

# Augmented Reality for a New Reality: Using UTAUT-3 to Assess the Adoption of Mobile Augmented Reality in Tourism (MART)

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## ABSTRACT

Few industries were more affected by the COVID-19 pandemic than tourism. One of Europe's leading tourist destinations, Porto had undergone a major tourism boom until the start of pandemic. Mobile Augmented Reality (MAR) is one of the many emerging technologies that has great potential for tourist operators. Using this technology, they can create innovative tourism products that will help them recover from the present crisis. As a result, in this study, we will empirically test the latest version of the Unified Theory of Acceptance and Use of Technology (UTAUT) model to explore the factor leading to the adoption Mobile Augmented Reality in Tourism (MART) in Porto. In doing so, we aim to contribute to growing literature on the topic of Mobile Augmented Reality (MAR). The originality of this study lies in the use of an extended UTAUT model with greater predictive power and the exploration of the moderative role of gender, age and experience. To the data obtained from a random sample of 201 respondents who voluntarily answered an anonymous online questionnaire, we applied structural equation modeling and partial least squares (SEM-PLS) analysis to test the model. Our findings show that habit, hedonic motivations and facilitating conditions are the determinants of the use of MART.

**Keywords:** Virtual Reality, UTAUT, Augmented reality, MART, SEM-PLS, Tourism.

## INTRODUCTION

Few industries have been more disrupted by the pandemic than tourism (Liberato et al., 2019). During the 2010s, Porto emerged as one Europe's most attractive destinations and tourism made up 16,2% of the Gross Domestic Product (GDP) of Portugal in 2019. Porto also has the features of a smart destination: good free Wi-Fi coverage including on public transportation; widespread presence of Interactive tourist stands; good support for tourists through websites and permanent customer care service available for clarification; widespread use of QR Codes and official apps for tourism (Liberato et al., 2019). However, the imposition of travel restrictions and social distancing measures had a dramatic impact on the tourism, an industry that McKinsey predicts may only fully recover by 2024 (Espírito Santo et al., 2021).

On the other hand, the widespread adoption of smartphones and tablets has delivered an affordable and

powerful platform capable of supporting augmented reality. Indeed, most smartphones have built-in sensors (camera, Wi-Fi, compass and accelerometer), fast internet connections and touch screens that enable the use of mobile augmented reality (AR) apps in areas as varied as gaming, education, retail and tourism. Virtual and Augmented Reality (VR/AR) applications have become even more widespread in the context of the COVID-19 pandemic. Indeed, augmented reality is a technology that can help the recovery of tourism and improve the experience visiting tourist attractions (Cranmer et al., 2018). In summary, the aim of this paper is to empirically test the UTAUT-3 the adoption of MART in the city of Porto to answer the following research questions:

What factors influence individuals to adopt MART apps?

What factors are the most important in predicting the adoption of MART?

Do age and gender have a moderating role in the relationship between some of the independent variables and the intention and use of MART?

Are there any statistically significant differences in the model variables between respondents of different age, experience and gender?

## RELATED WORK

Researchers have sought to understand the adoption AR using various methods. In a literature review of the predictive models of technology acceptance, Gharibi identified the Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB) and Unified Theory of Acceptance and Use of Technology (UTAUT) as the most used models in the area of tourism (Gharibi, 2020). The study by Paulo et al. combined elements of UTAUT-2 with Technology-Task Fit (TTF) to explore the adoption of AR in tourism in Portugal (Paulo et al., 2018). The authors conclude that the future use of MART is determined by Performance Expectancy (PE), Facilitating Conditions (FC), Hedonic Motivations (HM), Habit (HB) and Technology-Task Fit (TTF). The moderators of age and gender were not found in any construct to be statistically significant in the model. Gharibeh et al. used UTAUT-2 to study the adoption of MART in Jordan and found that performance expectancy and aesthetics to be the most significant factors (Gharibeh et al., 2020). In sum, these provide an important theoretical basis for the study of these technologies, but none of them were carried out after the pandemic.

## CONCEPTUAL FRAMEWORK

### UTAUT framework

The UTAUT framework was first formulated by Venkatesh to explain the adoption of information systems by users by consolidating the contributions of 8 models (Venkatesh et al., 2003). The original model was based on 4 key constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC). In 2012, the original model was later expanded by adding 3 additional constructs to overcome the limitations of the original model: hedonic motivation (HM), price value (PV) and habit (HB) (Venkatesh et al., 2012). In addition, age, gender, experience and voluntariness act as moderators between FC, HM, PV and HB and the behavioral intention and behavior of users. Finally, UTAUT-3 was also chosen because Farroq added a new variable, personal innovativeness in IT, that has been found to be significant (Gunasinghe et al., 2019). Thus, UTAUT-3 was chosen due to its superior predictive power when compared to other versions of the model.

According to Venkatesh, older users tend to have greater difficulty in processing new information as their cognitive capabilities decline (Venkatesh et al., 2012). As a result, Venkatesh hypothesizes that older users will have greater difficulty in adopting new technologies and place greater importance on the availability of support. In addition, men tend to be more willing to spend effort in overcoming difficulties to reach their goals and depend less on external

support than women. More experienced users are naturally more familiar with a technology. As a result, they rely less on external support and find it easier to learn how to use new technologies. Gender differences and roles become more pronounced with age. To keep our model concise, we will only focus on the moderating effects of age and gender.

Now we shall describe the key constructs of UTAUT-3 (Farroq et al., 2017; Venkatesh et al., 2012, 2003). Performance expectancy (PE) is how much an individual perceives a technology like MART to be useful and bring benefits. Since adopting a new technology requires effort, effort expectancy (EE) is the perceived degree of ease of using these mobile apps in tourism activities. Social influence (SI) measures the level of pressure from family, friends and other influential people exert over an individual to adopt a MART. Facilitating conditions (FC) measures the existence of technical and organizational infrastructure (mobile internet, smartphones, etc...) that people believe are needed to use this technology. Likewise, hedonic motivation (HM) measures the pleasure and fun that an individual obtains from using MART. Price value (PV) measures the costs and benefits associated with using MART as consumers will seek to use apps that offer "good value for money". Habit (HB) represents the self-reported previous experiences of an individual in using a technology. Personal Innovativeness (PI) is a personality trait that reflects the tendency of certain individuals to try out and adopt the latest advancements in IT. Certain consumers tend to be "early adopters" of new gadgets while others will only adopt them when their use is widespread. Finally, while behavioral intention (BI) measures the reported commitment of an individual to use MART, use (U) measures the self-reported actual behavior of the user.

### Mobile Augmented Reality in Tourism (MART)

Augmented Reality is seen as a variation of VR, hence the use of terms like "VR/AR". AR blends the visual aspects of computer and physical world. By pointing the mobile device to an object it provides additional information (Turban et al., 2018; Van Krevelen and Poelman, 2010). It synchronizes real and virtual objects with each other, runs in 3D in real time and is highly interactive (Van Krevelen and Poelman, 2010). AR can make the experience of tourists more creative, spontaneous and convenient. It can help tourists with find parking, accommodation, restaurants and monuments, navigating public transport systems, obtaining weather forecasts and give more information about the surrounding environment (Law et al., 2014). The integration with social media can allow tourists to share information and tips online. The imposition of international travel restrictions affecting 90% of the world population jeopardized the tourism and travel industries (Singh et al., 2020). Thus the demand for mobile and web-based AR increased dramatically and is seen as an important tool to help relaunch the tourism industry (Mohanty et al., 2020).

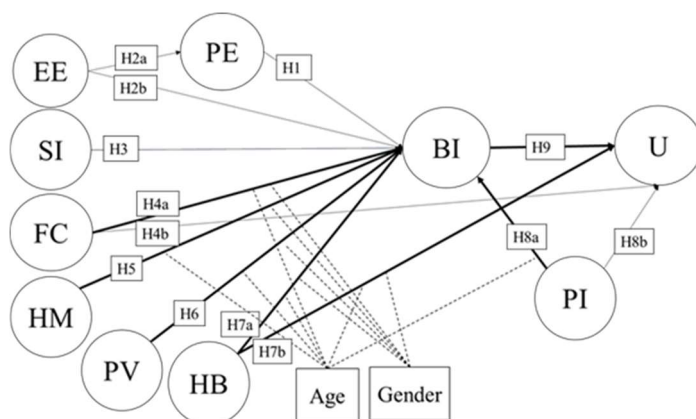
## METHODS

This study is quantitative in nature. Based on a literature review, we will propose and empirically test a model based on UTAUT-3. To that end, we will use WarpPLS 7.0<sup>1</sup> to run a partial least square regression (SEM-PLS) to estimate the model that can

be seen in **Figure 1**. This method was chosen because not all items in the data follow a normal distribution ( $p < 0,05$  based on Kolmogorov-Smirnov test) and the model is complex. To further explore differences in mean between different age and experience groups we carried the independent variables *t*-test and a one-way ANOVA test to explore differences between age groups. In the following section, we will list the hypothesis that we shall test and provide empirical studies to support them:

- H1: The relationship between performance expectancy and the behavioral influence to use MART is positive. (Giovanis et al., 2019; Oliveira and Baptista, 2017; Saxena and Kumar, 2017)
- H2b: The relationship between effort expectancy and performance expectancy is positive. (Paulo et al., 2018; Venkatesh et al., 2012)
- H2b: The relationship between effort expectancy and the behavioral influence to use MART is positive. (Bhatiasavi, 2015; Gharaibeh et al., 2020; Tan and Leby Lau, 2016)
- H3: The relationship between social influence and the behavioral influence to use MART is positive. (Giovanis et al., 2019; Oliveira and Baptista, 2017; Paulo et al., 2018; Tan and Leby Lau, 2016)
- H4a: The relationship between facilitating conditions and the behavioral intention to use MART is positive and moderated by age and gender. (Alqahtani and Kavakli, 2017; Gharaibeh et al., 2020; Krogstie, 2012; Oliveira and Baptista, 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Shang et al., 2017)
- H4b: The relationship between facilitating conditions and the actual use of MART is positive.
- H5: The relationship between hedonic motivation and behavioral intention to use MART is positive and moderated by age and gender. (Ali et al., 2016; Arain et al., 2019; Heijden, 2004; Jung et al., 2015; Richards, 2011)
- H6: The relationship between price value and behavioral intention to use MART is direct and moderated by age and gender. (Blaise et al., 2018; de Kerviler et al., 2016; Sharma et al., 2017; Slade et al., 2015)
- H7a: The relationship between habit and behavioral intention to use MART is positive and moderated by age and gender. (Kim and Malhotra, 2005; Venkatesh et al., 2012)
- H7b: The relationship between habit and actual use of MART is positive and moderated by age and gender.

- H8a: The relationship between personal innovativeness and behavioral intention to use MART is positive and moderated by age. (Ramos-de-Luna et al., 2016)
- H8b: The relationship between personal innovativeness and the actual use of MART (Ramos-de-Luna et al., 2016)
- H9: The relationship between behavioral intention to adopt MART and actual use of MART is positive. (Davis, 1989; Paulo et al., 2018; Venkatesh et al., 2003)
- H10a: Gender moderates the relationship between habit and behavioral intention to use MART. (Ahmad et al., 2005; Dirin et al., 2019; Paulo et al., 2018; Venkatesh et al., 2012)
- H10b: Gender moderates the relationship between habit and actual use of MART. (Ahmad et al., 2005; Dirin et al., 2019; Paulo et al., 2018; Venkatesh et al., 2012)
- H11: Gender moderates the relationship between price value and behavioral intention to use MART. (Ahmad et al., 2005; Dirin et al., 2019; Paulo et al., 2018; Venkatesh et al., 2012)
- H12: Gender moderates the relationship between hedonic motivation and behavioral intention to use MART. (Ahmad et al., 2005; Dirin et al., 2019; Paulo et al., 2018; Venkatesh et al., 2012)
- H13: Gender moderates the relationship between facilitating conditions and the behavioral intention to use MART. (Ahmad et al., 2005; Dirin et al., 2019; Paulo et al., 2018; Venkatesh et al., 2012)
- H14: Age moderates the relationship between personal innovativeness and behavioral intention. (Farooq et al., 2017; Paulo et al., 2018; Seifert and Schlomann, 2021; Venkatesh et al., 2012)
- H15a: Age moderates the relationship between habit and behavioral intention to use MART (Paulo et al., 2018; Seifert and Schlomann, 2021; Venkatesh et al., 2012)
- H15b: Age moderates the relationship between habit and actual use of MART (Paulo et al., 2018; Seifert and Schlomann, 2021; Venkatesh et al., 2012)
- H16: Age moderates the relationship between hedonic motivation and behavioral intention to use MART. (Paulo et al., 2018; Seifert and Schlomann, 2021; Venkatesh et al., 2012)
- H17: Age moderates the relationship between price value and behavioral intention to use MART (Paulo et al., 2018; Seifert and Schlomann, 2021; Venkatesh et al., 2012)
- H18: Age moderates the relationship between facilitating conditions and the behavioral intention to use MART. (Paulo et al., 2018; Seifert and Schlomann, 2021; Venkatesh et al., 2012)



**Figure 1.** Research Model Proposal

**Table 1.** Analysis of the Sample

		n	%
Gender	Male	78	39
	Female	123	61
Age	<21	16	8
	[21,41]	134	67
	[41,61]	27	13
	>61	24	12
Experience with MART	Yes	172	86
	No	29	14

**Table 2.** Descriptive statistics and individual reliability for all items

Item	Mean	S.D.	$\lambda$	Item	Mean	S.D.	$\lambda$
PE1	4.36	0.99	0.956	PV2	3.38	0.99	0.960
PE2	4.18	1.01	0.946	PV3	3.36	1.01	0.943
PE3	4.13	1.04	0.941	HB1	3.28	1.37	0.927
EE1	4.28	0.93	0.917	HB2	2.67	1.20	0.817
EE2	4.17	0.92	0.940	HB3	2.90	1.27	0.893
EE3	4.17	0.85	0.902	HB4	3.21	1.32	0.926
EE4	4.18	1.01	0.947	PI1	3.77	1.17	0.914
SI1	3.21	1.19	0.868	PI2	3.66	1.14	0.922
SI2	3.24	1.19	0.829	PI3	2.82	1.27	0.851
SI3	2.75	1.33	0.781	BI1	3.87	1.12	0.953
SI4	2.37	1.27	0.791	BI2	3.57	1.18	0.957
FC1	4.00	1.05	0.811	BI3	3.78	1.17	0.975
FC2	4.06	1.10	0.842	U1	4.39	1.10	0.751
FC3	3.99	1.00	0.860	U2	3.45	1.27	0.774
FC4	3.59	1.10	0.723	U3	4.18	1.11	0.848
HM1	3.75	1.00	0.934	U4	3.84	1.30	0.777
HM2	3.75	1.04	0.947	U5	3.92	1.23	0.785
HM3	3.59	1.09	0.922	U6	3.56	1.30	0.676
PV1	3.32	0.99	0.941	U7	2.91	1.56	0.806

### Sample and Data Collection

Based on an extensive literature review, we developed a questionnaire that distributed on social media to an audience of consumers from the city of Porto (see **Table 7**). Confidentiality and anonymity of participants was assured, all items were measured with a 5-point Likert scale and participation was voluntary. A pilot test was carried out with 20 answers and final adjustments were made. The Harman's single factor test was carried out and no evidence of common method bias was found.

We obtained a random and independent sample of 201 respondents from the city of Porto. Indeed, for a SEM-PLS analysis, the dimension of the sample should not be below 200 (Boomsma and Hoogland, 2001). Over 95% of respondents have a smartphone or tablet and mobile internet on their smartphones. 86% of respondents have experience with MART (see **Table 1**). In terms of age and gender, 61% of respondents are female and 75% are below the age of 41. Thus, this sample of mostly tech-savvy, urban and young individuals mirrors that the population of MART users but not the general population of the city.

## RESULTS

### Reliability and Validity Analysis

For an item to reflect the construct it is trying to measure, their outer loading ( $\lambda$ ) must be at least 0,7 (Hussain et al., 2018). Items whose  $\lambda$  is under 0,7 were eliminated –

U6(0.676). We used to metrics of convergent validity: Composite Reliability (CR) and Cronbach's Alpha ( $\rho_T$ ) whose values tend to be similar. Since all constructs have a CR and  $\rho_T$  above 0.8, we have a level of convergent validity adequate for applied research (Netemeyer et al., 2003; Nunnally and Nunnally, 1978). Convergent validity is assured as no key construct has an average variance extracted (AVE) below 0.5 (Fornell and Larcker, 1981). The analysis of descriptive statistics reveals that our sample displays high levels of PE, EE, FC, HM, BI and U (3,5-5) and moderate levels (2,5-3,5) of SI, PV, HB and PI (see **Table 2**). Divergent validity establishes how a certain construct differs from the others in our study. All constructs have discriminant (divergent) validity as the positive square root of the AVE for all factors is higher than the highest correlation with any other factor (see **Table 3**) (Fornell and Larcker, 1981).

### Predictive Power

In **Table 4**, to assess the predictive power of the latent endogenous variables we will use two indicators: Explained Variance and Stone-Geisser test. Since the  $Q^2$  values for all latent endogenous values are above 0 and the explained variance is above 0,1, the variables have reasonable predictive power (Falk and Miller, 1992). Since all latent endogenous variables have an  $R^2$  above 0,1, these constructs have a reasonable predictive power.



**Table 3.** Measures of validity and reliability for all key constructs

	$\rho_r$	CR	AVE	PE	EE	SI	FC	HM	PV	HB	PI	BI	U	Gender	Age
PE	0.943	0.964	0.898	.95											
EE	0.945	0.960	0.858	.69	.93										
SI	0.834	0.890	0.669	.01	.04	.82									
FC	0.824	0.884	0.657	.54	.63	.19	.81								
HM	0.927	0.954	0.873	.58	.64	.30	.55	.93							
PV	0.944	0.964	0.899	.50	.46	.21	.53	.54	.95						
HB	0.913	0.939	0.795	.45	.47	.39	.42	.59	.59	.89					
PI	0.877	0.925	0.804	.45	.62	.18	.57	.58	.43	.43	.90				
BI	0.959	0.974	0.925	.51	.56	.29	.49	.68	.58	.80	.52	.96			
U	0.885	0.913	0.637	.41	.49	.32	.48	.52	.38	.57	.49	.67	.78		
Gender				-.29	-.09	.26	-.17	-.06	-.18	-.02	-.00	-.03	.06	1.0	
Age				.47	-.46	.18	-.26	-.27	-.22	-.14	-.28	-.15	-.01	.35	1.0

**Table 4.** Predictive Power: Explained Variance and Stone-Geisser test values

Latent endogenous variables	R <sup>2</sup>	Q <sup>2</sup>
Performance Expectancy (PE)	0.527	0.534
Behavior Intention (BI)	0.748	0.753
Use (U)	0.576	0.580

**Table 5.** Results of the tests of hypothesis<sup>2</sup>

Hypothesis	$\beta$	<i>t</i>	<i>p</i> -value	Hypothesis	$\beta$	<i>T</i>	<i>p</i> -value
H1 – PE→BI	0.03	0.4	0.34	H9 – BI→U	0.28	4.18	<0.001***
H2a – EE→PE	0.73	11.8	<0.001***	H10a – Gender*HB→BI	-0.07	-1.07	0.144
H2b – EE→BI	-0.05	-0.73	0.23	H10b – Gender*HB→U	-0.01	-0.07	0.471
H3 – SI→BI	-0.02	-0.23	0.41	H11 – Gender*PV→BI	-0.07	-0.99	0.161
H4a – FC→BI	0.16	2.37	0.009**	H12 – Gender*HM→BI	0.06	0.88	0.190
H4b – FC→U	0.19	2.73	0.004**	H13 – Gender*FC→BI	-0.07	-1.01	0.157
H5 – HM →BI	0.18	2.63	0.005**	H14 – Age*PI→U	0.19	2.86	0.002**
H6 – PV→BI	0.08	1.21	0.114	H15a – Age*HB→BI	0.12	1.68	0.047*
H7a – HB→BI	0.52	8.10	<0.001***	H15b – Age*HB→U	0.06	0.85	0.198
H7b – HB→U	0.2	3.00	<0.002**	H16 – Age*HM→BI	0.06	0.89	0.189
H8a – PI→BI	0.03	0.44	0.331	H17 – Age*PV→BI	-0.08	-1.09	0.140
H8b – PI→U	0.00	0.03	0.490	H18 – Age*FC→BI	-0.05	-0.65	0.257

**Results of the hypothesis tests**

For a one-sided Student’s *t* distribution with 200 degrees of freedom, the critical *t* values are:  $t(95\%)=1.6525^*$ ,  $t(99\%)=2.3451^{**}$ ,  $t(99.9\%)=3.131^{***}$ . In a total of 24 hypothesis, only 9 were not rejected with 95% confidence. H1, H2b, H3, H6, H8a, H8b, H10a, H10b, H11-13, H15b-18 can be rejected with 95% confidence because their *t* values are below 1,652 and their *p*-value is higher than 0,05. H2a, H4a, H4b, H5, H7a, H7b, H9 and H14-15a cannot be rejected with 95% confidence because their *t* values are above 1,652 and their *p*-value is lower than 0,05 (see Table 5).

Unlike what was initially hypothesized, with 95% confidence, we can say that the only variables that influence the use of MART are facilitating conditions, hedonic motivations and habit. Behavioral intention influences the actual use of MART, hence, all variables that influence BI have an indirect effect on U. People who intent to use MART end up using this technology. HM only plays and indirect role (through BI) while FC and HB have both a direct and indirect effect on U. Habit is the most important determinant of the use of MART – total effect = indirect effect + direct effect =  $\beta_{H9} * \beta_{H7a} + \beta_{H7b} = 0,52*0,28+0,2 = 0,346$ . We can also break down the total effect of FC on the use of MART in indirect ( $\beta_{H9} * \beta_{H4a} = 0,16*0,28= 0,045$ ) and direct effects ( $\beta_{H4b} = 0,19$ ). Finally, at 95% confidence, contrary to our initial hypothesis, there is no evidence that gender moderates the relationship between any

of the variables. Age only seems to moderate the relationship between personal innovativeness and use and habit and behavioral intention. As people grow older, the link between HB and BI and PI and U grows stronger. With 95% confidence, after running an independent samples *t*-test, there are no statistically significant differences between men and women except two variables: performance expectancy and social influence. On average, female respondents exhibit higher levels of performance expectancy and lower levels of social influence than male respondents. On the other hand, between the group of respondents with and without experience, there are significant differences all variables except SI. On average, users with experience exhibit significantly higher levels of performance and effort expectancy, facilitating conditions, hedonic motivations, price value, habit, personal innovation, behavioral intention and use of MART than users without experience. To explore the differences between different age groups we ran a one-way ANOVA test with 95% confidence. There are statistically considerable differences between age groups in all variables. On average, the only variable that steadily increases with age is social influence. The group aged between 21 and 41 years old (Millennials and some Gen-Z) is the group with the highest levels of BI, PI, HB, PV, HM, FC, EE and PE. The group over the age of 61 (Baby Boomers and Silent Generation) exhibits the lowest average score in all variables except SI in which they have the highest average score. As a result, in line with the ideas of Venkatesh, all variables except SI tend to decline with age.

<sup>2</sup> $p<0.05$  (\*),  $p<0.01$  (\*\*),  $p<0.001$  (\*\*\*)

**Table 6.** Model fit indicators (Kock, 2010)

Indicators	Values	Acceptable values
GoF	0.748	$\geq 0.36$
AFVIF	3.229	$\leq 5$
SPR	0.708	$\geq 0.7$
RSCR	0.930	$\geq 0.9$
SSR	1	$\geq 0.7$
NLBCDR	1	$\geq 0.7$
STDSR	0.824	$\geq 0.7$
STDRCR	0.942	$\geq 0.7$
SMAR	0.076	$\leq 0.1$
SRMR	0.097	$\leq 0.1$

**Table 7.** Items and sources of the questionnaire

Item	Question	Source
PE	PE1 I believe that mobile internet and apps are useful in tourism	(Farooq et al., 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Venkatesh et al., 2012, 2003)
	PE2 I believe that mobile internet and apps enhance my chances of getting things that are important	
	PE3 I believe that MAR makes tourism more convenient	
EE	EE1 Learning how to use mobile internet and apps for touristic activities is easy	(Farooq et al., 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Venkatesh et al., 2012, 2003)
	EE2 My interaction with MART is clear and understandable	
	EE3 I find mobile internet and apps are easy to use in touristic activities	
	EE4 It is easy to become adept at using mobile internet and apps in tourism	
SI	SI1 People who influence me think that I should use MART	(Farooq et al., 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Venkatesh et al., 2012, 2003)
	SI2 People who are important to me think that I should use MART	
	SI3 People in my environment who use MART are more prominent	
	SI4 Using MART is a status symbol	
FC	FC1 I have the necessary resources to take advantage of MART	(Farooq et al., 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Venkatesh et al., 2012, 2003)
	FC2 I have the necessary knowledge to use MART	
	FC3 Mobile internet is compatible with other technologies I use in tourism	
	FC4 I can get help from others when I have difficulties with MART	
HM	HM1 Using mobile internet and apps in touristic activities is fun	(Farooq et al., 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Venkatesh et al., 2012)
	HM2 Using mobile internet and apps in touristic activities is enjoyable	
	HM3 Using mobile internet and apps in touristic activities is captivating	
PV	PV1 Mobile internet and apps for touristic activities are reasonably priced	(Farooq et al., 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Venkatesh et al., 2012)
	PV2 Mobile internet and apps for touristic activities are good value for money	
	PV3 At the current price, MART provides good value for money	
HB	HB1 The use of mobile internet and apps in touristic activities is a habit	(Farooq et al., 2017; Paulo et al., 2018; Saxena and Kumar, 2017; Venkatesh et al., 2012)
	HB2 I am addicted to using mobile internet and apps in touristic activities	
	HB3 I must use mobile internet and apps in touristic activities	
	HB4 Using mobile internet and apps in touristic activities is natural	
PI	PI1 I like to experiment new apps, gadgets and technologies	(Farooq et al., 2017)
	PI2 When a mobile app introduces a new feature, I am keen to try it out	
	PI3 Usually I am the first to use new gadgets and technologies among my peers	
BI	BI1 I intend to continue using mobile internet and apps in the future	(Paulo et al., 2018; Venkatesh et al., 2003)
	BI2 I will always try to use mobile internet and apps in touristic activities	
	BI3 I plan to continue to use mobile internet and apps frequently in tourism	
U	U1 Maps	(Paulo et al., 2018)
	U2 Museums and Tourist Attractions	
	U3 Finding restaurants, bars and cafés	
	U4 Find accommodation	
	U5 Transports	
	U6 Events	
	U7 Virtual Trips and E-tourism	

### Results of the hypothesis tests

Finally, we sought to assess the if our model has a good fit by presenting several indicators in **table 6**. As we can see, since all the values of the indicators are within the acceptable values, this model is reasonably consistent with the data. No re-specification of the model is required. The Average full collinearity VIF (AFVIF) is below 3.3 which is ideal and shows that there are no signs of multicollinearity. In **figure 2**, we present a summary of the estimated empirical model.

### CONCLUSION AND FUTURE WORKS

In sum, after empirically testing the UTAUT3 model we can reveal important findings about the state of adoption of MART in Porto. In contrast to initial premises, the only variables that have an impact on the use of MART are facilitating conditions, hedonic motivations and habit. Thus, respondents seem not to be influenced by prices, the opinions of others (relatives, friends and colleagues), the effort that it takes to use MART, their own expectations of the benefits they can obtain from using this technology nor do they seem to be influenced by their tendency to be “early adopters” of new technologies. The independent variables of UTAUT-3 can explain 75% of variation in BI. In turn, EE can explain 53% of variation in PE. BI, FC, HB and PI explain 58% of variation in the use of MART.

Our study has several important implications. First, tech and tourism companies should study the market that they are trying to reach and segment the market. Our analysis of moderators showed that only age has a significant influence in the relationships between personal innovation and use and habit and behavioral intention. There are significant differences in behavior and attitudes of various age groups. Most notably, the groups under 21 and between 21 and 41 (Gen Z and Millennials) exhibit the highest levels of intention to use MART, but the group that shows the highest level of use is the aged between 41 and 61 (Gen X and some Baby Boomers). As a result, the younger generations are the ones that are driving the growth in the use of mobile technologies. As a result, the needs of consumers vary with age. For example, Gen Z and Millennial tourists are usually very keen on using maps to get

around the city, apps to find a place to eat and to stay but use apps for cultural events and virtual trips far less often than Gen X users. Indeed, the adoption of this technology makes tourist activities more convenient, fun and enjoyable. However, special attention needs to be given to older tourists as they require greater support than most. Because the elderly tend to suffer more from health conditions, app developers need to make accessibility a top priority to reach this growing market segment in Portugal. Gender plays no moderating role and gender differences between men and women are only felt in two variables. In contrast, there are very large differences between experienced and non-experienced users in nearly all indicators.

Consumers are also becoming increasingly demanding and focused on experiences. The use of MART is largely a matter of habit. Maintaining a loyal user base should be a greater priority than simply boosting the number of downloads of an app. Even before the begging of the tourist trips, users can use apps to help them plan a trip (places to visit, places to eat, booking hotels, etc...). In designing the apps, the most important thing is to make them pleasant to use and able to provide moments of enjoyment to travelers. Facilitating conditions is statistically significant because to use MART requires that users adopt other technologies (smartphones, tablets, 4G internet, etc...) beforehand. Though the use of smartphones and tablets has become widespread and Porto has an good public Wi-fi network, it is essential not to take for granted that all consumers have the necessary equipment and support to use MART. Finally, it is important to remember that these technologies are still developing and the introduction of 5G technology may open many new applications for MART.

Our research paper has some limitations related to the size and composition of the sample. The sample is comprised of consumers from Porto and its composition is different from that of the general population of the city. In general, the group of respondents is, on average, significantly younger than the population of the city. However, users of MART tend to be mostly urban, tech-savvy and young just like our sample. Thus, one must be careful before generalizing the findings of this study to other contexts. Another limitation is that we relied on self-reported user behavior. Future researchers should seek to monitor how much participants use a certain app in practice.

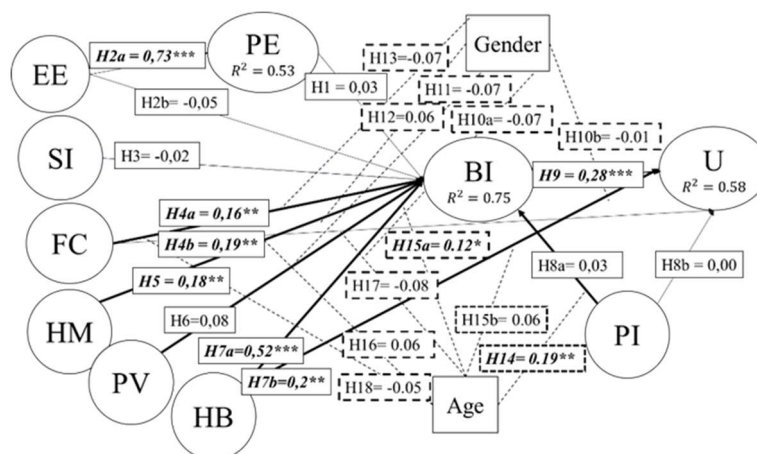


Figure 2. Summary of Estimated Research Model

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