AGE AND USAGE OF TECHNOLOGY. A STRCUTURAL EQUATION MODEL BASED ON THE THEORY OF PLANNED BEHAVIOR

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Abstract: *Despite of its great disruption, users' access to technology is limited and influenced by individual attitudes and capabilities. We take a look at how social media usage, as a form of online social capital, varies based on the theory of planned behavior. Analyzing 2018 data from the United States of America, gathered within the Core Trends Survey – Pew Research Center, we develop a structural equation model comparison between younger and older respondents. Our results show that a more positive attitude towards the Internet increases the difficulty to give up digital devices, which also determines a higher level of social media usage for both younger and older individuals. However, older people tend to have a less positive attitude towards the Internet compared with their younger counterparts, which relates to their lower engagement in social media usage. We also identify intersections between age and variables such as education, income, and gender accounting for individuals' digital behavior. Provided that online social capital may have an important role for well-being and medical prevention, our research highlights the need to further investigate this current digital divide.*

Key words: *technology; smartphone; social media; age differences; structural equation modeling.*

1. Introduction

Older people still face limited access to information and communication technologies (ICTs), which results in inequalities in terms of usage and potential benefits related to it (Atkinson, Curtis and Black, 2008; Casado-Muñoz, Lezcano and Rodríguez-Conde, 2015; Fang, Canham, Battersby, Sixsmith, Wada, and Sixsmith, 2019). Education is one of the most important predictors for usage of technology (Graham 2010 apud Fang *et al.*, 2019). Moreover, social origin characteristics, such as parents' income, occupation, wealth, as well as individual's age and gender influence one's level of education, which ultimately affects access and usage of technology (Duncan, Daly, McDonough, and Williams 2002 apud Fang *et al.*, 2019; Mitzner *et al.*, 2019). The intersection of "personal, social, technological contexts" and "agentic and structural processes" is inherent to the digital divide phenomenon (Neves, Waycott and Malta, 2018: 244-246).

Regarding the concept of digital inequality, Reinartz (2016) developed a systematic literature review to investigate the current status of digital inequality research. She found that there is a scarcity of papers linking phones or mobile devices to the topic of aging. The existing literature documents age-related characteristics regarding usage of mobile phones as well as seniors' particular needs in this area, despite its current limitations.

Schäffer (2007) concluded that quantitative studies tend to score older people worse on scales of skills in comparison with the younger ones. This might happen due to the items that are used in the design of the study, items which take into account current skills needed by the workforce, while older people are most probably not up-to-date with those skills, given their occupational status as pensioners. Technological development has had an exponential development during recent years, thus older

people did not used the current technology at work, considering that younger generations are still adapting to their usage. Moreover, Wong's analysis (2013) of older adults in Malaysia revealed usage difficulties, such as changes in user interfaces (from keypad-enabled to touch-screen) that older users experience as a form of digital inequality.

Hwang, Chan-Olmsted, Nam, and Chang (2016) study on data from a United States panel formed by mobile phone users showed that the age variable strongly moderated the effect of the type of mobile application on usage. According to these results, older people were less likely than young people to engage in the usage of mobile applications. Seniors' usage of mobile phones was basically utilitarian in the study of Conci, Pianesi and Zancanaro (2009). Also, seniors' usage was dependent of perceived ease of use, even after several years since mobile phones' adoption. Another study was on senior mobile phone usage in South Africa. Most of South African seniors received a phone from their family members and lacked use training. A solution proposed by the authors was a checklist for mobile phones selection (van Biljon, van Dyk and Gelderblom, 2010).

While revising the literature, we observed that older users' learning process of how to use mobile phones and related devices was different in comparison with other age groups. One study indicated older users' needs and issues regarding technology. The study was written by Harada, Sato, Takagi, and Asakawa (2013) and it stressed the importance of variance in exposure levels to technology during the formative period of someone's life as an explanation for seniors' learning methods. The learning process of seniors was identified by Nimrod (2016) as the process of domestication of technology and it was related to usability problems. The domestication of technology is a process that comprises 4 phases: appropriation, objectification, incorporation, and conversion (Silverstone 1994, Silverstone et al. 1992 apud (Nimrod, 2016). The usability problems appear in the incorporation phase and they influence the learning process (Renaud and van Biljon, 2008).

The design of digital devices can discourage older people from using them, as it may not be adequate for age-related impairments that are common among the older population (Fang *et al.*, 2019). Social scientists who conducted research in this area of study discussed the differences regarding mobile phone usage, emphasizing the importance of mobile phones' visual characteristics for seniors. Sight or hearing issues resulted from mobile usage might be relevant for anyone, independently of age, because the dimension of characters used by phones or the volume of the sound produced by phones is sometimes quite inadequate (Keating *et al.*, 2007). The target of improvements stressed here would be for a more widespread population, not only the older people group, especially with the aim of improving human capabilities, as Harari (2016) argued.

Despite this, older people are getting involved with technology, especially those who want to be socially active. Been-Lirn Duh, Yi-Luen Do, Billinghurst, Quek, and Hsueh-Hua Chen (2010) presented several benefits of mobile phone usage: "entertainment, socialization, relief from social isolation, mental exercising and a heightening of self-esteem" (p. 4514). Among the participants in Rosales and Fernández-Ardèvol's research (2016), there were seniors who used smartphones beyond basic functions. These participants used smartphones for social interaction, hobbies, and entertainment. Australian seniors reported as Internet usage purposes "seeking information, entertainment, commerce, communication, and finding new people" (Sum, Mathews, Pourghasem, and Hughes, 2008: 202). Therefore, social media usage impacts bonding social capital as a result of how online and offline relationships

overlap (Erickson, 2011). Beyond bonding and bridging social capital (Putnam, 2001), a third type of social capital accounts for connections that are supported by the use of social networks in the absence of face-to-face interactions – maintained social capital (Antheunis, Abeele Vanden and Kanters, 2015).

Communication via Internet has a positive impact on social relationships for the general population (Antheunis, Abeele Vanden and Kanters, 2015). Usage of social networks has been identified as a factor that strengthens sociability and human interaction (Sabatini and Sarracino, 2014). However, seniors' usage of social media impacts positively the relationships they already have, but it is not necessarily linked to creating new social ties. For the category of older users, social media usage gets alternated with telephone usage (Quan-Hasse, Mo and Wellman, 2017).

A theoretical model that is relevant for the study of technology usage is the theory of planned behavior. This model explains the adoption of a certain behavior based on the attitude towards the respective behavior, the subjective norms, and the perceived behavioral control (Ajzen, 1991). We constructed a structural equation model starting from the theory of planned behavior, elaborated by Icek Ajzen, in order to explain social media usage. Our main hypothesis is that social media usage is a behaviour that was created or influenced by attitudes towards it and the perceived behavioural control based on difficulty of giving up its usage We used this theory to empirically test a comparative model for younger and older people. Our model included variables related to the attitude towards Internet, the difficulty to give up a device, which accounts for the perceived behavioral control, and the actual behavior – social media usage. Based on previous research documenting social origins' and demographics' influence on technology usage (see also Vulpe and Ilinca, 2017; Ilinca, 2020 as reasons for choosing to create our hypotheses), presented earlier in this paper, we also tested the influence of socio-demographic characteristics on social media usage.

2. Materials and methods

2.1. Measures

For social media usage, the main endogenous variable, we constructed a summative index with the purpose to capture the frequency of usage of social media in general, provided that the users have their own preferences with respect to the channels investigated. We constructed the summative index using the variables related to respondents' usage of social media platforms. These variables were measured using the following questions: "Please tell me if you ever use any of the following social media sites online or on your cell phone. Do you ever use... Twitter? / Instagram? / Facebook? / Snapchat? / YouTube? / WhatsApp? / Pinterest? / LinkedIn?"

We included in our model the attitude towards the Internet as a latent variable having two indicators. The questions for the two indicators were the following: "Overall, when you add up all the advantages and disadvantages of the Internet, would you say the Internet has mostly been a GOOD thing or a BAD thing for society?" and "How about you, personally? Overall, when you add up all the advantages and disadvantages of the Internet, would you say the Internet has mostly been a GOOD thing or a BAD thing for you?" We reordered the response scale as follows: 1 "Bad thing", 2 "Some of both", 3 "Good thing."

We used another latent variable for the perceived behavioral control, measured as the difficulty to give up a device. The observed variables that we used for this factor were measured using the following questions: "How difficult would it be, if at all, to give up the following things in your life? If you do not use or have the item, just tell me. How

hard would it be for you to give up... Your cell phone or smartphone?; The Internet?; Social media?" The response scale for these variables ranged from "1 Very hard" to "4 Not hard at all." Additionally, there was "5 Impossible", as a voluntary response. We reordered the scale in order to have low values for low levels of difficulty and high values for high levels of difficulty (from Not hard at all to Impossible).

The socio-demographic variables that we included in our model are: sex, age, education, occupation, income, and marital status.

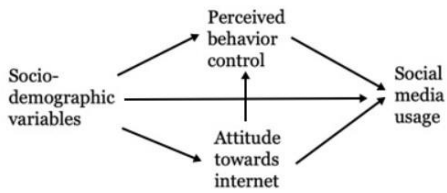
2.2 Analytical approach

Multi-group structural equation model comparison was employed to test our theoretical model, using the Core Trends Survey data from Pew Research Center, a nationally representative survey from the U.S.A., gathered in 2018. The data that support the findings of this study are openly available in Pew Research Center Internet & Technology (2018) at https://www.pewresearch.org/internet/dataset/jan-3-10-2018-core-trends-survey/.

We used the multi-group multi-model (MGMM) procedure from IBM AMOS 23 to run our model simultaneously for two groups: younger and older respondents. The estimation approach that we use for this structural equation model is full information maximum likelihood (FIML), due to its technique for handling missing data. We assumed that data are missing at random (MAR) in the sample. The variables in our analysis have missing data in a proportion varying between 2% and 33%. The variable having 33% missing data measures respondents' difficulty to give up social media and over 32% of missing data are system missing. According to Collins, Schafer, and Kam (2001), if the assumption of MAR data is incorrect, this will have a small impact on analysis estimates and standard error of the model.

The conceptual diagram that we used to construct our model is available below (Figure 1).

Figure 1: Conceptual diagram



3. Results

3.1 Descriptive statistics

Considering the usage of social media, 17% of respondents use 2 social media platforms, 1% use 8 platforms, whereas almost 15% do not use any of the social media platforms they were questioned about. Almost 67% of respondents say that the Internet is a good thing overall and 79% of them say the Internet is good for them personally. 49% of participants say it would be very hard for them to give up their cell phone/smartphone, 45% say it would be very hard to give up the Internet, and 9% say it would be very hard to give up social media. The mean age of respondents is 50 years old. Over 50% of respondents have a university degree and the income level is $50,000 or more for 42% of them. For more information on descriptive statistics, see Table 1.

Table 1: Descriptive statistics for variables used in the analysis

Variable	%	Mean	SD	Min.	Max.
Social media usage		2,98	2.08	0	8
0	14,7				
1	11,6				
2	17,0				
3	16,0				
4	13,7				
5	11,3				
6	7,8				
7	3,9				
8	1,4				
(N)	(1952)				
"Overall, when you add up all the advantages and disadvantages of the internet, would you say the internet has mostly been a GOOD thing or a BAD thing for society?" 1 Bad thing	14,7				
2 Some of both	14,4				
3 Good thing	66,8				
(N)	(1920)				
"How about you, personally? Overall, when you add up all the advantages and disadvantages of the internet, would you say the internet has mostly been a GOOD thing or a BAD thing for you?"					
1 Bad thing	4				
2 Some of both	4,1				
3 Good thing	79,3				
(N)	(1750)				
"How hard would it be for you to give up... Your cell phone or smartphone?"		3,21	1,08		
1 Not hard at all	11,6				
2 Not too hard	10,5				
3 Somewhat hard	21,6				
4 Very hard	49,1				
5 Impossible	2,6				
(N)	(1910)				
"How hard would it be for you to give up... The internet?"		3,21	1,07		
1 Not hard at all	10,6				
2 Not too hard	9,8				
3 Somewhat hard	20,8				
4 Very hard	44,8				
5 Impossible	2,4				
(N)	(1770)				
"How hard would it be for you to give up... Social media?"		2,21	1,03		
1 Not hard at all	20,6				
2 Not too hard	20,2				
3 Somewhat hard	17				
4 Very hard	8,9				
5 Impossible	0,1				
(N)	(1339)				
Gender					
0 Male	54				
1 Female	46				
(N)	(2002)				
Age		50,6	18,71	18	97
(N)	(1953)				
Education					
0 Pre-university education	46,9				
1 University education	51,5				
(N)	(1970)				
Income					
0 Less than $50,000	40,6				
1 $50,000 or more	42,5				
(N)	(1663)				
Marital status					
0 Other	50				

Variable	%	Mean	SD	Min.	Max.
1 Married	47,8				
(N)	(1957)				

Source: Core Trends Survey, Pew Research Center Internet & Technology (2018); authors' analysis

3.2 Multivariate results

After comparing the goodness of fit tests for the models resulting from MGMM procedure, we decided that the Structural Weights Invariance model is adequate. The model is over-identified, having 71 degrees of freedom, thus the results can be further interpreted. All of the indicators used to construct latent variables load significantly on the factors, the values for all loadings being above 0.5 for both of the analyzed groups (see Table 2 and Table 3 below).

Table 2: Factor loadings for the group of young people

	Attitude towards Internet	Difficulty to give up a device
Internet		0.846
Smartphone		0.650
Social Media		0.517
Overall, Internet is good/bad	0.711	
Personally, Internet is good/bad	0.544	

Source: Core Trends Survey, Pew Research Center Internet & Technology (2018); authors' analysis

Table 3: Factor loadings for the group of older people

	Attitude towards Internet	Difficulty to give up a device
Internet		0.859
Smartphone		0.621
Social Media		0.548
Overall, Internet is good/bad	0.789	
Personally, Internet is good/bad	0.603	

Source: Core Trends Survey, Pew Research Center Internet & Technology (2018); authors' analysis

The majority of the effects of exogenous variables on the endogenous ones are statistically significant in the model. The variables that have no statistically significant effects are gender on attitude towards Internet and marital status, which does not influence any of the three endogenous variables, controlling for other influences in the model.

For the group of young people (less than 65 years of age), a positive attitude towards Internet increases their difficulty to give up a device and it also has a small positive effect on their social media usage. A higher difficulty to give up a device increases young people's social media usage. Young women report a higher level of difficulty to give up a device and they also tend to use social media more than men. Among those who are aged less than 65, younger people have a more positive attitude towards the Internet. In addition, it is more difficult for them to give up a device and their usage of social media is higher. For people aged less than 65, a higher level of income is associated with a higher difficulty to give up a device and with a higher level of social media usage. Young people with a higher level of education have a more positive attitude towards the Internet. Also, it is more difficult for them to give up

digital devices. For more information on SEM coefficients for the group of young people, see Table 4 below.

Table 4: Unstandardized (standardized in parentheses) coefficients and their level of significance for the group of young people (less than 65 years of age)

	Attitude towards Internet	Difficulty to give up a device	Social Media usage
Attitude towards Internet		0.630*** (0.473)	0.262* (0.067)
Difficulty to give up a device			0.884*** (0.303)
Gender	-0.014 (-0.013)	0.186*** (0.134)	0.455*** (0.112)
Age	-0.004*** (-0.121)	-0.005** (-0.100)	-0.049*** (-0.343)
Education	0.236*** (0.228)	0.187*** (0.136)	0.447*** (0.111)
Income	0.094* (0.091)	0.211*** (0.153)	0.320*** (0.080)
Marital status	0.047 (0.046)	-0.050 (-0.036)	-0.091 (-0.023)

*Dependent variables in the structural model: attitude towards the Internet, difficulty to give up a device, social media usage. *p < .05 **p < .01 ***p < .001*
Source: Core Trends Survey, Pew Research Center Internet & Technology (2018); authors' analysis

People aged 65 and over having a positive attitude towards Internet find it harder to give up a device, the correlation coefficient between these two variables being quite strong. This category of people also reports a higher level of social media usage. For those who find it more difficult to give up a device, social media usage is higher. It is more difficult for older women to give up a device and their social media usage is higher compared with older men. Within the group of 65+, older people have a less positive attitude towards Internet. Moreover, they face less difficulty when giving up a device and they also use social media to a lower extant. Older people with a higher level of education have a more positive attitude towards Internet, give up devices harder, and use social media more than their less educated counterparts. Similarly, people aged 65 and over having a higher level of income are more likely to have a positive attitude towards the Internet, to find it difficult to give up a device, and to use social media. Additional information on SEM coefficients for the group of older people is available in Table 5.

Table 5: Unstandardized (standardized in parentheses) coefficients and their level of significance for the group of older people (65+ years of age)

	Attitude towards Internet	Difficulty to give up a device	Social Media usage
Attitude towards Internet		0.630*** (0.554)	0.262* (0.093)
Difficulty to give up a device			0.884*** (0.357)
Gender	-0.014 (-0.011)	0.186*** (0.132)	0.455*** (0.130)
Age	-0.004*** (-0.053)	-0.005*** (-0.051)	-0.049*** (-0.206)
Education	0.236*** (0.190)	0.187*** (0.132)	0.447*** (0.127)
Income	0.094* (0.075)	0.211*** (0.149)	0.320*** (0.091)

	Attitude towards Internet	Difficulty to give up a device	Social Media usage
Marital status	0.047 (0.038)	-0.050 (-0.035)	-0.091 (-0.026)

**Dependent variables in the structural model: attitude towards the Internet, difficulty to give up a device, social media usage. *p < .05 **p < .01 ***p < .001*
Source: Core Trends Survey, Pew Research Center Internet & Technology (2018); authors' analysis

The squared multiple correlations show moderate levels of explanatory power for some of the relationships in the model. Social media usage, the main endogenous variable, is explained in proportion of 33% for the group of younger people and 35% for the group older people in the analysis. The perceived behavioral control (difficulty to give up a device) is explained in proportion of 36% for young people and in proportion of 42% for older people. The explanatory power of the model is lower for the attitude towards the Internet – 9% for younger people and 7% for older people.

4. Discussion

Our model shows differences between younger and older groups. Nonetheless, there are also differences that transcend this age-related divide and point to an intersectional dimension of the digital divide. For both of the groups that we analyzed, there are age categories that differ with regard to their digital behavior as a result of how age interferes with education, income, or gender, as was the case in our model. The intersections that we identified between age and several other variables accounting for digital behavior contribute to acknowledging and explaining "alternative trends of adoption and use", as mentioned by Rosales and Fernández-Ardèvol (2016: 500).

Gender influences the control older and younger people perceive they have over their behavior. According to younger and older women's perceptions, they have less control over their behavior than men, which means younger and older women face more difficulty when giving up a device compared with younger and older men, respectively. Women's increased difficulty to give up digital devices is further related to their higher level of social media usage. Younger and older people who are better educated are more engaged digitally, education influencing positively all of the variables accounting for the theory of planned behavior. A similar pattern occurs for the income variable. Income is relevant for younger people to a higher extent, having a positive influence on their attitude and perceived behavioral control, whereas for their older counterparts, income has a stronger influence on social media usage.

Our analysis is in line with previous research that showed the role of education, age, and gender for creating digital divides (Hwang *et al.*, 2016; Fang *et al.*, 2019; Mitzner *et al.*, 2019). In addition, our analysis points to the intersection of these variables which are responsible for disparities regarding attitude towards technology and usage of digital devices.

Following the principles of the theory of planned behavior, our model showed that a more positive attitude towards Internet increases one's difficulty to give up a device, either smartphone, Internet, or social media. Furthermore, an increased difficulty to give up a device, which represents the perceived behavioral control in our model, leads to a higher usage of social media. This dynamic occurs for both younger and older individuals, but the relationship is stronger for people aged 65 and over. The attitude towards Internet has also a direct effect on social media usage, which means that the attitude towards behavior influences directly the actual behavior. A more

positive attitude towards Internet is related to a higher level of social media usage, although the correlation coefficients are low for this relationship in both groups.

For both younger and older groups, there is a negative relationship between age and the variables corresponding to the theory of planned behavior: the attitude towards the Internet, the perceived behavioral control, and the actual behavior (social media usage). In other words, it is more common for older people to have a negative attitude towards the Internet, to give up devices easily (smartphone, Internet, and social media), and to have a low usage of social media, all of which could be attributed to a cohort effect.

Social media usage can be related to acquiring digital social capital (Uz and Muscanell, 2015). If we take into account the devices that can be used in order to access social media, smartphones can be considered a relevant tool in this regard. If all of our cited papers rated seniors' mobile phone usage as utilitarian, Zhou, Rau and Salvendy (2014) concluded that feature phones could be more adequate for them, being more simple. One of the concerns that were addressed in the literature was the adaptation of mobile phones and mobile technology as to meet the needs of the older users and to respond to age – related specificities. One of the most important needs of the older people with respect to the usage of mobile phones (Schäffer, 2007) was being socially active and keeping in touch with their friends and relatives. Smartphone usage has been previously related to socialization and relief from social isolation of older people (Been-Lirn Duh *et al.*, 2010), who sought social interaction and maintenance of hobbies through their usage (Rosales and Fernández-Ardèvol, 2016). One of our suggestions would be to consider questions about social capital by differentiating between digital social capital and face to face social capital (see [Voicu, 2008] for more details on social capital).

Social media usage is higher for better educated, wealthier individuals. Lower levels of education are more common among older generations, due to a cohort effect (Boockmann and Steiner, 2006). As a further matter, lower levels of education determine lower levels of income, due to social stratification mechanisms (Leo *et al.*, 2016), which result in structural dynamics that account for disparities in technology usage. Socio-demographic characteristics, such as education and income, influence social capital and people's chances to fight social isolation. People who are lower educated and earn lower income levels are less likely to engage in social media usage and therefore their social capital is reduced compared with higher educated, wealthier people. Although this phenomenon affects all age groups, older people are more prone to suffer from social isolation, as a result of reduced social participation, among other factors (National Health Service, 2018).

Our research also contributes to the development of social policies targeting seniors' problems with isolation and social exclusion. By incorporating the results of our analysis into the policy domain, providers (nursing homes or other types of care centers) could tackle social isolation by encouraging seniors' engagement in social media usage. A first step in this regard would be influencing older people's attitude towards Internet by diminishing the negative frame, which we identified as a prime obstacle for seniors' usage of social media. Such measures would help with expanding seniors' social capital by integrating the digital dimension of social capital into their lives.

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