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Acceptance of Online Mapping Technology among Older Adults: Technology Acceptance Model with Facilitating Condition, Compatibility, and Self-Satisfaction

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Abstract: The benefits of traveling for older adults are extensively supported in the literature. Online mapping technology (OMT) is one of the most widely used applications by people during traveling. This study aimed to obtain insight into the acceptance of OMT among older adults. Additionally, an OMT acceptance model for older adults was developed in this study by integrating facilitating condition (FC), compatibility (COM), and self-satisfaction (SS) into the technology acceptance model (TAM). In this study, structural equation modeling was applied to the test of the OMT acceptance model. This study adopted a cross-sectional structured questionnaire survey for collecting quantitative data from older adults in China. Four hundred and sixteen Chinese older adults were involved in this survey. This study found that TAM was useful to explain the OMT acceptance among older adults. Additionally, FC was confirmed to be a positive factor in determining the perceived ease of use, while COM and SS were found to positively influence perceived usefulness. The results of this study are helpful for OMT developers to design OMT and adopt measures to enhance the use of OMT among older adults, thereby increasing their travel frequency.

Keywords: online mapping technology; technology acceptance model; older adults

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1. Introduction

Population aging is becoming a challenging issue for most developed countries in which the older adult proportion has been gradually increasing over the past decade. According to the 7th National Census of China [1], the number of older adults (who were aged greater than or equal to 60 years) was 2.64 billion in 2020, representing 18.7% of the population. Compared with the statistics in 2010, the percentage of the total population accounting for older adults in 2020 increased by 5.44. It is expected that the number of older adults will be more than 3 billion in 2025, which will exceed 20.0% of the total population. Compared with young adults, older adults are wealthier and have more discretionary time to travel [2]. The aging population results in an increasing share of vacations and travel expenditures [3]. As a result, older adults become a major consumer force in tourism [4]. The tourism segment of older adults has obtained growing attention from scholars in the past decade [5].

There is substantial literature demonstrating how traveling benefits older adults. Zhang and Zhang [6] suggested that tourism is closely related to the quality of older adults' lives. Totsune et al. [7] investigated how tourism benefits the subjective well-being of older adults and the relations among subjective well-being, travel frequency and curiosity with a mediator of the family budget situation. They found that tourism has a large potential to enhance older adults' subjective well-being. Ferrer et al. [8] used a structural equation

model to provide a tentative conclusion that tourism has positive influences on older adults' mental and physical health. Pan et al. [9] advocated that tourism positively influences the life satisfaction of older adults.

Information and communications technology (ICT) is useful for the development of tourism [10]. For instance, ICT has great impacts on destination competitiveness [11], vocational education and training [12] and tourism product competitiveness [13]. Moreover, ICT has modified people's ways of planning and experiencing their trips and has enhanced tourism companies' efficiency [14]. The use of ICT made the tourism industry smart by collecting and exchanging useful information [15]. With the application of ICT, the tourism industry can connect with travel activities in real time to enhance the travel experience of people [16]. According to Houssien et al. [17], the development of the tourism industry relied on ICT and various mobile applications. ICT can assist in the integration of the various operations of the tourism industry and supply chain management into a single line to facilitate the business activities of the tourism industry [17].

ICT has completely changed tourism, as people share their experiences through social media [18,19]. Previous studies examined how hotels use social media such as Facebook as a marketing tool to promote their services [20–22] and increase tourists' satisfaction [23]. ICT and social media can also facilitate online interactions between tourists [24]. Hysa et al. [25] found that social media helps promote the responsible behavior of the public for sustainable tourism.

Among the different types of ICT, online mapping technology (OMT), such as Baidu Maps, Amap, Apple Maps, and Google Maps, is one of the most widely used applications by people during traveling. OMT enables people to identify available directions through driving, walking, public transportation, or biking with a route planner during traveling. OMT may be helpful for older adults to overcome unfamiliarity with new places during traveling [26]. The study of Pai et al. [27] demonstrated that smart tourism technology experience is a critical factor in affecting travel experience and retravel intention. Given an increasingly large number of older adults who may benefit from the use of OMT, issues related to aging and OMT are critically important in increasing the travel frequency of older adults.

Some excellent studies were recently conducted for understanding the ICT acceptance among the public in the tourism context. For instance, Mohamad et al. [28] explored how the use of mobile technology affects people's intention to reserve hotel rooms via smartphone. El-Said and Aziz [29] determined the factors influencing whether people adopted virtual tours during the COVID-19 pandemic. Shen et al. [30] used perceived price value and hedonic motivation to explain why students adopt virtual reality (VR) and augmented reality applications in tourism education. Law et al. [31] conducted a review to provide a research agenda that understanding how people accept the emerging ICT applicable to tourism should receive more research efforts. However, there is no research concerning the OMT acceptance of older adults in the literature. Research efforts to identify the factors affecting older adults' intentions to use OMT are lacking in the literature.

For addressing the above-mentioned research limitations, this study aimed to obtain insightful knowledge about the acceptance of OMT among older adults by answering the research question: "What are the critical factors that affect the OMT acceptance of older adults?" Additionally, an OMT acceptance model for older adults was developed in this study by integrating the technology acceptance model (TAM), facilitating condition (FC), compatibility (COM), and self-satisfaction (SS).

2. Literature Review and Model Development

2.1. Technology Acceptance Model (TAM)

TAM (shown in Figure 1), firstly introduced by Davis et al. [32], was a widely used theory to explain how people adopt technology [33–39]. TAM suggested that perceived ease of use (PEOU), perceived usefulness (PU), and attitude toward using a technology (ATUT) are important factors in shaping people's technology acceptance. PEOU and PU positively

determine ATUT. ATUT and PU have a positive effect on intention to use the technology (ITU). Consequently, ITU leads to people's actual use of the technology. Moreover, external factors may affect PU and PEOU, such as risk perception, perceived cost, and facilitating condition. According to the study context and TAM [32], PU means the degree to which older adults consider that using OMT improves their performance during traveling. PEOU means the extent to which older adults suppose that using OMT is easy and needs little effort. ATUT is older adults' evaluation toward using OMT. ITU means the extent to which older adults are likely to use OMT.

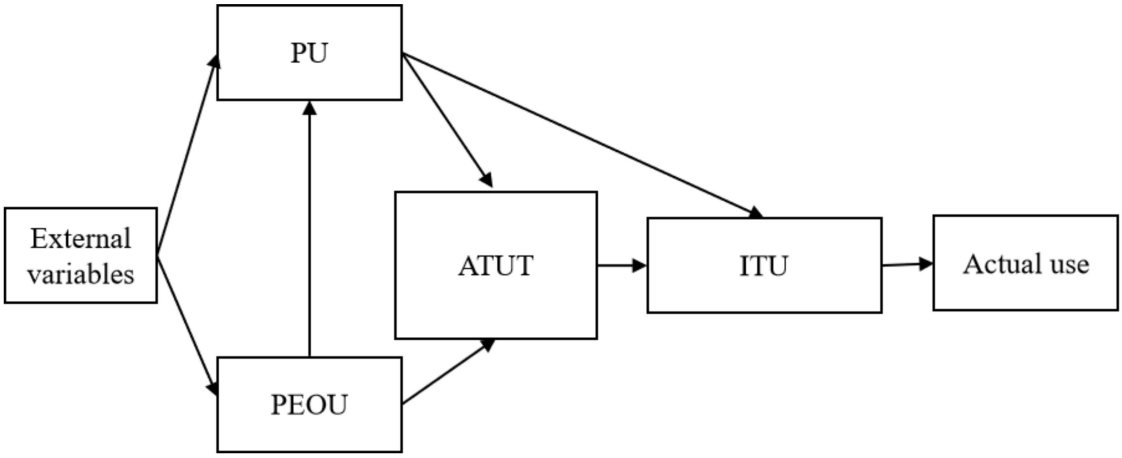

Figure 1. TAM by Davis, Bagozzi, and Warshaw [32].

Many tourism-related studies have applied TAM to interpret people's acceptance of various technologies, for example, hotel mobile applications [40], VR applications [30], and robots [41]. Therefore, this study applied TAM to explain the OMT acceptance of older adults. Based on TAM, this study proposed five hypotheses:

H1: *PU has a positive effect on ATUT.*

H2: *PEOU has a positive effect on ATUT.*

H3: *PEOU has a positive effect on PU.*

H4: *PU has a positive effect on ITU.*

H5: *ATUT has a positive effect on ITU.*

2.2. Facilitating Condition (FC)

FC means the degree to which people think that infrastructure and devices are available for them to use a technology [42]. Due to the unfamiliarity with a new technology, older adults may require more support than the populations of other age segments [43]. Guner and Acarturk [44] examined the influence of FC on PEOU and PU among older adults for their ICT acceptance and indicated that FC positively influences PEOU but not PU. Similarly, the study of Li et al. [45] on smart wearables acceptance among older adults found that FC positively influences PEOU. FC may help older adults to manage resources and obtain knowledge for facilitating their use of OMT. In the context of OMT, no study examined the influence of FC on PEOU among older adults. Thus, this study hypothesized that:

H6: *FC positively affects PEOU.*

2.3. Compatibility (COM)

COM is the degree to which technology meets users' needs and complies with their experience and lifestyles [46]. COM was commonly added to TAM for enhancing TAM's

explanatory power for the acceptance of various technologies among older adults, including wearable health monitoring technologies [45], self-driving vehicles [47], and self-service technologies [48]. Previous research showed that COM positively influenced PU and PEOU [45] among older adults. COM may be an important factor in explaining why older adults adopt OMT when traveling. However, no studies examined the extent to which COM influences older adults' OMT acceptance. As a result, this study hypothesized that:

H7: *COM positively affects PU.*

H8: *COM positively affects PEOU.*

2.4. Self-Satisfaction (SS)

SS means the extent to which a technology provides older adults satisfaction with their achievements [49]. Previous studies used SS to illustrate the acceptance of various technologies among older adults, such as VR exergames [50], smartphone technology [51], and Telecare [52]. Generally, SS was found to positively influence PU and PEOU among older adults. When older adults use OMT, their SS can be obtained from the desired values, such as positive feelings and a sense of achievement during traveling. Hence, this study hypothesized that:

H9: *SS positively affects PU.*

H10: *SS positively affects PEOU.*

2.5. Model Development

For obtaining an in-depth insight into the OMT acceptance among older adults, this study developed an OMT acceptance model according to the ten proposed hypotheses related to TAM, FC, COM, and SS. Figure 2 depicts the OMT acceptance.

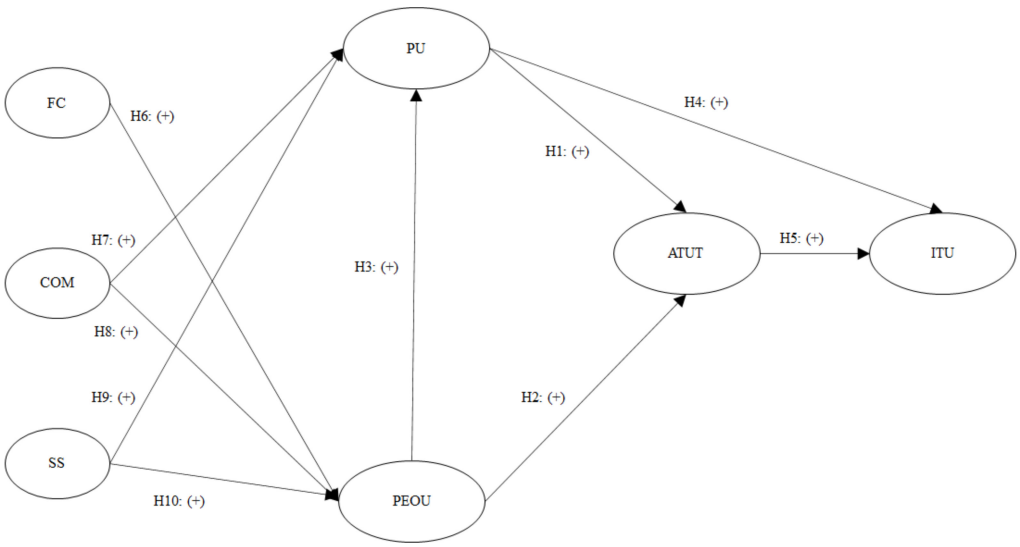

Figure 2. OMT acceptance model for older adults.

3. Methodology

3.1. Study Design

This study used a cross-sectional structured questionnaire survey for collecting quantitative data from older adults in China. The OMT acceptance model for older adults was tested and validated with the data using SEM to identify critical factors influencing the OMT acceptance among older adults. SEM can effectively investigate people's technology acceptance in different research areas, for example, automated vehicles [53,54], personal protective equipment [36,55], and enterprise resource planning systems [39]. Therefore, this study used SEM to investigate the OMT acceptance among older adults.

3.2. Measurement

The questionnaire provided a brief definition of OMT and examples such as Baidu Maps, Amap, Apple Maps, and Google Maps. In addition, two sections of the questionnaire were used to collect data about (1) participants' demographic information (i.e., age, gender, education level, and travel frequency in the last 12 months) and (2) the constructs including PU, PEOU, ATUT, ITU, FC, COM, and SS in the developed research model. For the travel frequency, it was defined as the frequency of traveling to a tourist attraction. The items for measuring the constructs were designed based on previous technology acceptance studies to suit the study context with a five-point Likert-type scale (i.e., 1 = strongly disagree and 5 = strongly agree). The item details are given in Table 1 with corresponding references.

Table 1. Measurement items of this study.

Construct	Item	Content	Reference
Perceived usefulness (PU)	PU1	Using OMT can be helpful in satisfying my traveling needs.	Davis, Bagozzi and Warshaw [32]
	PU2	Using OMT can improve my effectiveness while traveling.	
	PU3	I can find OMT helpful during my traveling.	
Perceived ease of use (PEOU)	PEOU1	Learning to use OMT is easy to me.	Davis, Bagozzi and Warshaw [32]
	PEOU2	It is easy for me to use OMT masterly.	
	PEOU3	I find OMT easy to use.	
Attitude toward using a technology (ATUT)	ATUT1	Using OMT is a good idea.	Davis, Bagozzi and Warshaw [32]
	ATUT2	Using OMT is a wise idea.	
	ATUT3	Using OMT is a pleasant experience.	
Facilitating Conditions (FC)	FC1	It is important to obtain assistance from someone when I use OMT.	Venkatesh, Morris, Davis and Davis [42]
	FC2	I have the required knowledge to use OMT.	
	FC3	Training practice is helpful and critical for the use of OMT.	
Compatibility (COM)	COM1	I consider that using OMT fits my traveling habits.	Corrocher [46]
	COM2	I consider that using OMT is compatible with my lifestyle.	
	COM3	I consider using OMT is perfect for the way I like to travel.	
Self-Satisfaction (SS)	SS1	Using OMT makes you feel younger.	Park, Han, Kim, Cho and Park [49]
	SS2	Using OMT enhances your sense of achievement.	
	SS3	Using OMT helps you to keep pace with the times.	
Intention to use (ITU)	ITU1	I will intend to use OMT during traveling.	Davis, Bagozzi and Warshaw [32]
	ITU2	I hope I will use OMT during traveling.	
	ITU3	I plan to use OMT during traveling.	

3.3. Participants

A convenience sampling method with a face-to-face questionnaire survey was adopted for collecting quantitative data from Chinese older adults (aged $\geq$ 60) from dwelling communities and parks in Guangzhou, China. Four hundred and sixteen older adults participated in this study. Table 2 shows the demographic information of the participants. The mean age of the participants was 66.6 (SD = 4.3). About half (54.1%) of the participants were female, and approximately half of the participants (49.3%) had a junior high school education level or higher. Most of the participants (93.2%) traveled once or more in the past 12 months.

Table 2. Summary of the demographic characteristics (n = 416).

	Frequency	Percentage
Age		
60–64	150	36.0%
65–69	168	40.4%
>70	98	23.6%
Gender		
Male	191	45.9%
Female	225	54.1%
Education		
Informal or Elementary	211	50.7%
Junior high school	92	22.1%
High school	81	19.5%
Post-high school	32	7.7%
Travel frequency in the last 12 months		
0 time	28	6.8%
1 time	198	47.6%
2 times	125	30.0%
>3 times	65	15.6%

3.4. Data Analysis

Confirmatory factor analysis (CFA), a technique to examine the measurement model, was adopted with the model fitness indices (Table 3) [45]. When the model fitness indices met the criteria shown in Table 3 [56], the construct validity of the measurement was regarded as acceptable. Additionally, the convergent validity (i.e., the extent to which the items for measuring the same construct are consistent) and discriminant validity (i.e., the assessment of the difference among constructs) of the measurement were examined [47]. When the average variance extracted (AVE) of each construct exceeds 0.5 and the composite reliability of each construct and the factor loading for each item exceed 0.7, the appropriate convergent validity of the measurement is supported [57]. The values of the square root of AVE (SAVE) of the constructs should be larger than the correlations among the constructs. As a result, the discriminant validity of the measurement is acceptable [57]. Cronbach's alpha was utilized to test the internal consistency of each construct measurement. A Cronbach's alpha value of 0.7 or above indicates the acceptable internal consistency of the measurement [58].

Table 3. Model fit indices for the measurement model and structural model.

Model Fit Index	Recommended Value	Measurement Model	Structural Model
χ^2/df	<5	2.21	3.05
CFI	>0.9	0.97	0.95
SRMR	≤0.08	0.04	0.07
RMSEA	≤0.08	0.05	0.08

When the reliability and validity of the measurement were proven to be acceptable, the test of all the hypotheses of the structural model (i.e., the OMT acceptance model for older adults) was conducted using SEM. The goodness-of-fit criteria for assessing the model fit of the OMT model were the same as those for measurement model assessment. AMOS 22 software was utilized to conduct CFA and SEM in this study.

4. Results

4.1. Measurement Model Assessment

The results of the measurement model assessment showed that χ^2/df, CFI, SRMR, and RMSEA satisfied the recommended criteria (Table 3), reflecting that the measurement model was sufficiently fitted to the data. The factor loading of each item and the composite

reliability of each construct were larger than 0.7 (Table 4). Additionally, the AVE of each construct was greater than 0.5. As a result, the convergent validity of the measurement was acceptable. Table 5 shows that all SAVEs were greater than bivariate correlations among the constructs, which suggested that the discriminant validity was acceptable. In addition, the Cronbach's alpha value of each construct was over 0.7, indicating that the measurement had good internal consistency reliability.

Table 4. Results for the convergent validity and reliability assessment of the measurements.

Construct	Item	Mean	Standard Deviation	Factor Loading	AVE	CR	Cronbach's Alpha
Perceived usefulness (PU)	PU1	3.68	0.97	0.83	0.71	0.88	0.88
	PU2	3.73	0.96	0.85			
	PU3	3.90	0.91	0.84			
Perceived ease of use (PEOU)	PEOU1	3.86	0.93	0.87	0.73	0.89	0.89
	PEOU2	3.82	0.90	0.90			
	PEOU3	3.77	0.93	0.79			
Attitude toward using a technology (ATUT)	ATUT1	3.76	0.85	0.90	0.70	0.87	0.86
	ATUT2	3.68	0.81	0.85			
	ATUT3	3.72	0.90	0.75			
Facilitating Conditions (FC)	FC1	3.56	0.91	0.89	0.82	0.93	0.93
	FC2	3.56	0.92	0.93			
	FC3	3.51	0.92	0.89			
Compatibility (COM)	COM1	3.68	1.07	0.88	0.81	0.93	0.93
	COM2	3.73	1.10	0.91			
	COM3	3.68	1.11	0.92			
Self-Satisfaction (SS)	SS1	3.73	0.90	0.76	0.67	0.86	0.85
	SS2	3.76	0.92	0.87			
	SS3	3.63	0.89	0.82			
Intention to use (ITU)	ITU1	3.90	0.92	0.88	0.76	0.91	0.91
	ITU2	3.71	0.93	0.87			
	ITU3	3.56	1.02	0.88			

Table 5. Results for the discriminant validity assessment.

	PU	PEOU	ATUT	FC	COM	SS	ITU
PU	0.84						
PEOU	0.66	0.85					
ATUT	0.72	0.70	0.84				
FC	0.69	0.65	0.81	0.91			
COM	0.58	0.48	0.61	0.62	0.90		
SS	0.54	0.43	0.56	0.61	0.56	0.82	
ITU	0.59	0.57	0.64	0.66	0.60	0.48	0.87

Note: All the diagonal values are square roots of the average variance extracted values for the corresponding constructs, and all off-diagonal numbers are correlations among the constructs.

4.2. Structural Model Assessment

Table 3 showed that the model fit indices for the structural model assessment met the criteria, which demonstrated that the OMT acceptance model for older adults can sufficiently represent the hypothesized relationships among the constructs. The results also showed that the OMT acceptance model could explain 48.2%, 60.9%, 64.8%, and 45.7% of the variance in PEOU, PU, ATUT, and ITU, respectively.

Table 6 summarizes the standardized path coefficients. All five hypotheses of TAM (H1–H5) were supported. Specifically, PU (β = 0.446, $p < 0.001$, H1) and PEOU (β = 0.430, $p < 0.001$, H2) positively influenced ATUT. PEOU had a positive effect on PU (β = 0.450, $p < 0.001$, H3). In addition, PU (β = 0.336, $p < 0.001$, H4) and ATUT (β = 0.388, $p < 0.001$, H5) had a positive effect on ITU. Three out of the five hypotheses related to FC, COM,

and SS were supported. Specifically, FC (β = 0.617, p < 0.001, H6) had a positive effect on PEOU. COM (β = 0.275, p < 0.001, H7) had a positive effect on PU but had no positive effect on PEOU (β = 0.108, p = 0.064, H8). Similarly, SS had a positive effect on PU (β = 0.222, p < 0.001, H9) but had no positive effect on PEOU (β = 0.006, p = 0.924, H10). Therefore, H6, H7, and H9 were supported, while H8 and H10 were rejected.

Table 6. Hypotheses testing results.

Hypothesis	Standardized Path Coefficient	*p*-Value	Result
H1: PU has a positive effect on ATUT.	0.446	<0.001	Supported
H2: PEOU has a positive effect on ATUT.	0.430	<0.001	Supported
H3: PEOU has a positive effect on PU.	0.450	<0.001	Supported
H4: PU has a positive effect on ITU.	0.336	<0.001	Supported
H5: ATUT has a positive effect on ITU.	0.388	<0.001	Supported
H6: FC positively affects PEOU.	0.617	<0.001	Supported
H7: COM positively affects PU.	0.275	<0.001	Supported
H8: COM positively affects PEOU.	0.108	0.064	Not supported
H9: SS positively affects PU.	0.222	<0.001	Supported
H10: SS positively affects PEOU.	0.006	0.924	Not supported

5. Discussion

The advancement of OMT allows older adults to overcome unfamiliarity with new places during traveling [26], thereby motivating them to travel. This study investigated important factors that affect the OMT acceptance among older adults by developing and testing the OMT acceptance model. The OMT acceptance model was developed with the theoretical framework of TAM and involved FC, COM, and SS as the external factors. The results confirmed that the OMT acceptance model sufficiently represented the hypothesized relationships. The results are explicitly discussed below from the theoretical and practical aspects, followed by the research limitations of this study.

5.1. Theoretical Contributions

This study successfully developed and tested the OMT acceptance model by integrating TAM, FC, COM, and SS to explain how older adults adopt OMT. The study results fully supported that TAM is applicable in the understanding of older adults' OMT acceptance. PU and PEOU positively affected ATUT, which, in turn, positively influenced ITU. When older adults think using OMT is easy and OMT is useful for finding available directions through public transportation, driving, walking, or biking, they tend to have a positive attitude toward using OMT. This positive attitude determines their intention to use OMT. These results are consistent with TAM of Davis, Bagozzi, and Warshaw [32] and previous studies on people's acceptance of smartwatches [59], automated vehicles [53], and personal protective equipment [36,55]. This study is pioneering to provide empirical evidence to validate TAM in the current research context (i.e., the OMT acceptance of older adults).

This study considered FC, COM, and SS as external factors for shaping PU and PEO. These factors have not been considered to explain the OMT acceptance of older adults in the literature. The results supported that PEOU was positively affected by FC. This was in line with the study of Li, Ma, Chan, and Man [45], who found that FC positively influenced PEOU in the context of smart wearables acceptance among older adults. Facilitating conditions include assistance from someone and training practice for older adults to learn skills at using OMT. Given adequate facilitating conditions, older adults consider using OMT easy. This study also found that COM and SS failed to positively influence PEOU. The compatibility of OMT and self-satisfaction were not the antecedents for PEOU in the current research context. However, COM and SS positively affected PU. When older adults feel self-satisfied with the use of OMT and perceive that OMT can satisfy their needs and comply with their experience and lifestyles, they tend to think that OMT is useful to them during traveling. These results were consistent with those of Guner and Acarturk [44],

who found that SS positively affected PU but failed to affect PEOU in the context of ICT acceptance among older adults. Additionally, Man, Xiong, Chang, and Chan [53] found that COM positively affected PU. This study confirmed the important role of FC, COM, and SS in understanding older adults' acceptance of OMT.

5.2. Practical Implications

The results of the current study are expected to be helpful for OMT developers to design OMT and adopt measures to enhance the use of OMT among older adults. First, this study found that PU positively influenced ATUT so that OMT developers should put advertisements on social media to promote the merits of using OMT, such as route planner, traffic condition information provision, and street viewer. This way can increase the PU of OMT among older adults. Second, FC and COM were found to positively affect PEOU and PU, respectively. Therefore, OMT developers should provide training videos for older adults to learn skills at using OMT [60]. Additionally, OMT developers should ensure that the user-friendly interface design of OMT facilitates its compliance with the experience and lifestyles of older adults [61] so that older adults think OMT is useful to them. Last, as self-satisfaction positively affected PU, OMT developers should pay great attention to how to enhance the self-satisfaction of older adults when using OMT.

5.3. Research Limitations

The limitations in this study provide future research opportunities. First, this study recruited participants in China. The interpretations of the study results should be cautious, because the results may not be applicable to populations in other countries. Thus, more research efforts should be made to reconduct this study with participants from other countries to generalize the results of this study. Second, this study adopted a questionnaire survey for quantitative data collection to understand the OMT acceptance among older adults. Qualitative approaches such as interviews should be applied to obtain qualitative data about the opinions of older adults about the factors affecting the acceptance of OMT in future research.

6. Conclusions

This study proposed an OMT acceptance model by integrating TAM, FC, COM, and SS for explaining the OMT acceptance among older adults. This research model was tested using SEM. The results showed that TAM was useful to explain the OMT acceptance among older adults. FC was confirmed to be a positive factor in determining PEOU, while COM and SS were found to positively influence PU. This study stressed the importance of understanding the OMT acceptance of older adults and enriched the relevant literature. The findings of this study were consistent with those of previous studies on the technology acceptance of older people in the context of smart wearables [45], smartphone [51], smart home technology [62], and online shopping [63]. The study results are helpful for OMT developers to design OMT and adopt measures to enhance the use of OMT among older adults, thereby increasing their travel frequency.

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