

GPS Tracking in Dementia Caregiving: Social Norm, Perceived Usefulness, and Behavioral Intent to Use Technology

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Abstract

Remote monitoring technology has taken a place in dementia caregiving by providing assistive tools such as tracking devices using Global Positioning Systems (GPS). Nevertheless, caregivers' attitudes toward this technology are still inconclusive, and the factors leading up to their behavioral intent to use the technology remain unclear. Based on a survey of 202 dementia caregivers, our analysis with structural equation modeling demonstrates that care recipients' (i.e., persons with dementia) wandering, caregivers' concern, as well as caregivers' smartphone usage positively predict caregivers' behavioral intent to use GPS tracking devices. Meanwhile, social norm and perceived usefulness of technology mediate the relationship between individual attributes and behavioral intent. Theoretical and practical implications are discussed.

1. Introduction

Dementia has significant social and economic implications with regard to medical and caregiving costs. In 2019, more than 16 million Americans

provided a total of 18.6 billion hours of unpaid care to people with Alzheimer's and other dementias, at an economic value of nearly \$244 billion [1].

Dementia caregiving has been found negatively associated with caregivers' health and quality of life [2]. Nearly 60% of Alzheimer's and dementia caregivers have reported high emotional stress, and almost 75% of them feel concerned about maintaining their own health since becoming a caregiver [1]. As noted by caregiving research, "under some circumstances, (caregiving) is transformed from the ordinary exchange of assistance among people standing in close relationship to one another to an extraordinary and unequally distributed burden," and "the emergence of a serious and prolonged impairment such as Alzheimer's disease, is such a circumstance" [3, p.583]. In facilitating activities of daily living, dementia caregivers often experience physical stress, emotional strain, and financial pressure; help becomes nonreciprocal, solely from the caregiver to the care recipient, and this transformation of a cherished relationship causes anxiety and other psychological burdens [4-6]. This is especially the case when the caregiver is not professional, formal, or paid. Therefore, in this study, dementia caregiver refers to such informal or unpaid (usually family members or friends) caregivers who provide care to persons with

dementia who need ongoing assistance with everyday tasks on a regular or daily basis.

Against this backdrop, recent years have witnessed a technological revolution in healthcare industry, and an increasing amount of evidence demonstrates the positive role of technology in supporting dementia caregiving [7]. Technology has the potential to reduce healthcare costs, increase healthcare access, as well as improve healthcare outcomes. As big data and artificial intelligence lend themselves to health reform, several prominent technologies have emerged to empower individuals to better manage their health, such as telemedicine, cloud-based medical records, robotic surgery, and monitoring devices [8].

Despite the development of healthcare technology, few studies have examined how the role of remote monitoring technology in caregiving, particularly in caring for persons living with dementia. Given that one of the most concerning issues for dementia caregiver is tracking the wandering persons with dementia, assistive technology in this context has evolved largely using GPS location to track the motion and activities. Examples include basic alerting devices attached to door or window with motion sensor, small device inside the pad of a shoe to track GPS, and more recently, mobile applications and GPS bracelets that not only monitor the activities but also track the location. Different from assistive technologies that are set up at home or in the private sphere of persons with dementia, GPS-based tracking devices can report the care recipient's real-time position and thus enable the caregiver to keep track of the recipient, especially when the recipient is outside his or her home [9].

This study, therefore, aims to investigate the potential antecedents of dementia caregivers' use of remote monitoring technology. Understanding the antecedents can help technology designers and policy makers to make better decisions in healthcare technology design and policy making. Our particular focus is on remote monitoring solutions developed on the basis of Global Positioning System (GPS), and we examined several psychosocial constructs suggested by previous literature that directly or indirectly predict dementia caregivers' intent to use this technology. Among the first line of research examining the use of remote monitoring solutions in dementia caregiving, our study seeks to shed light on technology-aided caregiving and personal health management in a broader sense.

The remainder of this paper is structured as follows. The following section describes the theoretical and conceptual background of the research on dementia caregiving with GPS tracking technology, leading us to the hypotheses development, which is followed by the research method and the results. Finally, we discuss how

the findings can inform future studies on healthcare and remote monitoring technology.

2. Theoretical and Conceptual Background

2.1. Dementia-Associated Wandering and Use of Remote Monitoring Technology

For caregivers, wandering can be a significant source of safety concern and stress. Dementia-associated wandering refers to physically moving oneself through space in seemingly purposeless movement accompanying cognitive impairment [10-14]. It is a commonly seen direct result of physical changes in the brain among people with dementia and often occurs concurrently with adverse situations such as fatigue, sleep disturbance, and injury [15-17]. Wanderers with dementia are usually found depressed, confused or disoriented, and are often exposed to dangers such as traffic or bad weather conditions [18]. Wandering is more common in the middle or the late stages of dementia [18,19], making caregiving even more quotidian and stressful. This wandering-specific concerns that dementia caregivers have warrant their needs for GPS-based tracking technology.

Dementia caregiving benefits from technological advancements. For example, caregivers who used in-home nighttime monitoring and automated telephone systems to track the activities of persons with dementia reported less anxiety and depression, as well as an improvement of sleep quality [20,21]. At the same time, however, dementia caregivers are often faced with many issues regarding technology use. Hanson and Clarke [22] found that some caregivers may not have sufficient time to learn how to manipulate technologies such as remote monitoring or assistive multimedia devices. Meanwhile, caregivers may be concerned about the cost of obtaining technological devices [23-25]. Given that many caregivers are older adults, using technology in caregiving could be challenging for them due to insufficient skills [26,27]. Landau and Werner [28] conducted a study on ethical issues regarding GPS tracking technology, and they suggested caregivers should be attentive to the care recipients' privacy and autonomy yet admitting that in most cases the need for protecting care recipients' safety seems more imperative.

2.2. Role of Social Norm in Predicting Behavioral Intent to Use GPS Tracking for Dementia Caregiving

Individuals' perceived social norm has been found to shape their health-related behaviors and intentions as

it guides one's understanding of what others think and behave, which is associated with one's desire to belong and general social needs. Therefore, understanding technology users' perceived social norms and their motivations behind technology adoption will allow developers to design user-friendly features that can help the users maintain or expand their social circles.

Research showed that young adults' perceptions of peer norms in online social networking sites tend to impact their sexual risk behaviors [29]. With respect to the promotion of healthy eating, social norm messages are found to be more effective than informative messages in persuading consumers to follow dietary guidelines [30]. Social norm also leads up to other healthy behaviors such as taking part in exercise programs [31]. Moreover, social norms and the expectations about professional roles are ingrained in healthcare professions and thus affect how new technologies diffuse into health practice. Research studying healthcare professionals' intent, a strong proxy for behavior, to use a computational event reporting system has demonstrated social norm's significant and direct impacts on the intent to use this system [32]. A more recent study further confirms the positive effects of health professionals' perceived social norm on their intentions to use health-related computing clouds [33]. Taken together, our study proposed the following hypotheses:

H1: The care recipient's a) wandering behavior, and the caregiver's b) concern about the recipient's wandering, c) current use of a smartphone, d) current use of a computer and other types of technology hardware will be positively associated with the caregiver's perceived social norm of using GPS tracking technology in dementia caregiving.

H2: The caregiver's perceived social norm will be positively associated with the intent to use GPS tracking technology in dementia caregiving.

H3: The caregiver's perceived social norm of using GPS tracking technology will mediate the effects of a) the care recipient's wandering behavior, b) caregiver's concern about the recipient's wandering, c) caregiver's current use of smartphones, and d) caregiver's current use of computers and other types of technology hardware on the caregiver's intent to use GPS tracking technology in dementia caregiving.

2.3. Role of Attitude in Predicting Behavioral Intent to Use GPS Tracking for Dementia Caregiving

Behavioral intent to use technology has been found to result from the extent to which one perceives a given technology as useful (i.e., perceived usefulness of technology) as well as affective feelings about using technology. When technology developers understand the users' attitudes toward the technology, they are better able to consider how to reflect users' needs in their designs. For example, Pai and Huang [34] examined the implementation of healthcare information system and demonstrated a positive and direct impact of perceived usefulness on behavioral intent to use the system. A review conducted by Or and Karsh [35] confirmed the critical role played by perceived usefulness in altering consumers' intent to use health information technology. Likewise, individuals' affective feelings about using information technology are found to produce significant impacts as well [36].

Social norm has been recognized as an antecedent of perceived usefulness of technology as well as affective feelings about using technology. Venkatesh and Davis [37] suggested that an individual's perception of others' attitudes and behaviors has the power to change his or her own thinking. For example, with regard to using high-tech products, research has demonstrated that social influence positively predicts individuals' perceptions of technology usefulness [38]. Social norm results in healthcare professionals' perceived usefulness of intelligent personal assistants, which then positively predicts use intentions [39]. Further, social norm is found to be influential particularly among technology users who can exchange social support with one another [40]. It also increases trust in healthcare electronic devices [41], and hence potentially boosts individuals' positive affective feelings about healthcare technology. Therefore, our research hypothesizes:

H4: The care recipient's a) wandering behavior, and the caregiver's b) concern about the recipient's wandering, c) current use of smartphones, d) current use of computers and other types of technology hardware will be positively associated with the caregiver's perceived usefulness of GPS tracking technology in dementia caregiving.

H5: The care recipient's a) wandering behavior, and the caregiver's b) concern about the recipient's wandering, c) current use of smartphones, d) current use of computers and other types of technology hardware will be positively associated with the caregiver's affective attitude toward using GPS tracking technology in dementia caregiving.

H6: The caregiver's a) perceived usefulness of GPS tracking technology and b) affective attitude toward using tracking technology will be positively associated with the intent to use tracking technology.

H7: The caregiver's perceived usefulness of GPS tracking technology will mediate the effect of caregiver's perceived social norm on the intent to use tracking technology.

H8: The caregiver's affective attitude toward using GPS tracking technology will mediate the effect of caregiver's perceived social norm on the intent to use tracking technology.

3. Method

3.1. Data Collection

This study was approved by the institutional review boards of the organization with which the research team is affiliated. A total of 210 US citizens were recruited via Qualtrics panel service. Eligibility criteria were 1) respondent was currently taking care of someone who has some type of cognitive impairment, such as mild cognitive impairment, Alzheimer's disease, Lewy Body disease, vascular dementia, etc., who will be referred to as the "care recipient"; 2) the respondent was the primary caregiver for the care recipient; 3) the respondent was not receiving any kind of payment or financial consideration for being a caregiver/care manager to the care recipient; 4) the care recipient did not live in a secure memory care unit or a nursing home. The questionnaire items derived from the prior literature [42] were reviewed by the researchers to ensure it reads clear. A total of 34 questions relevant to the present study were asked in the survey¹. After preliminary data cleaning, the final sample contained 202 completed cases. Missing values were identified, and the corresponding cases were eliminated. Demographic information is summarized and presented in Table 1.

3.2. Measures

3.2.1. Intent to Use GPS Tracking Technology.

This variable was measured by three questions asking participants how likely they will be to consider using GPS tracking technology when providing care to persons living with dementia in next three months, using

a 7-point Likert scale (1-very unlikely, 7-very likely). Specifically, the items were: "In the coming three months, how likely or unlikely will you be to use a technological device to track your care recipient's comings and goings and find them if they get lost"; "Do you agree or disagree with the statement that "I plan to use a technological device in the coming three months to track my care recipient's comings and goings and find them if they get lost"; "Do you intend to use a technological device in the coming three months to track your care recipient's comings and goings and find them if they get lost". The reliability of this scale was acceptable (Cronbach's $\alpha = 0.97$).

3.2.2. Care Recipients' Wandering and Caregivers' Concern. The caregiver's concern was measured by a dichotomous question that asked, "Are you at least somewhat concerned about your care recipient wandering or getting lost?". Regarding the care recipient's wandering behavior, our study adapted the Algase wandering scale [43,44] and measured this construct by asking eight questions on a 5-point Likert scale (1- never or unable, 5 - always). In particular, we asked caregivers to score the statements that described the care recipient's current ability or behavior: "He/she runs off"; "While walking alone, he/she walks beyond intended destination"; "He/she attempts to go outside"; "He/she stands at the out-door wanting to go out"; "He/she attempts to find or go to familiar locations, even unrealistic ones"; "He/she attempts to leave his/her own area"; "He/she gets lost outside the house"; "He/she enters private or unauthorized areas". This scale obtained an acceptable reliability (Cronbach's $\alpha = 0.90$).

3.2.3. Caregivers' Current Use of Smartphone.

To measure the caregiver's usage of smartphones, we listed 34 features and asked respondents to select all that they are currently using, and then calculated the total number of features that each respondent reported. The smallest number was 0 and the largest 33. Specifically, the features listed were "making phone calls"; "receiving phone calls"; "web browsing"; "taking pictures or videos"; "GPS navigation and maps"; "hands-free talking"; "voice messaging"; "sending a text message"; "receiving a text message"; "online shopping"; "getting coupons or specials"; "getting a ride like Uber"; "sending or receiving money"; "getting news and information"; "making video calls (Skype, FaceTime)"; "playing games (Pokemon Go, Candy Crush, etc.)"; "participating in social media"; "keeping an eye on my house or apartment"; "reading books"; "accessing medical records"; "sending and receiving emails"; "looking up the weather"; "downloading

¹ <https://github.com/GitHub-files/Health-Technology-Study.git>

and/or playing music”; “keeping a journal or diary”; “adjusting things in my house such as a thermostat or security system”; “making to-do lists”; “tracking health statistics (for example, step counts or weight)”; “streaming TV shows and movies”; “making videos and stories to share with others”; “looking up where things are located”; “finding out where my friends or family members are”; “doing work-related business, such as answering emails”; “taking a voice memo”; “using camera for note-taking or taking a screenshot (taking pictures of information you need to remember)”.

3.2.4. Caregivers’ Current Use of Computers and Other Types of Communication Technology Hardware. Similar to the use of smartphones, this construct listed 13 types of communication technology devices that one might use and was calculated by counting the total number of devices that the respondent was currently using (ranging from 1 to 12). The particular types of technology hardware listed were “desktop computer”; “laptop computer”; “e-Book reader, such as a Kindle”; “iPod or other portable music player”; “tablet computer like an iPad”; “basic cell phone”; “smartphone”; “webcam”; “any smart-home products like a Nest thermostat or other controller”; “smart speaker like Alexa or Echo”; “in-car GPS system for driving”; “fitbit or other fitness tracker”; “Apple Watch or similar product”.

3.2.5. Perceived Social Norm. This construct was measured on a 7-point Likert scale (1–strongly disagree, 7–strongly agree), with the items adopted from previous studies [45,46]. The final items in the survey were: “Most people who are important to me think that I should use technological devices to track my care recipient”; “Most people whose opinions I value would approve of my using technological devices to track my care recipient”; “Most people I respect and admire will use technological devices to track their care recipient”; “Most people like me will use technological devices to track their care recipient”. The reliability of this measurement was acceptable (Cronbach’s $\alpha = 0.98$).

3.2.6. Perceived Usefulness of GPS Tracking Technology. Based on a 7-point Likert scale (1-strongly disagree, 7-strongly agree), items for measuring this variable were adopted from prior research [47,48]. Specifically, the items were “A tracking device enables me to accomplish caregiving tasks more quickly”; “A tracking device improves my quality of caregiving work”; “A tracking device makes it easier to do my caregiving job”; “A tracking device improves my caregiving productivity/efficiency”; “A tracking device gives me greater control over my caregiving job”; “A tracking device enhances my effectiveness on the caregiving job”. The reliability of this scale was acceptable as well (Cronbach’s $\alpha = 0.99$).

3.2.7. Affective Attitude toward Using GPS Tracking Technology. This variable was measured on the basis of a 7-point differential semantic scale [49,50] that asked respondents’ affective feelings about using tracking technology in dementia caregiving. Particularly, respondents were asked to give scores on the following items, “for you, using a technological device to track your care recipient or find them if they get lost is: Good—Bad; Pleasant—Unpleasant; Beneficial—Harmful; Desirable—Undesirable”. This scale has an acceptable reliability in the present sample (Cronbach’s $\alpha = 0.92$).

3.2.8. Control Variables. Several control variables were included in our statistical model. Previous studies showed that age [51,52] and the support received from others [53] tend to influence an individual’s intention to use new technology in both caregiving and other contexts. Therefore, we asked the ages of both the caregiver and the care recipient, whether or not the caregiver has a child/children (1-yes/2-no with reversed coding), as well as whether or not the care recipient has a child/children (1-yes/2-no with reversed coding). We also asked whether or not the respondents were concerned about the care recipients’ getting into trouble if left alone (1-yes/2-no with reversed coding). The reason some caregivers resist tracking technology was also one interest of ours, as the barriers may lay the foundation for future development of the technology. As such, we asked whether non-adoption was because of the caregiver’s consideration of respecting the care recipient’s privacy (0-no, 1-yes) and autonomy (0-no, 1-yes), as the literature indicated that some caregivers stressed the importance of respecting the care recipient’s privacy and autonomy [28]. In addition, technology being expensive (0-no, 1-yes) can also be a barrier to new technology use [30]. Finally, we asked the frequencies (5-point Likert scale, Cronbach’s $\alpha = 0.86$) of the care recipient’s other types of dementia-related abnormal behaviors [3], such as “keeping the caregiver up at night”, “repeating questions/stories”, “trying to dress the wrong way”, “becoming restless or agitated”, “becoming irritable or angry”, etc.

3.3. Data Analysis

Data was analyzed by structural equation modeling (SEM) with Amos 22.0. The parameters were estimated using maximum likelihood approach. The structural equation model for testing effects on the caregiver’s intent to use GPS tracking technology was specified. To improve the model fit, model re-specification was first conducted by removing non-significant paths [54]. Meanwhile, as Kline [55] suggested, when the absolute values of correlation residuals are bigger than 0.10, the

model needs to be modified by adding supplementary paths because it does not fully explain the correlations suggested by the data. Therefore, in addition to removing paths, we also closely examined correlation residuals and modification indices in order to specify supplementary correlations; accordingly, direct effects of independent variables on the dependent variable were added. The re-specified model (Figure 1) demonstrated satisfactory fit indices (Table 1).

4. Results

Zero-order correlations among major variables are reported in Table 2, and statistical coefficients are presented in Figure 1. First and foremost, when persons with dementia start exhibiting wandering behaviors, caregivers are likely to perceive a social norm of using tracking technology to provide care. Therefore, H1a was supported ($\beta = 0.23$; $SE = 0.09$; $p < 0.01$). Further, the more caregivers feel concerned about recipients' wandering, the higher the likelihood that they tend to view using tracking technology as a normative choice; H1b was supported ($\beta = 3.57$; $SE = 1.05$; $p < 0.001$). The caregiver's current use of smartphones also positively predicts the degree to which caregivers perceive a social norm of using tracking technology when providing care, thus H1c was supported as well ($\beta = 0.11$; $SE = 0.06$; $p < 0.05$). However, caregiver's current use of computers and other technical devices was not a significant predictor of his or her perception of social norm, and hence H1d was rejected.

Caregivers' perceived social norm of using tracking devices positively leads to the intent to use tracking devices, supporting H2 ($\beta = 0.24$; $SE = 0.09$; $p < 0.01$). Except for H3d, the set of hypotheses H3 was supported (statistics presented in Figure 1), demonstrating a positive mediating role of perceived social norm in the effects of the care recipient's wandering, the caregiver's concern about wandering, caregiver's use of smartphone, caregiver's use of computer and other types of technology hardware on the caregiver's behavioral intent to use tracking technology. Focusing on caregiver's perceived usefulness of tracking technology and their affective feelings about using tracking technology, results support H4b ($\beta = 3.82$; $SE = 1.16$; $p < 0.01$) and H4d ($\beta = 0.61$; $SE = 0.26$; $p < 0.05$), suggesting that those who are concerned about recipients' wandering as well as currently using computer and other types of technological hardware tend to find tracking technology more useful. H4a and H4c were rejected. Likewise, H5d was supported ($\beta = 0.47$; $SE = 0.18$; $p < 0.05$), meaning that caregivers' current use of computer and other technological devices is likely to result in positive affective attitudes toward tracking technology; H5a, H5b, and H5c were rejected.

Finally, caregivers' perceived usefulness of tracking technology not only positively leads to their intentions to use tracking technology, but also plays a mediating role in the relationship between perceived social norm and the intention to use tracking technology. As such, H6a ($\beta = 0.17$; $SE = 0.05$; $p < 0.01$) and H7 were supported (statistics presented in Figure 1). However, it was not the case with regard to the caregiver's affective attitude toward using tracking technology, thus H6b and H8 were rejected.

5. Discussion

Providing care to persons with dementia is time-consuming and stressful. The extent to which technology can ease the burden of care remains unanswered and has triggered considerable interest among healthcare scholars and practitioners. This research is one of the first studies investigating how social norm, attitude, as well as individual attributes jointly predict a caregiver's intent to use GPS tracking technology for dementia caregiving. Instead of examining each factor separately and independently, this study applies a systematic approach that takes into account the interconnections among all factors.

In the first place, social norm plays a key role in predicting caregivers' intent to use GPS tracking technology. Consistent with technology acceptance literature, social norm has both direct and indirect effects on the intent to use technology, the perceived usefulness of technology, as well as the affective attitude toward technology [56,57]. With the help from close friends, colleagues or family members, individuals tend to feel less nervous or uncertain about new technology [40, 58-60]. Particularly in dementia caregiving, when caregivers perceive that people in their reference groups find tracking technology useful, they are more likely to have a positive affective attitude and believe that they need the technology as well. In other words, the social norm of using GPS tracking technology emerged from caregivers' social networks motivates them to overcome psychological barriers and to make the decision of using this technology.

Furthermore, caregivers' perceived usefulness of GPS tracking technology has impacts on their intent to use it, whereas their affective feelings about using the technology were less influential. This finding suggests that for dementia caregivers, whether or not to use GPS tracking technology often involves a comprehensive rational thinking process. Apart from prior research on the effectiveness of emotion in technology adoption and use [61], our study demonstrates that such influence varies across different contexts, especially when it comes to healthcare issues. As shown in the present study, when providing care to persons with dementia,

caregivers intend to use GPS tracking technology only when they believe in its usefulness in helping them to achieve the caregiving goal.

Caregivers' individual differences, too, have impacts on their perceived social norm, perceived usefulness of tracking technology, and ultimately their intentions to use the technology. Findings of this study revealed both direct and indirect effects. First, different individual factors affect the degree to which caregivers perceive the social norm. Specifically, compared to those who use few smartphone features, caregivers who are currently using many smartphones features in their daily life are more likely to identify a social norm of using GPS tracking technology, because they may know more tech-savvy peers than non-users do, and thus a recognizable norm of using tracking technology naturally emerges from their social networks. Further, care recipients' actual wandering behavior as well as caregivers' anxiety generate a higher level of perceived social norm of using tracking technology amongst caregivers. One possible reason could be that, in order to satisfy informational and psychological needs [62], caregivers often tend to interact with peers taking care of patients at similar stages of dementia, and thus can be exposed to the social norm of using GPS tracking for dementia caregiving.

Second, caregivers' attitudes toward GPS tracking vary depending upon individual factors. In particular, caregivers' current use of technological hardware such as computers can predict their positive affective attitude as well as higher levels of perceived social norm and technology usefulness. The underlying mechanism could be that smartphone affords an easier access to networking with peers thanks to its high portability, compared to other types of technological hardware [63]. Consequently, caregivers who do not use smartphones may not be able to recognize the social norm of using tracking technology emerged from their social networks, even though they actually maintain a positive attitude toward the technology. Moreover, a caregiver's perceived usefulness of tracking technology and intent to use it also depend on whether or not the caregiver is concerned about the recipient's wandering. In alignment with previous literature, this finding suggests that when evaluating new technologies, perceived usefulness often pertains to actual needs, demands, and outcome expectancy [64,65]. Finally, older caregivers, compared to their young counterparts, are less likely to perceive tracking technology as being useful to them, possibly due to their sensory deficits and psychological resistance [52, 66-68].

Our study offers insights for healthcare practitioners and technology designers, as well as contributes to psychosocial care for family caregivers of people with dementia. First, our research encourages healthcare

practitioners and policy makers to take better advantage of technological advancements to improve health and social care for people living with dementia. Using GPS tracking technology, for example, can help reduce risk without costing caregivers more time and effort, and thus is beneficial for caregivers' psychosocial health [69]. For healthcare practitioners, tracking technology facilitates medical diagnoses and the customization of treatments. Healthcare policy makers, likewise, can benefit from the adoption of tracking technology to develop pragmatic solutions based on large-scale data collected with such technology. Moreover, our findings provide a guidance for health technology designers. Given that caregivers' use of smartphone and care recipients' wandering behavior are both strong predictors of caregivers' intent to use tracking technology, future designers should be more attentive to making technological improvements such as location accuracy as well as tracking devices' compatibility with various kinds of mobile operating systems. Specifically, designers could consider incorporating artificial intelligence techniques into analyzing and forecasting care recipients' wandering patterns as well as sending emergency alerts to caregivers.

Several limitations of this study are worth mentioning. First, although we focused on the GPS-tracking technologies in light of the wandering issue that concerns dementia caregivers, there are other assistive technologies worthy of note. For instance, voice-activated assistants particularly for the communicative purpose may serve increasing importance as with the development of artificial intelligence in healthcare. Second, our study did not consider cultural factors that might influence caregivers' intent to use tracking technology. As many studies suggested [70-72], individuals from different cultures can exhibit distinctive or even conflicting attitudes toward a new technology. Future research could investigate dementia caregivers' technology use across different cultures. Third, in future studies, it is worth examining whether and how pecuniary factors as well as the decision of relinquishing care to professionals would make a difference in enhancing or hindering dementia caregivers' intent to use technology [73,74]. Finally, our study focused on behavioral intent. Further research should examine this topic more closely by testing dementia caregivers' actual behaviors of technology use.

6. References

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Table 1. Data demographics

Gender (Self-identified)	Race & Ethnicity (Self-identified)	Educational Attainment	Living Arrangement (Multiple choice question)
Male 27.2%	White 90.1%	Completed high school or less 17.3%	Living with spouses 64.9%
Female 72.8%	Hispanic 4%	Completed some college or graduated from community college 26.3%	Living with a child or children 18.3%
	African American 2.5%	Bachelor's degree 23.8%	Living with parents 12.9%
	Asian 2.5%	Postgraduate's degree or completed some advanced graduate study 32.6%	Living with a partner 7.4%
	Other race, ethnicity or origin 0.9%		Living with other relatives 5.4%
			Living alone 4.5%

Table 2. Model fit indices

Index	Model value	Recommended value	Acceptance
χ^2/df	1.11 ($\chi^2=36.73$ $df=33$)	< 3 good fit	Good
<i>p</i>	0.30 (not significant)	Insignificant	Good
RMSEA	0.02	< 0.05 good fit	Good
CFI	0.99	Above 0.9	Good
NFI	0.95	Above 0.9	Good
IFI	0.99	Above 0.9	Good
TLI	0.97	Above 0.9	Good
AIC	274.72 (Hypothesized model AIC=305.18)	Smaller is better fit	Better fit compared to hypothesized model

Table 3. Zero-order correlations among major variables

	1	2	3	4	5	6	7	8
1. Recipient wandering	1							
2. Caregiver's concern about recipient's wandering	0.45**	1						
3. Caregiver's current use of smartphone	0.18*	-0.02	1					
4. Caregiver's current use of computer and other technology hardware	-0.53	-0.02	0.32**	1				
5. Social norm	0.35**	0.34**	0.16	0.01	1			
6. Perceived usefulness of tracking technology	0.36**	0.42**	0.12	0.14	0.71**	1		
7. Affective attitude toward tracking technology	0.21**	0.27**	0.21*	0.17*	0.65**	0.57**	1	
8. Behavioral intent (DV)	0.37**	0.42**	0.24**	0.13	0.52**	0.55**	0.38**	1
<i>M</i>	13.93	1.41	14.58	4.66	15.08	23.11	20.13	9.67
<i>SD</i>	6.53	0.49	8.53	2.22	5.99	9.98	6.15	5.68

* $p < 0.05$, ** $p < 0.01$

Table 4. Summary of hypotheses

	Hypotheses	Results
1. Positive effects on caregiver's perceived social norm of using GPS tracking technology:	a). The care recipient's wandering behavior	Supported
	b). The caregiver's concern about recipient's wandering	Supported
	c). The caregiver's current use of smartphone	Supported
	d). The caregiver's current use of computer and other types of technology hardware	Not supported
2. Positive effects of the caregiver's perceived social norm on the intent to use GPS tracking technology.		Supported
3. The mediating effects of caregiver's perceived social norm:	a). between the care recipient's wandering behavior and caregiver's intent	Supported
	b). between caregiver's concern about the recipient's wandering and caregiver's intent	Supported
	c). between caregiver's current use of smartphone and caregiver's intent	Supported
	d). between caregiver's current use of computer and other types of technology hardware and caregiver's intent	Not supported
4. Positive effects on caregiver's perceived usefulness of GPS tracking technology:	a). The care recipient's wandering behavior	Not supported
	b). The caregiver's concern about the recipient's wandering	Supported
	c). The caregiver's current use of smartphone	Not supported
	d). The care recipient's current use of computer and other types of technology hardware	Supported

5. Positive effects on the caregiver's affective attitude toward using GPS tracking technology:	a). The care recipient's wandering behavior	Not supported
	b). The caregiver's concern about the recipient's wandering	Not supported
	c). The caregiver's current use of smartphone	Not supported
	d). The caregiver's current use of computer and other types of technology hardware	Supported
6. Positive effects on caregiver's intent to use GPS tracking technology:	a). The caregiver's perceived usefulness of GPS tracking technology	Supported
	b). The caregiver's affective attitude toward using GPS tracking technology	Not supported
7. The mediating role of the caregiver's perceived usefulness of GPS tracking technology in the effect of caregiver's perceived social norm on the intent to use tracking technology.		Supported
8. The mediating role of the caregiver's affective attitude toward using GPS tracking technology in the effect of caregiver's perceived social norm on the intent to use tracking technology		Not supported

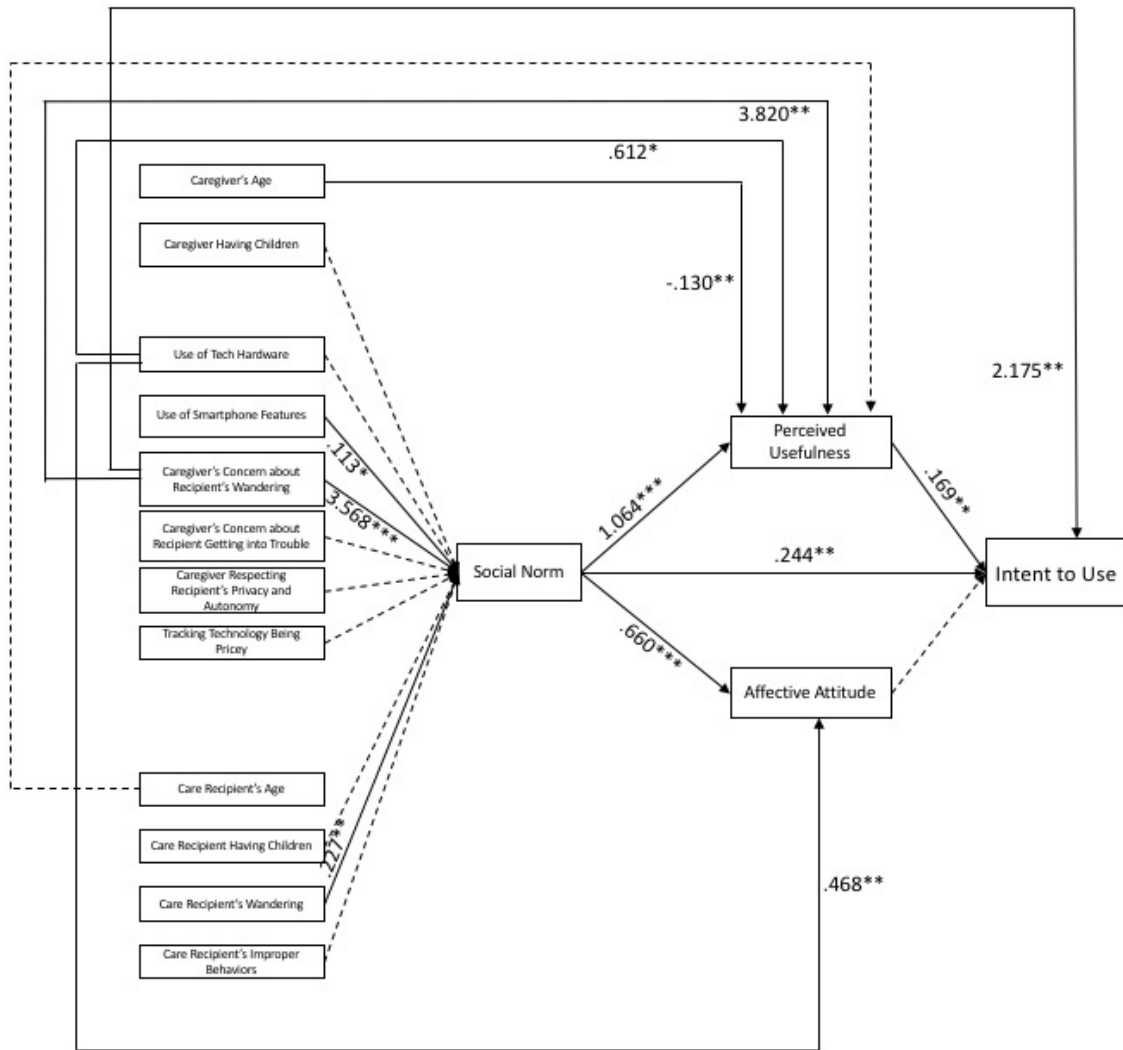


Figure 1. Final path model for predicting dementia caregiver's intent to use GPS tracking technology (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)