Social Ageing: Evaluating the Use of Digital Technologies to Engage the Elderly Socially

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1. Abstract

Singapore launched the Smart Nation initiative in 2014 as a national effort to create a state where people live lives that are enabled by technology. Many agencies have reached out to the elderly to help them pick up digital skills and integrate the use of technology confidently in their daily lives. In all these long-term initiatives, there is a belief that the benefits of digital technology can contribute to the well-being of the elderly. By surveying 30 elderly users, this study draws on the Almere model to examine the elderlies' perceptions and usages of mobile phone applications to discuss the extent to which social psychological factors and sociodemographic factors influence their usage behaviour. Through Ordinary Least Square (OLS) regressions and mediation analyses, it shows that usage is associated with perceived usefulness and anxiety. It also finds significant group differences between different age groups of elderly users and the number of generations living in household. We conclude the study by discussing the results in the context of Singapore and recommend ways to promote usage among elderly users.

2. Introduction

Singapore's population aged over 65 is expected to grow from 14.4% of total population in 2019 to 27% in 2030 (IndexMundi, 2018; Shiao, 2018). With the elderly comprising of one-third of the population, there is a need to consider their requirements in crafting national policy. In a bid to encourage the integration of digital technologies in our daily lives, the Singapore government launched the Smart Nation initiative, with a marked effort towards including the elderly in this national movement. However, we believe that the elderly population in Singapore continue to have little motivation or reason to adopt digital technologies. As the nation shifts toward a digital ecosystem, the elderly who refuse to adopt digital technologies may suffer from dissonance with society. To address this concern, the study aims to describe the factors affecting use of digital technologies among the elderly.

3. Literature Review

Studies have found that the use of digital technologies can lead to positive impacts on the social connectedness and psychological well-being among the elderly (Neves et al., 2017; Chen & Schulz, 2016; Fang et al., 2018), explained by the availability of digital tools for them to maintain interpersonal relationships (Chopik, 2016; Francis, Rikard, Cotten, & Kadylak, 2019). Phone applications are one of the most pervasive forms of digital technology, providing a wide range of services ranging from financial services to food delivery. In the US, 74% of those aged above 65 years use mobile phones, while the UK reports a figure of 72% (Smith, 2014; Ofcom, 2018). In view of this, our study focuses on phone applications to shed light on the factors affecting their use among the elderly.

The Almere Model developed by Heerink et al. (2010) was formulated to assess the acceptance and use of assistive social agent technology among the elderly. As both assistive

social agent technology and phone applications share the purpose of engaging the elderly using technology and therefore have overlapping functions of improving the social welfare of the elderly, we assessed that the variables could be adopted to study phone application use among the elderly. Even so, key differences include target geography and nature of the technology. We will test the feasibility of the model in the context of elderly use of phone applications in Singapore. Other technology acceptance models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) were considered less relevant to our study due to their organisational context. The aspects of the models are outlined in Appendix A. The Almere model also consists of constructs from both TAM and UTAUT and can be used to explain the variance of elderly use and acceptance of technology (Heerink et al., 2010). As such, we formulate our first hypothesis: elderly citizens who think mobile phone applications are useful, easy-to-use, gives them social influence, trust phone applications and have a good attitude towards phone applications (factors in the Almere) are more likely to use phone applications (H_1).

Studies have also shown that the older generation are more digitally aware compared to a decade ago. This is encouraged by community and national initiatives, together with the elderly's desire to remain connected with their family (Sayago, Sloan, & Blat, 2011; Hanson, 2009; Encuentra, Pousada, & Gómez-Zúñiga, 2009; Klimova & Maresova, 2016). Research conducted by Kubiatko (2013) found that ICT use differed among age groups due to different preferences. Older generations tend to prefer basic applications over applications with higher functionality favoured by younger generations such as WhatsApp. Research by Neves, Amaro, & Fonseca (2013) on the elderly in Portugal indicated that elderly use of phone applications was primarily

limited to basic functions such as making and receiving calls, despite 77% of their sample possessing a mobile phone.

Other studies have shown that mobile applications have the potential to improve elderly quality of life by enabling contact with family and friends, maintaining emotional well-being, preserving individual autonomy, and providing empowerment for social participation (Plaza et al., 2011; Brown, Bowling, & Flynn, 2004). This contributes to preventing social isolation among the elderly as they become less active at advanced ages (Neves et al., 2017). Studies found that the elderly will be more likely to use phone applications when it enables communication with family and friends, as they adopt smartphones in order to contact their family and friends (González, Paz Ramírez, & Viadel, 2012; Ivan & Fernández-Ardèvol, 2017, Neves, Amaro, & Fonseca, 2013). This is evident in Singapore, where smartphone users are most active on social media and communication phone applications such as WhatsApp, Youtube and Facebook (Singapore Business Review, 2018). Residing with family might therefore serve to encourage use of phone applications due to the presence of positive influences. The contrast can be seen from the reduced likelihood of technology adoption amongst elderly living alone (Vromana et al., 2014). We thus formulate hypothesis 2: elderly who do not live with younger generations will tend to use phone applications less frequently than younger elderly who live with younger generations (H_2).

Phone applications are a form of Information and Communication Technology (ICT). Research by Aesaert & Braak (2015) on primary school students suggests that higher Socio-Economic Status (SES) has a moderate positive effect on ICT competency. A separate study also suggests that SES might have an effect on the use of phone applications among the elderly, as elderly with higher education levels, wealth, or living with a partner had greater tendencies to

use ICT in their daily lives (Delello et al., 2017). The integration of ICT into their daily lives enabled them to become more independent, both physically and emotionally (Stark-Wroblewski, Edelbaum, & Ryan, 2007; Berkowsky, Cotten, Yost, & Winstead, 2013). This led us to formulate hypothesis 3: elderly who receive higher education and have a higher household income per capita will tend to use phone applications more than elderly who receive lower to no formal education and have lower household income per capita (H_3).

Numerous studies have shown that experiencing anxiety during ICT use can have significant future implications on further use of ICT (Beckers, Wicherts, & Schmidt, 2007; Parayitam, Desai, Desai, & Eason, 2010; Saadé & Kira, 2007; Smith & Caputi, 2007). They found that experiencing anxiety during ICT usage resulted in a distinct reduction of use in future contexts. This highlights the impact of anxiety on ICT use among the elderly, who are likely to be more prone to making mistakes and experiencing distress when using ICT. Issues that the elderly face when using phone applications revolve around fear of user error (Kurniawan, 2007; Al-Razgan, Al-Khalifa, Al-Shahrani, Al-Ajmi, 2012). A majority of phone applications are primarily in English. Some studies suggest that this creates a barrier to usage for elderly who are not fluent in English (Champanis & Rivett, 2012; Pieri & Diamantinir, 2010). Therefore, non-fluency in English might cause some elderly to be more apprehensive towards usage of phone applications, which could increase their anxiety. This is particularly relevant in Singapore's multiracial society, especially among the elderly. Callum, Jeffery, & Kinshuk (2014) defines such attitudes as computer anxiety: the belief that using computers create negative outcomes. This concept can be extended to phone applications as phone anxiety (Vaportzis, Clausen, & Gow, 2017). Based on the Almere Model, trust is a primary factor in predicting use. When taken in the context of trusting phone applications with sensitive information, we believe that the

mistrust stems from phone anxiety. As such, we formulate hypothesis 4: anxiety is a mediating variable between trust and use (H_4).

4. Methodology

4.1 Data

We utilised a combination of interviews and semi-structured surveys for our data collection. These two methods incorporated qualitative and quantitative aspects for this study. The survey was semi-structured, consisting of close-ended MCQs followed by some open-ended questions. The use of close-ended questions aids the collection of quantitative data while open-ended questions aid the collection of qualitative data. Sampling was conducted via convenience sampling and snowball sampling, with the study inclusion criteria in Appendix B. The online survey was administered to the respondents via a face-to-face session with two researchers present, one to assist the elderly with the survey and the other to observe the behavioral aspects of the elderly. Participants also completed a consent form prior to the survey. A final sample of 30 respondents was collected for the study.

4.2 Variables

Demographics and socio-economic variables include gender, race, first language, age, living arrangements, average household income, and highest education level. All demographics and socio-economic variables are categorical except for age and living arrangements, which were further processed to be categorised into age groups and number of generations in household, which were then dummy-coded to be used as inputs for regression analyses. On top of the demographics and socio-economic variables, we included psychological factors taken from the Almere model such as the attitude towards technology, perceived ease of use, trust, social

influence, and perceived usefulness. We then included anxiety, a non-primary predictor in Almere's model. Survey questions consisted of different categories of mobile applications: social media, consumption, government services, entertainment and games, news and information, health, and financial services; and purpose of usage: communication with family and friends, joining social activities, and engaging in news forum discussions.

The psychological factors are constructed by taking the mean score of responses on a Likert scale from selected questions after reliability tests and factor analyses to ensure internal consistencies and sufficient representation of variances. Attitude Towards Technology (Cronbach's Alpha 0.798) relates to positive impacts of phone applications on respondents and on people's lives in general. Perceived Ease-of-Use (Cronbach's Alpha 0.863) relates to the learnability of phone applications in the context of social media/communication, health-related, finance-related, and news and information exchange. Trust (Cronbach's Alpha 0.703) relates to the willingness to disclose personal and financial information on mobile applications and the trust in the level of security and protection for user data by mobile applications. Social Influence (Cronbach's Alpha 0.772) relates to whether respondents feels that others will have a good impression on them if they use phone applications, and if respondents will feel left out by not using phone applications. Perceived Usefulness (Cronbach's Alpha 0.885) relates to better communication, access, convenience, and productivity with the usage of mobile applications. Anxiety (Cronbach's Alpha 0.769) relates to the fear of making mistakes, comfortability and nervousness of using phone applications, and whether respondents find phone applications intimidating in general.

4.3 Statistical Analyses

Our primary form of analysis was done through ordinary least squares (OLS) regression, where the frequency of usage of mobile applications was set as the dependent variable. For the independent variables, we first tested the psychological primary predictors of the Almere model in our context, before adding a non-primary predictor, demographics, and socio-economic variables. Usefulness of independent variables are interpreted from the significance of the coefficients, representing the p-values after adjusting for the standard errors of each coefficient. The metric used to assess performance of models is the adjusted R^2, which favours models with less independent variables unless all are significantly useful. Through the process of adding and removing variables upon evaluation of significance, we observed mediating effects between variables, and investigated the possibility of mediation effects specific to our context.

5. Findings

5.1 Descriptive Statistics

Table 1
Descriptive statistics (n=30).

Variable	Range	Mean/ prop	SD
Demographic characteristics			
Male		0.47	
Age	64-84	71.07	4.67
Household Generations			
1 Generation		0.30	
2 Generations		0.23	
3 Generations		0.47	
Socio-economic Characteristics			
Education			
No Formal Education		0.30	
Primary School		0.30	
Secondary School		0.13	
Pre-tertiary (Polytechnic, Junior College, ITE)		0.10	
Tertiary (University)		0.17	

Household Income Per Capita			
Under $3,000		0.33	
Between $3,000-$5,000		0.37	
Over $5,000		0.30	
Psychological Factors			
Attitude Towards Technology	2-5	3.90	0.65
Perceived Ease of Use	1-5	2.74	1.02
Trust	1-4	2.74	0.76
Social Influence	1-4	1.60	0.91
Perceived Usefulness	1-4.5	3.01	1.09
Anxiety	2-5	3.47	0.83
Use Index	15-51	26.33	10.56

Note: SD = standard deviation (not shown for categorical variables).

Descriptive statistics for the analytic sample are shown in Table 3. In brief, 30% of the sample live in single generation households, 30% received no formal education, and 33% have a household income per capita under $3,000. Approximately half of the respondents were male (0.47). On average, elderly scored higher on attitude towards technology (3.9), anxiety (3.47) and perceived usefulness (3.01) and lower on social influence (1.6) and perceived ease of use (2.74). The use index has a low mean (26.33).

Table 2

Linear regression for use index of phone applications.

	Model 1	Model 2	Model 3	Model 4
	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Psychological Factors				
Attitude Towards Technology	-0.62 (2.83)	-1.87 (2.72)		
Perceived Ease of Use	1.77 (1.85)	1.14 (1.76)		
Trust	5.33 (2.68)$^{+}$	3.17 (2.72)		
Social Influence	-3.12 (1.69)$^{+}$	-1.45 (1.78)		

Perceived Usefulness	3.30 (1.70)$^{+}$	3.00 (1.60)$^{+}$	2.36 (1.12)*	1.86 (1.31)
Anxiety		-4.99 (2.42)$^{+}$	-6.16 (1.38)***	-6.50 (1.65)**
Demographic Variables				
Age group (Ref. 65-70 years old)				
Between 71-75 years old inclusive			-3.38 (2.58)	-4.04 (2.86)
Over 75 years old			-10.83 (3.20)**	-10.41 (3.63)*
Types of Household (Ref. Two-generation household)				
Single-generation Household			7.03 (2.88)*	6.35 (3.34)$^{+}$
Three-generation Household			-0.57 (2.81)	-1.62 (3.05)
Socio-economic Variables				
Education (Ref. No Formal Education)				
Basic Education (Primary & Secondary School)				-0.72 (3.23)
Higher Education (Polytechnic, JC, ITE & University)				1.01 (3.60)
Household Income Per Capita (Ref. Between $3,000-$5,000)				
Under $3,000				-2.21 (2.82)
Over $5,000				-3.76 (3.18)
(Constant)	4.77 (9.98)	32.65 (16.49)$^{+}$	41.69 (7.24)***	43.12 (8.27)***
Adjusted R^2	0.43	0.49	0.72	0.69
Observations	30	30	30	30

+: $p < 0.1$. *: $p < 0.05$. **: $p < 0.01$. ***: $p < 0.001$.

Linear regression findings are displayed in Table 4, when the use index of phone applications is regressed against the independent variables of each model. Model 1 shows the coefficients of direct psychological factors affecting intention to use as discussed in Almere's model by Heerink et al (2010). Attitude towards technology and perceived ease-of-use are found to have no significance in predicting usage, while trust, social influence, and perceived usefulness are all slightly significant. Elderly who have 1 score higher on their trust index, social influence index, and perceived usefulness index would score 5.33 higher (coefficient = 5.33, p <

0.1), 3.12 lower (coefficient = -3.12, $p < 0.1$), and 3.30 higher (coefficient = 3.30, $p < 0.1$) in the use index respectively. The results do not support H_1 as not all independent variables influencing use in Almere's model are significant when applied to phone applications.

Model 2 incorporates all factors from model 1, with the addition of anxiety as an independent variable. In model 2, attitude towards technology, perceived ease-of-use, trust and social influence are found to have no significance in predicting usage. Perceived usefulness is slightly significant in predicting use: elderly who have 1 score higher on the perceived usefulness index would score 3 higher in their use index (coefficient = 3.00, $p < 0.1$). Anxiety is also slightly significant in predicting use, with elderly who have 1 score higher on the anxiety index scoring 4.99 lower in their use index (coefficient = -4.99, $p < 0.1$). The mediation analysis of anxiety and trust will be represented in Table 3.

Model 3 retains only perceived usefulness and anxiety, which are the significant independent variables from model 2, with the addition of two demographic variables as independent variables: age groups and type of household. The age group of elderly over the age of 75 has high significance in predicting usage and would score 10.83 lower on their use index compared to elderly between 65-70 years old (coefficient = -10.83, $p < 0.01$). Elderly who live in single-generation households has moderate significance in predicting usage and would score 7.03 higher on their use index compared to elderly living in two-generation households (coefficient = 7.03, $p < 0.05$). Perceived usefulness has moderate significance in predicting usage, and elderly who score 1 point higher on the perceived usefulness index would score 2.36 higher on the use index (coefficient = 2.36, $p < 0.05$). Anxiety has a very high significance in predicting usage, and elderly who score 1 point higher on the anxiety index would score -6.16 lower on the use index (coefficient = -6.16, $p < 0.001$). Three-generation households and the age group of elderly

between 71-75 show no significant difference in comparison with their respective reference groups. The model suggests that younger elderly are more likely to use phone applications than older elderly, which supports H2, and elderly who live with younger generations are less likely to use phone applications, which does not support H2.

Model 4 includes all independent variables from model 3 with the addition of two socio-economic variables as independent variables: education level and household income per capita. In this model, education, household income per capita, three-generation households, the age group of elderly between 71-75 and perceived usefulness are not significant in predicting usage. Anxiety has high significance in predicting usage, and elderly who score 1 point higher on the anxiety index would score 6.50 lower on the use index (coefficient = -6.50, $p < 0.01$). The age group of elderly over 75 has moderate significance in predicting usage and would score 10.41 lower on their use index compared to elderly between 65-70 years old (coefficient = -10.41, $p < 0.05$). Elderly who live in single-generation households are slightly significant in predicting usage and would score 6.35 higher on their use index compared to elderly living in two-generation households (coefficient = 6.35, $p < 0.1$). The findings do not support H_3 that more educated elderly who have a higher household income per capita are more likely to use phone applications than lower educated elderly who have a lower household income per capita.

Table 3
Mediation Analysis on Trust and Anxiety.

	Model 1	Model 2 (Dep = Anxiety)	Model 3
	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Trust	7.73 (2.14)**	-0.61 (0.17) **	3.83 (2.26)
Anxiety			-6.44 (2.09)**
(Constant)	5.40 (6.01)	5.11 (0.48)***	38.34 (11.90)**
Adjusted R^2	0.29	0.29	0.46

Observations	30	30	30

Note: Dep = Dependent variable.

+: $p < 0.1$. *: $p < 0.05$. **: $p < 0.01$. ***: $p < 0.001$.

The mediation analysis of trust and anxiety is displayed in Table 3. Model 1 regresses the use index against the trust index. Trust is shown to have high significance in predicting usage, with elderly who score 1 point higher on the trust index scoring 7.73 higher on the use index (coefficient = 7.73, $p < 0.01$). Model 2 regresses the use index against the trust index and the anxiety index. In this case, trust is not significant in predicting usage, while anxiety is shown to have high significance in predicting usage, with elderly who score 1 point higher on the anxiety index scoring 6.44 lower on the use index (coefficient = -6.44, $p < 0.01$). Model 3 regresses the anxiety index against the trust index. Trust has high significance in predicting anxiety, with elderly who score 1 point higher on the trust index scoring 0.61 lower on the anxiety index (coefficient = -0.61, $p < 0.01$). Finally, model 4 regresses the use index against the anxiety index. Anxiety is shown to have very high significance in predicting usage, with elderly who score 1 point higher on the anxiety index scoring 8.42 lower on the use index (coefficient = -8.42, $p < 0.001$). This supports H_4 that anxiety is a mediating variable between trust and use frequency.

6. Discussion

We use model 3 as our final model as it has the highest adjusted R^2. In the model, frequency of use is constructed from anxiety, perceived usefulness, age and number of generations in household, and has strong predictive strength and a satisfying goodness of fit score. We discuss the implications of our findings below.

6.1 Constructs in the Almere Model

Although the Almere Model was designed for assistive social agents, some factors such as perceived usefulness and anxiety were found to account for the use of phone applications among the elderly. Most of the primary factors[1] used in the Almere Model were not significant in the context of phone applications. Social influence and trust were found to have significance in predicting use before anxiety was included. This suggests that influence and trust do affect use but are mediated by the level of anxiety towards phone applications. Our findings suggest that perceived ease-of-use and attitude towards technology may be insignificant in predicting use. This is likely because the elderly are not as influenced by these constructs in the usage of phone applications.

Perceived usefulness has been identified by research to be significant in elderly acceptance and use of phone applications (Klimova et. al., 2016; Chen, Chan, & Tsang, 2014; Kurniawan, 2008). Our findings support the observation that elderly who perceive that phone applications were useful were more likely to use them. This perception is grounded on the personal experience of the elderly as they were exposed to phone applications that granted overt tangible benefits like communication with family in the case of messaging apps. Research by Renaud & Biljon (2008), also found that elderly acceptance and use of technology was greatly influenced by perceived usefulness.

We found that anxiety predicts use of phone applications among the elderly. This highlights the importance of the initial impression and experience that the elderly have with phone applications, as negative experiences or impressions with phone applications can result in phone anxiety and discourage the use of phone applications (Beckers, Wicherts, & Schmidt, 2007; Callum, Jeffery, & Kinshuk, 2014; Parayitam, Desai, Desai, & Eason, 2010; Saadé & Kira,

[1]Primary factors are perceived ease-of-use, attitude towards technology, perceived usefulness, social influence and trust.

2007; Smith & Caputi, 2007). This is compounded by current designs of smartphones and phone applications with small touch interfaces, like the QWERTY keyboard, despite increasing screen sizes. Unless specifically tailored for the elderly, conventional phone applications also require a slight learning curve which may be beyond the abilities of digitally illiterate elderly. These can be overcome if the anxiety experienced during use can be mitigated and recast as a positive learning experience.

6.2 Elderly Living in Single-generation Households

Our findings suggest that elderly living in single-generation households tend to use phone applications more, contradicting our hypothesis (H_2). We deduced that elderly living in single-generation households have a greater tendency to use phone applications as they need to contact family who live separately, as opposed to elderly living together with their family who see less need to use phone applications. This is somewhat supported by Neves, Amaro, & Fonseca (2013), who found that the use of mobile phones among the elderly was motivated by the ability to connect with family members.

6.3 Socioeconomic Factors

Based on Delello et al. (2017), the team postulated that socio-economic factors would have an impact on the use of phone applications among the elderly due to reduced access to smartphones. However, H_3 is not supported as our findings suggest that socio-economic factors do not affect use. This differs from findings derived by Aesaert & Braak (2015) and is likely due to demographic differences as their findings were based on primary school students while ours was based on the elderly. According to statistics, Singapore has a high smartphone penetration rate, at 78% compared to 37% in Vietnam, 71% in Canada and 39% in Thailand (Statista, 2019a; Statista, 2019b; Statista, 2019c; Statista, 2019d). This high smartphone penetration rate could be

attributed to Singapore's high GDP (Iso, 2018), which suggests that citizens have increased purchasing power to procure goods such as smartphones. Thus, it is possible that access to smartphones is not a major factor affecting use of phone applications. It is possible that socio-economic factors do influence usage, but are outclassed by psychological (anxiety, trust) and sociodemographic (age, household generations) factors which are more pertinent to the use of phone applications. This is primarily because elderly use of phone applications is shaped by the level of anxiety when using phone applications (Beckers, Wicherts, & Schmidt, 2007; Parayitam, Desai, Desai, & Eason, 2010; Saadé & Kira, 2007; Smith & Caputi, 2007), perceived usefulness (Chen, Chan, & Tsang, 2014; Kurniawan, 2008; Klimova et. al., 2016; Neves, Amaro, & Fonseca, 2013), and the ability to communicate with family (González, Paz Ramírez, & Viadel, 2012; Ivan & Fernández-Ardèvol, 2017, Neves, Amaro, & Fonseca, 2013), regardless of SES. This is supported by our findings and literature review.

6.4 Recommendations

Our findings revealed that anxiety, often manifesting as phone anxiety, has a high significance in predicting usage of phone applications among the elderly. In order to increase frequency of usage, there is a need to reduce phone anxiety faced by the elderly. We propose the following changes to the design of phone applications: simple interfaces that are straightforward, large and visible icons in smartphones, easy mistake recovery (undo buttons and confirmation messages) and reduction of language barriers. This would reduce negative incidences that might lead to phone anxiety.

Our findings revealed that perceived usefulness affected the use of phone applications among the elderly. To promote usage, we recommend increasing the usefulness of phone applications to the elderly. This can be achieved through conducting specific surveys and focus

groups to collect primary data on what the elderly desire. In addition, a component of the Senior Technology Acceptance Model (STAM) developed by Renaud & Biljon (2008) comprises confirmed usefulness, which refers to the relative usefulness of the elderly's phone to themselves – composed of the features that he or she can learn to use. Thus, we recommend that phone applications being developed for the elderly will need to embody functions that meet their needs. Such functions include messaging functions to communicate with family or simple reminder apps. This will lead to higher levels of perceived usefulness among the elderly.

Our findings observed that elderly living in single-generation household had a higher propensity to use phone applications than elderly living in multi-generational households. This was likely due to their desire to maintain contact with family members that are living separately. (González, Paz Ramírez, & Viadel, 2012; Ivan & Fernández-Ardèvol, 2017, Neves, Amaro, & Fonseca, 2013). Nonetheless, families can encourage the elderly to use phone applications like messaging platforms, which can potentially enhance the level of social connectedness among family members as well as promote digital literacy (Neves et al., 2017). This would increase elderly's use of phone applications and help bridge the gap between elderly and digital technologies.

7. Conclusion

As Singapore progressively adopts technology into everyday use, it fails to consider if the elderly truly benefit from the changes. Although the literature supports the hypothesis that the elderly benefit from the use of technology through increased social connectedness and improved psychological well-being (Neves, Franz, Judges, Beermann, & Baecker, 2017; Chen & Schulz, 2016; Fang et al., 2018), actual adoption remains a key issue. With this information, our study presents factors that can be used to tailor solutions toward addressing this issue, thereby

providing the elderly adequate support for their inclusion in a tech-enabled society. Perceived usefulness is likely to remain significant for the elderly as the ability to learn diminishes with age. This is predicated on perceived usefulness being a good motivator for use and adoption of ICT.

Although trust was not treated significantly in this study, it should be noted that trust does have influence in the use of phone applications among the elderly and should therefore be developed in further research on technology adoption among the elderly. In terms of the SmartNation initiative, the government can address trust by way of educational campaigns that inform the elderly of Singapore's cybersecurity efforts as well as its emphasis on data security and privacy.

7.1 Future Research

For future studies, we recommend a larger sample size ($n > 30$) as it would be more representative. Researchers should employ the use of multi-stage sampling as it provides control over selection probabilities to construct unbiased estimates. It is recommended to employ the use of translators (to account for those non-fluent in English) so that the survey intent is clear to respondents. Further research can also explore different geographical regions of Singapore. We postulate that different geographical regions of Singapore may have different levels of technological penetration and adoption of digital technology. Regions may also differ in industry concentration, which may affect phone application usage. Anxiety, having the highest significance and being a mediator between trust and use, can be further unpacked to determine its constituents, while analysing the relationship between trust and anxiety. The relationships between age and use of technology, and age and willingness to learn can be further examined; the decline in usage with age could stem from a declining willingness to learn as Singaporeans

age. Lastly, we noted that there were differences in the distribution across demographic categories where categories scoring higher on the use index display larger variances. Further analysis can be conducted to review the drivers behind the lower quantiles of wider spread in order to better address them.

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Appendix A

Comparison of Published Technology Acceptance Models.

Model	Constructs Employed	Primary Contextual Environment
Technology Acceptance Model (TAM) - Davis, D. F., 1989	1. Perceived Usefulness 2. Perceived Ease of Use	Organizational
Unified Theory of Acceptance and Use of Technology (UTAUT) - Venkatesh et al., 2003	1. Performance Expectancy 2. Effort Expectancy 3. Attitude Toward using Technology 4. Social Influence 5. Facilitating Conditions 6. Self-Efficacy 7. Anxiety 8. Behavioural Intention to use the system	Organizational
Almere Model - Heerink et al., 2010	1. Anxiety 2. Attitude Towards Technology 3. Facilitating Conditions 4. Intention to Use 5. Perceived Adaptiveness 6. Perceived Enjoyment 7. Perceived Ease of Use 8. Perceived Sociability 9. Perceived Usefulness 10. Social Influence 11. Social Presence 12. Trust 13. Use	Gerontological

Appendix B

Study Inclusion Criteria.

Category	Detail
Age	64 - 84 years old
Race	1. Chinese 2. Malay 3. Indian 4. Eurasian
Primary Spoken Language	• English • Mandarin • Bahasa Melayu • Tamil/Hindu • Others (other Chinese Dialects)
Living Arrangements	1. Living with Spouse 2. Living with Siblings 3. Living with Children 4. Living with Grandchildren 5. Living with other Relatives 6. Living Alone
Educational Level	• No formal education • Primary • Secondary • Pre-tertiary (Polytechnic, Junior College, ITE) • Tertiary (Degree and above)
Past Employment	All
Socioeconomic Status	1. High (Average Family Income > $5,000) 2. Middle ($3,000 ≤ Average Family Income ≤ $5,000) 3. Low ($3,000 < Average Family Income)
ICT Use and Digital Literacy	Minimal to Maximal users; All levels of digital literacy