and may undermine overall societal social cohesion (Álvarez-Dardet et al. 2020; Blades-Hamilton 2015). Indeed, unprecedented rates of technological change have resulted in many seniors feeling disempowered, socially excluded, and anxious about using ICT (Hajkowicz 2015), which can be further exacerbated when they lack the capabilities to engage with ICT (Hill et al. 2015).

Several studies have shown that anxiety about ICT negatively influences seniors' adoption and future use of ICT (Guner and Acarturk 2020; Kim et al. 2021; Vroman et al. 2015). Anxiety about using ICT can result in self-imposed barriers and low levels of engagement with ICT (Marquié et al. 2002; Turner et al. 2007). It has been found, for example, that differences between older and younger users of ICT were often not associated with their actual knowledge but rather with their levels of confidence and anxiety, which in

turn resulted in older adults underestimating their knowledge and abilities (Guner and Acarturk 2020; Mitzner et al. 2010). Other research has suggested that older users have significantly higher technology-related anxiety than younger users due to the perceived cognitive and physiological declines associated with age, such as deteriorating sight, dexterity, cognitive processing, and learning challenges (Charness and Boot 2009; Czaja et al. 2006; Vaportzis et al. 2017).

While anxiety often features in research as a mediator or a predictor of ICT engagement, it has yet to be thoroughly analysed as a dependent variable or end-state. That is, what factors are associated with anxiety related to ICT adoption and continued use? A failure to understand drivers of ICT anxiety in older adults and address it through education and support programmes may result in the development of a computer phobia or technophobia and negative impacts on life satisfaction (Nimrod 2018; Kim et al. 2023).

2. Conceptual Framework

2.1. The Adoption and Use of ICT

Researchers have utilised behavioural and information systems theories to examine the acceptance and engagement with ICT, including the Technology Acceptance Model (TAM) proposed by Davis (1989), the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. (2003), and the Theory of Planned Behaviour (TPB; Ajzen 1991).

As a foundation theory, TAM in its various modified forms is used extensively in ICT-related research to assess technology acceptance by individuals (Guner and Acarturk 2020; Legris et al. 2003; Yadegari et al. 2024). Despite criticisms of TAM regarding a lack of inclusion of social, organisational, and contextual factors, considerations of long-term use and user satisfaction, and a focus on rational user behaviour (Davis et al. 2024), it remains a relevant and valid foundation for research into older consumers and their engagement with technology (Long et al. 2024; Martín-García et al. 2022). Further, the results of a recent metadata analysis reveal that research on the usage of TAM in marketing is on an upward curve (Musa et al. 2024).

TAM has its foundations in the theory of reasoned action (TRA) (Lee and Kim 2009). Generally, TAM-related models assess how attitude and behavioural intentions are influenced by perceived usefulness, perceived ease of use, and other external factors. The relationship between perceived usefulness and perceived ease of use, and the acceptance of technology, has been supported by numerous studies and has resulted in modified versions, including augmented TAM (Taylor and Todd 1995), TAM2, TAM3, and UTAUT (Venkatesh and Davis 2000; Venkatesh et al. 2003). In addition, TAM is often extended by adding other external factors theorised to impact the acceptance of technology (Cheng 2019; FakhrHosseini et al. 2024; Guner and Acarturk 2020), including social influence, facilitating conditions, self-satisfaction, self-efficacy, cost tolerance, perceived enjoyment, and experience (Abdullah and Ward 2016). This research applies an expanded TAM (see Taylor and Todd 1995) and further draws on elements of the TPB, the UTAUT, and digital competence.

2.2. Hypothesis Development

Using a multivariate approach, the present study examines the effects of digital competencies, psychological characteristics, technology use ease, and perceived risks on anxiety older adults feel when engaging with and using ICT.

Attitude refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour of interest (Ajzen 2011; Lee and Kim 2009). From an ICT perspective, Guner and Acarturk (2020) note that attitude significantly predicts the intention to adopt and use ICT in TAM and TPB studies (e.g., Kim et al. 2009). Moreover, research on technology acceptance by older adults has shown that attitudes, experiences, and self-efficacy in interacting with ICT are critical factors for ICT acceptance and adoption (Czaja et al. 2006; Schomakers et al. 2018). For example, experiences with technologies and

other individual differences can shape attitudes, such as ability and knowledge, gender, education, and social background. In this research, we propose that a positive attitude towards adopting and using ICT will result in a lower perceived anxiety of older adults towards adopting and using ICT. Thus, we hypothesise the following:

Hypothesis 1. *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 act when one or more critical referents say they should, even though they may not like or believe in it (Schepers and Wetzels 2007). This influence is called subjective norm (e.g., in TPB) and social influence (e.g., in TAM2 and TAM3). Subjective (social) norms can also reference the atmosphere of a society or the surroundings that affect an individual's decision-making process regarding social pressures or collective beliefs (Venkatesh and Bala 2008). Researchers have found that subjective norm has some influence on the ICT-related behaviour of older consumers (Han and Nam 2021; Pan and Jordan-Marsh 2010), although the evidence is mixed (Schepers and Wetzels 2007). From the perspective of anxiety, the perceived pressure from others or society to behave in a certain way, such as pressure to engage with ICT, may heighten anxiety, especially if individuals perceive that they cannot engage at a level that others expect or want them to. Thus, we hypothesise the following:

Hypothesis 2. *For older adults, subjective norm has a positive relationship with anxiety (increases) towards using ICT.*

The ability to engage with ICT and the reduction in anxiety about engaging with ICT is 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 organisational and technical infrastructure exists to support the use of ICT (Venkatesh et al. 2012). In other words, it reflects environmental barriers or the availability of resources that older adults may perceive about engaging with ICT (Macedo 2017). In earlier versions of the UTAUT model, facilitating conditions were theorised as a driver of user behaviour, meaning that the more the users perceive the availability of resources, knowledge, and support, the more likely they will 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 ICT forms (Choudrie et al. 2018). It may also involve support, assistance, and mentoring that shape engagement with ICT and reduce 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 the resources to afford and the skills to use (facilitating conditions resources) and the social support and assistance available to use ICT (facilitating conditions—use) (Guner and Acarturk 2020; Michailidou et al. 2015). Thus, we hypothesise the following:

Hypothesis 3. *For older adults, (H3a) facilitating conditions (help) for ICT and (H3b) facilitating conditions (resources) for ICT 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 judgement that people make about the characteristics and severity of a risk (Arfi et al. 2021). ICT and consumer research has demonstrated that perceived risk influences the adoption and use of products and services, including ICT (Laukkanen et al. 2007; Nunan and Di Domenico 2019). Perceived risks can manifest in many ways, including financial, performance, social, physical, psychological, and time risks (Featherman and Pavlou 2003). In this research, we utilise a reconceptualisation of these perceived risk factors

as presented by [Figueiredo et al. \(2021\)](#), incorporating the following: Perceived Operational and Functional Risks (e.g., forgetting instructions or passwords, not keeping up, wasting time), Perceived Personal and Social Risks (e.g., being made fun of, feeling incompetent, becoming frustrated, being overwhelmed), Perceived Privacy and Transaction Risks (e.g., losing privacy, identity theft, automatic payments), Perceived Purchase Transaction Risks (e.g., making transaction mistakes, not receiving goods, processing errors), Perceived Overspending Risks (e.g., buying too much online, software upgrade or device costs), and Perceived Physical Harm Risks (e.g., becoming addicted to ICT, eyesight strain, or repetitive strain injury). Thus, we hypothesise the following:

Hypothesis 4. *For older adults, higher perceived risks in using ICT have a positive relationship with anxiety (increases) towards using ICT.*

Perceived ease of use is defined as the difficulty or effort needed to use technology. At the same time, perceived usefulness is the level of belief an individual has about whether 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 and external factors like digital competencies ([Guner and Acarturk 2020](#); [Mac Callum and Jeffrey 2014](#)). The model has also been tested to show a relationship between perceived usefulness and ease of use (ease of use influencing perceived usefulness). According to TAM, perceived usefulness and ease of use also determine the acceptance of ICT. If older adults consider ICT useful and easy to use, they are more likely to hold positive attitudes towards the adoption and use of ICT and subsequently be less anxious about adoption and use. We therefore hypothesise the following:

Hypothesis 5. *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.*

Hypothesis 6. *For older adults, perceived usefulness has a positive relationship with positive attitude towards ICT.*

Digital competencies are fundamental in today's knowledge economy and information society ([van Dijk and van Deursen 2014](#)). The literature includes many terms and concepts related to digital competency, such as digital literacy, e-skills, Internet skills, ICT literacy, technological literacy, and 21st-century digital skills ([Ochoa Pacheco and Coello-Montecel 2023](#)). Digital literacy is perhaps the most frequently used alternative, which, according to [Calvani et al. \(2008\)](#), includes different types of literacy, such as visual, information, media, ICT, computer, and technology literacy. As such, digital literacy is a broader term that has evolved over time ([Reddy et al. 2020](#); [Tinmaz et al. 2022](#); [Vercruyssen et al. 2023](#)). Consequently, different approaches and definitions exist in the literature depending on the context and research field. For the purpose of this research, we employ digital competency as this term is not so much focused on the ability to use basic digital tools but is also focused on the integration of these skills into critical thinking, problem-solving, ethical considerations, and participation in society ([Ochoa Pacheco and Coello-Montecel 2023](#)).

[Ochoa Pacheco and Coello-Montecel \(2023\)](#) defined digital competencies as “the set of knowledge, abilities, skills, attitudes, and other characteristics regarding digital technologies that are fostered by an individual's personal, cognitive, social, and global competencies for communicating, collaborating, creating, and sharing content, managing and sharing information, solving problems, and adopting and spreading the digital culture, taking into account ethical and sustainable practices” (p. 3). Digital competencies facilitate constructing new knowledge, creating media expressions, and communicating with others in the context of specific life situations 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 assessed the digital competencies 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). In addition, research suggests that people with higher digital competencies have less anxiety associated with using ICT in their daily lives (Di Giacomo et al. 2019). Digital competencies and associated internet-related skills are also likely to significantly influence attitudes towards using ICT, the level of self-efficacy, 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 competencies are also associated with ICT's perceived ease of use and usefulness (De Boer et al. 2019). We hypothesise the following:

Hypothesis 7. *For older adults, a higher level of digital competencies has a positive relationship with perceived ease of use of ICT (H7a), positive attitude to ICT (H7b), subjective norms (H7c), facilitating condition for ICT (help; H7d), and facilitating condition for ICT (resources; H7e), and a negative relationship with perceived risk of ICT (H7f).*

The model employed, hypotheses, and noted interrelationships are shown in Figure 1.

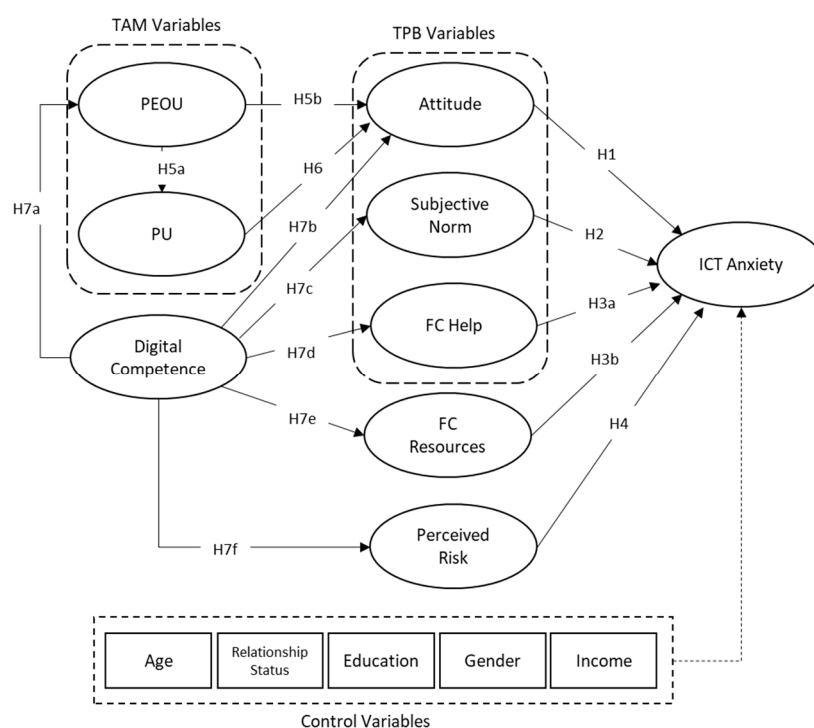


Figure 1. Research model (Note: TAM = Technology Acceptance Model; TPB = Theory of Planned Behaviour; PEOU = perceived ease of use; PU = perceived usefulness; FC = facilitating condition).

3. Materials and Methods

3.1. Participants

The data are based on survey responses from 706 older adults. Respondents completed the survey either online (86.9%) or by completing a paper version (13.1%). Table 1 shows a profile of the final sample. The largest age category of respondents was 70–74 years of age (37.8%). There were significantly more female respondents (69.2%) than male respondents (30.7%). Education varied among the respondents, with 13.4% having achieved lower than year 11 or below and 7.6% completing secondary school (year 12). A significant proportion had a graduate diploma (17.7%), with a considerable number of respondents being highly educated with a bachelor's degree (21.5%) and postgraduate qualifications (17.9%). As expected for this age group, most respondents were retired or no longer working (87.3%). The income of most respondents (53.2%) was less than AUD 51,999. However, 10.5%

had an income of over AUD 91,000 per year. Most respondents were currently in couple relationships (57.1%) compared to single (35.4%). A greater percentage of respondents lived in urban areas (67.5%) than in rural or regional locations (31.6%).

Table 1. Sample characteristics.

Characteristics		Frequency	Percentage
Sex	Female	489	69.2
	Male	217	30.7
	Other (Please specify)	1	0.1
Age	Less than 50 years	6	0.8
	50–54	1	0.1
	55–59	6	0.8
	60–64	60	8.5
	65–69	158	22.4
	70–74	267	37.8
	75–79	123	17.4
	80–85	71	10.1
	85+	13	1.8
	Prefer not to say	1	0.1
Education	Year 11 or below	95	13.4
	Year 12	54	7.6
	Certificate I/II	8	1.1
	Certificate III/IV	30	4.2
	Advanced diploma and diploma	100	14.1
	Bachelor's degree	152	21.5
	Graduate diploma/certificate	125	17.7
	Postgraduate degree	127	17.9
	Prefer not to say	15	2.1
Work status	Working full-time (ongoing)	10	1.4
	Working part-time (ongoing)	32	4.5
	Working casually (intermittent)	33	4.7
	Unemployed/seeking work	4	0.6
	Fully retired/no longer working	618	87.3
	Prefer not to say	6	0.8
Relationship status	Never partnered and living alone	24	3.4
	Widowed and living alone	119	16.8
	Divorced and living alone	91	12.9
	Married	336	47.5
	Separated and living alone	16	2.3
	De facto/partnered	68	9.6
	Other	21	3.0
	Prefer not to say	28	4.0
Personal income	Prefer not to say	151	21.3
	AUD 7800–AUD 15,599 per year	52	7.3
	AUD 15,600–AUD 20,799 per year	64	9.0
	AUD 20,800–AUD 25,999 per year	74	10.5
	AUD 26,000–AUD 33,799 per year	64	9.0
	AUD 33,800–AUD 41,599 per year	68	9.6
	AUD 41,600–AUD 51,999 per year	55	7.8
	AUD 52,000–AUD 64,999 per year	46	6.5
	AUD 65,000–AUD 77,999 per year	19	2.7
	AUD 78,000–AUD 90,999 per year	14	2.0
	AUD 91,000–AUD 103,999 per year	12	1.7
	AUD 104,000–AUD 155,999 per year	4	0.6
	AUD 156,000 or more per year	74	10.5
Location	Rural	224	31.6
	Urban	478	67.5

Regarding the breadth of ICT ownership and usage, almost all survey respondents had personal access to the internet (92.5%) and a smartphone (91.4%). A laptop followed this (71.5%), and an iPad or tablet (69.3%) was the most owned technology. Just over half owned an internet-enabled TV or a desktop computer. Wearable devices and the iPod Touch (digital music player) were less commonly owned items (24.7% and 10.7%, respectively).

3.2. Procedure

Respondents were recruited through the University of the Third Age (U3A) Network Victoria (www.u3avictoria.org.au accessed on 15 July 2024), Australia. U3A Network is the peak body for the U3A movement in Victoria. This international movement provides lifelong learning opportunities through a variety of courses and activities to retired or semi-retired people over 50. The Network represents 104 Member U3As and their 33,000 members. U3A members were contacted via email, newsletter, and nominated course enrolments to complete the survey.

Respondents 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 hence not all questions were answered. The university ethics committee approved the collection of data from human subjects.

The online version of the survey was hosted on a Qualtrics platform. Three recruitment bulletin emails were sent to the Network's 104 member U3As, and a bulk email was sent to a broader member base. In addition, notifications were placed in U3A Network Victoria publications (Network News, Facebook, Network Council papers). The survey was also promoted through the U3A Social Seniors programmes which focus on a range of social, educational, creative, and cultural activities. Ten U3As had members complete it in their ICT education classes.

Further responses were elicited through the distribution of a paper copy of the survey to various U3A venues in both urban and rural locations to capture those older adults less able or willing to complete an online version. In this way, the sample comprises those who have a range of ICT experiences and engagement.

Incomplete responses lacking completion of the demographics section were not included in the final analysis.

3.3. Survey Development

This research is part of a larger programme investigating how information and communication technology use supports and enhances older adults' connectedness, social inclusion, and participation. The survey was carefully designed to be applied to older adults, with varying ICT engagement, after a review of the literature and an initial phase of 22 exploratory interviews. These interviews were recorded, transcribed, and analysed. In addition, several video vignettes were created to help understand older consumers and their engagement with ICT. In total, thirteen interviewees were women, and eight were men—four respondents self-reported as culturally and linguistically diverse (CALD) persons. The cohort was between 59 and 85 years, with a mean age of 71.8 and a median of 71 years.

Before the survey was finalised, ten academics and PhD-qualified researchers reviewed the questionnaire to ensure 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 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 the completion of the survey. Their responses were not included in the final sample used for analysis.

Alongside the promotion of the online survey, trusted U3A representatives were asked to distribute the paper version of the survey instrument to their members, which reduced older adults' perceived 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 limit participation resistance and mitigate concerns about scams, cyberbullying, general security threats, and other risk perceptions (Aleti et al. 2019).

Following Macedo's (2017) recommendations, common method bias was addressed using the 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.

3.4. Measures

Theoretical constructs were operationalised using previously validated multi-item scales. Scales were adapted with slight modifications and rephrasing through consultation and prior qualitative research with older adults.

The -item-dependent variable measure of ICT anxiety was based on Guner and Acarturk (2020) and Venkatesh et al. (2003). Each item was measured on 7-point Likert scales ranging from strongly disagree (1) to strongly agree (7). Items measuring attitude, subjective norm, facilitating conditions, perceived ease of use, and perceived usefulness were also measured and were based on Guner and Acarturk (2020) and Venkatesh et al. (2003). Again, each item was measured on 7-point Likert scales ranging from strongly disagree (1) to strongly agree (7).

Following Ochoa Pacheco and Coello-Montecel's (2023) approach, Van Deursen et al.'s (2016) scale was used to measure digital competencies. The scale encompasses technical ability (8 items that include operational skills) and other technical and cognitive skill types that support engagement with the internet and other ICT. 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. Finally, creative skills (5 items) are 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 ranging from strongly disagree (1) to strongly agree (7). The scale is treated as a second-order factor in the analysis (Rehman et al. 2020).

Risk perceptions were 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 and adapted to the older adult context through qualitative research with older adults and subsequent quantitative analysis using exploratory and confirmatory factor analysis (Figueiredo et al. 2021). 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 ranging from strongly disagree (1) to strongly agree (7). The scale is treated as a second-order factor in the analysis (Rehman et al. 2020).

4. Analysis and Results

Descriptive and crosstab statistics examining the respondents and their anxiety levels (Table 2) were calculated using IBM SPSS Statistics (Version 28). Partial least squares structural equation modelling (PLS-SEM) was undertaken using SmartPLS (Version 3.3.3) (Ringle et al. 2015). PLS-SEM is a distribution-free method of determining the predictive

power of complex models (Hair et al. 2019). Therefore, PLS-SEM was appropriate for analysing a predictive model that utilised multiple constructs and indicators. Furthermore, PLS-SEM was also deemed suitable, given the relatively small sample size ($N = 706$).

Table 2. ICT Anxiety Characteristics.

Characteristic	Not Anxious	Somewhat Anxious	Quite Anxious	Chi-Square Significance
Age				
younger	51.9%	28.1%	19.9%	$\chi^2 = 1.74$ (2df), $p = 0.42$
older	46.7%	31.8%	21.5%	
Sex				
Female	44.5%	32.6%	22.9%	$\chi^2 = 11.50$ (4df), $p = 0.021$
Male	56.9%	25.5%	17.6%	
Income level				
lower AUD				$\chi^2 = 6.46$ (2df), $p = 0.040$
0–AUD 51,999	47.6%	27.8%	24.6%	
higher AUD 62k+	52.1%	32.9%	15.0%	
Education level				
No Degree	38.9%	36.5%	24.6%	$\chi^2 = 19.11$ (2df), $p < 0.001$
Degree or higher	55.9%	25.9%	18.2%	
Employed				
Retired	47.5	31.3	21.2	$\chi^2 = 0.918$ (2df) $p = 0.63$
Employed	53.3	28.0	18.7	
Location				
Rural	49.5%	32.0%	18.5%	$\chi^2 = 1.23$ (2df), $p = 0.54$
Urban	47.8%	30.1%	22.1%	
Relationships status				
Single	35.2%	38.6%	43.8%	$\chi^2 = 2.96$ (2df), $p = 0.23$
Coupled	51.1%	30.8%	18.1%	
Devices owned and used				
1–3	24.8%	33.3%	41.8%	$\chi^2 = 88.49$ (4df), $p < 0.001$
4–6	50.6%	31.4%	18.0%	
7–9	81.6%	18.4%	0.0%	

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

4.1. ICT Anxiety Characteristics

To understand the nature of ICT anxiety in the sample, respondents were divided into three groups based a simple k-means cluster analysis using the 4 item ICT anxiety measure (Guner and Acarturk 2020; Venkatesh et al. 2003). Overall, 339 (47.9%) of participants were classified as not anxious about ICT, 214 (30.2%) were classified as somewhat anxious, and 149 (21%) were classified as quite anxious). To further understand whether ICT anxiety was related to socio-demographics characteristics a crosstab analysis was run for age, gender, income, education, location, employment status, and relationship status. Further crosstab analysis was undertaken for the relationship between ICT anxiety groups and ownership and use of ICT devices. Results and Pearson chi-square significance levels are shown in Table 2.

No significant differences were seen between the ICT anxiety groups based on the age of respondents, whether they were working or not working and retired, whether they lived in a rural or urban location, or whether they were single or in a coupled relationship. Differences were identified between ICT anxiety groups on the sex of participants, with

females expressing greater ICT anxiety than males. Those on lower incomes expressed greater ICT anxiety than those on higher incomes, and similarly those with education below the bachelor's degree level also indicated having higher levels of ICT anxiety.

Data were also collected on the number of ICT-related devices owned and used. Analysis showed that higher levels of ownership and use was related to lower levels of ICT anxiety. Whilst these findings do not suggest any causal relationships between socio-demographic characteristics, device ownership and usage, and ICT anxiety, they do provide some initial insights for issues related to policy design and for the design of courses or tools that endeavour to reduce ICT anxiety and promote engagement with ICT devices and applications.

4.2. 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 Composite Reliability (CR) values above 0.95, suggesting some potential item redundancy (Hair et al. 2019) for measures of perceived ease of use (CA = 0.96, CR = 0.97), perceived usefulness (CA = 0.95, CR = 0.97), 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 the evaluation of Average Variance Extracted (AVE), which was above 0.5 (whereby 50% or more of the variance is explained). In addition, all the composite reliability scores were above 0.7 (Hair et al. 2019).

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	0.95	0.86	0.69
ATT	Attitude Toward Using ICT	0.85	0.87	0.64	0.60
DC	Digital Competencies	0.87	0.88	0.67	---
FCH	Facilitating Conditions Help	0.71	0.93	0.59	0.01
FCR	Facilitating Condition Resources	0.86	0.92	0.71	0.57
PEOU	Perceived Ease of Use of ICT	0.96	0.96	0.89	0.59
PU	Perceived Usefulness of ICT	0.95	0.95	0.87	0.31
PR	Perceived Risk	0.90	0.93	0.68	0.45
SUBN	Subjective Norm to use ICT	0.85	0.76	0.64	0.03
ANX	Anxiety in Using ICT	0.94	0.95	0.86	0.69

The next phase in determining the validity and reliability of the constructs is to assess discriminant validity. Discriminant validity measures indicate the extent to which each construct differs from the others. Two approaches were used to assess discriminant validity—the 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. 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.

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 ratio (FCR and PEOU = 0.85), all inter-variable assessments were adequate (Table 5). Four ratios were above 0.80 but not greater than 0.85. Overall, the scales and subscales used in the model demonstrated sufficient internal consistency and discriminant validity.

Table 4. Discriminant validity—Fornell–Larcker criterion.

	ANX	ATT	DC	FCH	FCR	INC	PEOU	PU	REL	PR	SUBN	Age	EDU
ANX	0.93												
ATT	−0.63	0.80											
DC	−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				
PR	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; DC = digital competencies; FCH = facilitating condition help; FCR = facilitating condition resources; INC = income; PEOU = perceived ease of use; PU = perceived usefulness; REL = relationship status; PR = perceived 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.

Table 5. Heterotrait–monotrait ratio (HTMT).

	ANX	ATT	DC	FCH	FCR	INC	PEOU	PU	REL	PR	SUBN	Age	EDU
ANX													
ATT	0.70												
DC	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					
PR	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; DC = digital competencies; FCH = facilitating condition—help; FCR = facilitating condition—resources; INC = income; PEOU = perceived ease of use; PU = perceived usefulness; REL = relationship status; PR = perceived risk; SUBN = subjective norm; EDU = education level.

4.3. The Structural Model

Table 6 details the path coefficients' significance and shows that 11 of the 14 hypotheses were supported. Concerning 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 the anxiety felt by older adults. Further, subjective norms significantly influenced increased ICT-related anxiety felt by older (H2). Furthermore, perceived risks (H4) associated with engaging with ICT were associated with higher anxiety scores. Finally, contrary to what was hypothesised, facilitating conditions (help) (H3a) was not a significant driver (either positive or negative) of ICT anxiety.

For the TAM-related variables, the relationship between perceived ease of use/usefulness was significant in that perceived ease of use positively impacted usefulness (H5a). In addition, perceived usefulness (H5b) and perceived ease of use (H6) had a significant positive impact on attitude.

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

Hypothesis	Relationships	Beta	t-Value	p-Value
H1	Attitude>Anxiety	−0.165	5.657	<0.001
H2	Subjective norm > Anxiety	0.102	4.743	<0.001
H3a	Facilitating conditions (help) > Anxiety	0.013	0.480	0.632
H3b	Facilitating conditions (resources)>Anxiety	−0.280	8.065	<0.001
H4	Perceived Risk>Anxiety	0.480	16.716	<0.001
H5a	Perceived ease of use>Perceived usefulness	0.419	7.667	<0.001
H5b	Perceived usefulness>Attitude	0.448	12.390	<0.001
H6	Perceived ease of use>Attitude	0.360	8.825	<0.001
H7a	Digital competencies>PEOU	0.764	40.604	<0.001
H7b	Digital competencies>Attitude	0.088	2.087	0.037
H7c	Digital competencies>Subjective norm	−0.167	5.405	<0.001
H7d	Digital competencies > Facilitating conditions (help)	−0.044	0.911	0.362
H7e	Digital competencies>Facilitating conditions (resources)	0.755	41.671	<0.001
H7f	Digital competencies>Perceived Risk	−0.674	32.733	<0.001

Note. Hypothesis numbers in bold are supported.

Our analysis showed that digital competencies are a significant driver of perceived ease of use of ICT (H7a), facilitating conditions (resources) (H7e), and attitude toward ICT use (H7a). It was not associated with facilitating conditions (help) (H7d). Digital competencies significantly influence the perceived risk of engaging with ICT (H7f). The higher the level of digital competencies, the less likely older adults were to perceive ICT use as risky. This is important, as the model demonstrates that high perceived risk scores significantly increase ICT anxiety scores. People who perceive the use of ICT as fraught with risks, 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 competencies do not directly affect the attitude toward ICT, the impact of digital competencies on attitude is indirect through perceived use and perceived ease of use.

Interestingly, digital competencies were shown to have a negative impact on subjective norms (H7c). This suggests that the higher an older adult's digital competencies, 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 associated with higher ICT-related anxiety levels. In the overall PLS analysis, the control variables, age, relationship status, education, gender, and income were not significantly associated with ICT anxiety (Table 7) and ICT anxiety is mostly explained by other TAM, TPB, and digital competence variables included in the study.

Table 7. Control variables.

	Beta	t-Value	p Values
Age -> Anxiety	−0.039	0.870	0.384
Education -> Anxiety	0.008	0.167	0.867
Gender -> Anxiety	−0.014	0.634	0.526
Income -> Anxiety	0.017	0.342	0.732
Relationship status -> Anxiety	0.050	1.013	0.311

Overall, the analysis revealed the significant impact of digital competencies on perceived ease of use (H7a) and indirectly on perceived usefulness and a positive ICT attitude (H5–6). In addition, digital competencies were a significant influencer of perceived risk (H7f), which has the most significant influence on reducing ICT anxiety.

For older adults, it appears that improving digital competencies holds the key to reducing ICT anxiety. A higher level of digital competencies reduces perceptions of ICT risk and 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 (H7d).

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 competent. ICT that enables positive and active ageing by facilitating access to information, entertainment, health and healthcare, socio-economic participation, and other life activities is essential to adopt. Understanding how to reduce the anxiety associated with change and ICT adoption and on-going engagement is paramount.

Although many older adults are frequent users of information and communication technologies, many 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). Our research has examined several critical barriers and enablers of older adults' ability to engage with ICT and has done so through the lens of reducing anxiety. Understanding drivers of anxiety will enable policymakers, companies, and agencies dealing with older adults to craft timely and effective strategies and programmes that foster capability and engagement. The impetus to do this has only increased with the advent of COVID-19 (Martins Van Jaarsveld 2020).

5.1. Anxiety

Often relegated to an independent variable and predictor of ICT engagement, we explored the implications of anxiety as an end-state to realise the implications of individual attitudes on technology adoption and long-term phobia. Our analysis showed that higher anxiety levels are influenced by attitudes older adults hold towards ICT, facilitating the resources they have available to engage with ICT, and perceived risks associated with ICT engagement. This supports other claims that rather than actual knowledge, levels of confidence and individual attitudes over time to ICT can reduce self-imposed barriers to engagement (Mitzner et al. 2019). Addressing and understanding ICT-related anxiety is essential, as our findings support previous claims that the rapid development of technologies can exclude these seniors (Álvarez-Dardet et al. 2020). Failure to engage with such barriers may see anxieties develop or mutate into phobias such as technophobia or cyberphobia (Khasawneh 2018). Through the lens of healthy ageing, the ability to reduce or mitigate such mutations is critical to reducing the potential anxiety and depression that such long-term phobia poses (Hofer and Hargittai 2024). Further, the mainstream uptake of mobile health solutions provides further barriers to those with higher ICT anxiety, such as individuals who struggle to assess the benefits of such systems and rely on affective factors to justify uptake (Meng et al. 2020). If older adults develop phobias of ICT, the strategies, programmes, and initiatives designed to engage older consumers with ICT are likely to be less effective and will require the more significant application of counselling and psychological services, not just the development of additional technical skills and competencies.

Whilst demographic influences were not seen in the overall structural analysis, our crosstab analysis of anxiety groups revealed that women experience greater ICT anxiety than men, highlighting the necessity of incorporating gender considerations into strategies aimed at mitigating ICT anxiety and fostering broader technological engagement. This gender difference suggests that policy design and educational interventions could profit from adopting gender-sensitive approaches such as the development of targeted programmes to enhance digital competency, support ICT engagement across range of devices and applications, and reduce anxiety among women, particularly those with lower incomes and education levels. Such tailored or nuanced interventions are crucial for ensuring that strategies effectively address the unique challenges faced by different demographic groups in engaging with ICT.

5.2. 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 it is important to use today's ICT and not be left behind, and that it is enjoyable to use (Seifert and Schelling 2018). For older adults, it is vital to foster a positive attitude towards engaging with ICT, especially as individuals age and retire and potentially lose their work-related connection to ICT and the impetus to remain up to date with new ICT forms (Wang et al. 2017). Creating a positive attitude towards ICT or changing a negative one can be conducted through well-considered communication strategies (both messaging and media choices), other forms of interpersonal persuasion, and engaging older consumers in experiences that illustrate the value of today's ICT (Fernández et al. 2017). From a communication perspective, it is crucial to employ sources that older adults trust. It is also essential to ensure the right message characteristics are used to engage and persuade those with negative attitudes (Chen et al. 2018).

5.3. Perceived Ease of Use and Perceived Usefulness

In line with other research, our analysis found that perceived ease of use and usefulness had a significant and positive impact on attitude towards using today's ICT (Davis 1989; Guner and Acarturk 2020; Venkatesh and Davis 2000) and hence a lower level of anxiety. The relationship between these variables was also significant in that the perceived ease of use positively impacted perceived usefulness. If older adults perceive ICT as easy to use, they will likely be willing to engage with it and be more open to using current forms of ICT. Perceived ease of use is often related to the design and use 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, older adults may feel that they can extract more value from its use, be prepared to engage with it further, and find it less stressful (Pal et al. 2018).

5.4. Subjective Norm

Our analysis found that subjective norms increased feelings of anxiety about using ICT. Subjective norms can be considered social norms, including the pressure imposed by friends, family, and others important to the individual to adopt a particular behaviour. These behaviours could be the adoption of ICT, an increase in the repertoire of ICT used, or remaining current, knowledgeable, and skilful in using ICT. Whilst research has looked at relationships between subjective norms and their effect on ICT-related behaviour (Ho et al. 2017), there is little work carried out on how significant others can best support and encourage older adults. Support from family, friends, and others is considered necessary in supporting ICT adoption and use in older adults (Neves et al. 2013). However, care is needed to ensure that support is implemented appropriately so that it is not perceived negatively and subsequently increases 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. Still, they may not be skilled as teachers and may lack patience and sufficient technical skills to help their parents or other older adults (Perez et al. 2019). Their attempts and lack of supporting skills may be perceived as pressure or coercive behaviour by their parents, which results in increased anxiety.

5.5. Facilitating Conditions

Facilitating conditions are people's beliefs about the costs, money, knowledge, and assistance they need to access and use ICT. Our research examined two aspects of facilitating conditions: having help and support (friends, family, informal mentoring) and having resources (knowledge, skills, money) to access and use ICT. We found that lower anxiety was associated with resources but not with help and support. In line with previous research, our findings suggest that older adults are less anxious about using today's ICT if they have the necessary knowledge, skills, and money to acquire and use ICT (Guner and Acarturk

2020; Kavandi and Jaana 2020; Kohnke et al. 2014; Macedo 2017). In this sense, having the internal agency to act helps reduce anxiety, while the presence of external socialisation agents does not. This may be related to the fact that significant others pressure older adults to act (through subjective norms), increasing their anxiety.

5.6. Perceived Risks

Risk perceptions are beliefs about potential harm or the possibility of a loss. It is a subjective judgement 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 services, including ICT (Laukkanen et al. 2007; Mitchell 1999; Nunan and Di Domenico 2019). Our analysis identified the relationship between perceived risk and anxiety as the most significant. Our research uses an expanded notion of perceived risk (Figueiredo et al. 2021), where older consumers' willingness to engage with ICT and to have less fear around using ICT is related to several different types of perceived risk. Older adults can face operational and functional risks, including challenges associated with forgetting instructions or passwords on devices and platforms, being unable to keep up with current changes to ICT, and wasting time trying to make things work as they would like.

They also face perceived personal and social risks, including being made fun of by others and feeling incompetent, frustrated, and overwhelmed. Privacy and transaction risk perceptions 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 entail risk perceptions associated with overspending (e.g., buying too much, 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.

5.7. Digital Competencies

Understanding the digital competencies needs of older adults is a complex challenge. Our study went beyond basic digital literacy, looking at skills like technical ability, operational skills, information navigation, mobile skills, social skills, and creative skills (Van Deursen et al. 2016; Van Deursen and Mossberger 2018). We found that higher digital competencies significantly reduced the perceived risk of using or considering ICT among older adults. In other words, as older adults become more digitally skilled, their confidence in engaging with technology increases, leading to a lower sense of risk. Digital competencies also related closely to the perceived ease of use and availability of resources for ICT. Those with stronger digital skills felt more equipped to use technology, boosting their confidence and positivity towards ICT. Interestingly, our findings showed that higher digital competencies can reduce the impact of social pressure—meaning that skilled older adults feel more independent in their technology use decisions, rather than being influenced by others.

Older adults, often considered digital migrants, typically learn these skills later in life, which can make the process more challenging (Magsamen-Conrad and Dillon 2020; Prensky 2001; Schreurs et al. 2017). Even those with previous IT experience may reduce their technology use after retirement (Nimrod 2013; Selwyn 2004). Developing digital competencies in this group involves more than just teaching technical skills; it requires addressing their motivations, opportunities, and abilities to use digital tools effectively (Mohammadyari and Singh 2015).

Martin (2005, p. 135) 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, to enable constructive social action; and to reflect upon this process”. However,

many older adults hesitate to adopt new technologies, which can lead to higher levels of anxiety ([Quan-Haase et al. 2014](#)). This highlights the need for teaching approaches that match their learning styles and address their specific needs. Our study suggests that improving digital competencies can help reduce ICT anxiety, but we also recognize that older adults are a diverse group with varying needs.

While our research focused on general patterns, future studies should explore different groups within the older adult population to better understand how various individuals develop and use digital competencies. This deeper understanding could lead to more tailored strategies for reducing ICT anxiety and promoting digital inclusion among older adults.

6. Study Limitations and Recommendations for Further Research

Our research has five key limitations. The main limitation 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 programmes may reduce anxiety and foster a desire for engagement with ICT. Focusing on the variables investigated in this study, further research should seek to design training in digital competencies for older adults and directly measure the impact of training on anxiety reduction over time.

A second limitation of this study is the potential bias in the selection of control variables, which may impact the generalizability of the findings. Specifically, the participants' physical and digital health were not accounted for, raising the possibility that differences in physical health could have influenced the study's outcomes ([Arias López et al. 2023](#)). Future research should aim to mitigate this limitation by incorporating comprehensive health assessments as control variables. This would allow for a more nuanced understanding of how physical health and digital interacts with the variables under study ([Shi et al. 2023](#)), ultimately enhancing the robustness and applicability of the findings.

A third limitation is the focus on ICT use in general, rather than through the lens of specific devices. While this broader approach allows us to identify potential factors and relationships, it limits the depth of analysis at the specific device level. Future studies could benefit from a more targeted examination of individual ICT devices to provide more detailed insights.

A fourth limitation of the study is the quantitative nature of the analysis. For older adults to be digitally literate, it is crucial to look beyond technical competence or exposure and consider a combination of cultural, cognitive, and emotional resources as well ([Schreurs et al. 2017](#)). 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. This would be particularly useful to examine further how subjective norms are seen as points of pressure that increase anxiety. Qualitative research would also aid in understanding the ICT ecosystem of older adults, in what way and how ICT adds value to their lives, and how it influences anxiety associated with adoption and engagement with ICT.

Finally, we used convenience sampling, which as opposed to random sampling, does not allow generalisation to the entire population. Moreover, we utilised U3A as our primary source of participants. Participants in this type of organisation and associated courses tend to be more highly educated than the general population, although our sample would suggest we were able to capture a broad socio-demographic profile. Extending the research into lower SES populations and those with a more diverse cultural and linguistic background would be important. There is a potential lack of diversity in the sample. Specifically, the sample comprised U3A members, who are typically older adults actively seeking to improve their knowledge, skills, and quality of life. This characteristic may make them more receptive to ICT, potentially skewing the results. As with [Lissitsa et al. \(2022\)](#), we argue that the findings of previous studies support the findings of this study but that some caution should be exercised about generalising results. Our survey sample

may not be representative due to the noted limitations. Future research could address this limitation by recruiting participants from a broader range of institutions or organisations to ensure a more diverse and representative sample.

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