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A study on adoption of mobile augmented reality in tourism sector

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Abstract: *The COVID-19 pandemic significantly impacted the tourism industry worldwide, a major tourist destination that had experienced a tourism boom before the crisis. Augmented Reality (AR) presents opportunities for tourist operators to innovate and recover. This study tests an extended version of the Unified Theory of Acceptance and Use of Technology (UTAUT) model to identify factors influencing the adoption of Augmented Reality in Tourism in India. By analysing data from 201 respondents through structural equation modelling, the study finds that habit, hedonic motivations, and facilitating conditions are key determinants for AR use.*

Key Words: *Augmented Reality, UTAUT, Adoption, SEM-PLS, Tourism.*

1. INTRODUCTION:

The pandemic has significantly disrupted the tourism industry, which had become a prominent destination by 2019. It features sAugmented Reality destination elements such as free Wi-Fi, interactive tourist stands, and robust online support services. Despite these advantages, the introduction of travel restrictions and social distancing has severely affected tourism, with forecasts indicating a full recovery may not occur until 2026.the factors influencing the adoption of Augmented Reality Tourism apps, focusing on age and gender's moderating roles in adoption intentions and usage. It highlights significant disruptions in the tourism industry due to the pandemic, which has severely impacted destinations where tourism comprised 16.2% of india's GDP in 2019. it is characterized by its sAugmented Reality destination features, such as widespread Wi-Fi and QR codes. The rise of sAugmented Realityphones has facilitated the integration of augmented reality in tourism, which may aid recovery post-pandemic. The paper aims to test the UTAUT-3 model to analyze AR adoption in India and respond to specific research questions regarding these dynamics.

Researchers have examined the adoption of Augmented Reality (AR) through various models, notably the Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT), particularly in tourism contexts. A study by Paulo et al. integrated UTAUT-2 with Technology-Task Fit (TTF) to analyze AR adoption finding that future use is influenced by Performance Expectancy (PE), Facilitating Conditions (FC), Hedonic Motivations (HM), Habit (HB), and TTF, with no significant effects from age or gender. Similarly, Gharaibeh et al. explored Augmented Reality adoption in Jordan using UTAUT-2, highlighting performance expectancy and aesthetics as key factors. However, notable gaps exist as none of these studies were conducted post-pandemic.

2. Conceptual Framework :

The UTAUT framework, developed by Venkatesh to explain information systems adoption, initially included four key constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). In 2012, the model was expanded to include three additional constructs—hedonic motivation (HM), price value (PV), and habit (HB)—to address its limitations. Moderators such as age, gender, experience, and voluntariness also influence the relationship between these constructs and user behavior. UTAUT-3 was later introduced, incorporating personal innovativeness in IT, enhancing its predictive power compared to previous versions.

Venkatesh (2012) suggests that older users struggle more with new information due to cognitive decline, making them less likely to adopt new technologies without adequate support. Men typically put more effort into overcoming challenges and rely less on external help compared to women. More experienced users find it easier to learn new technologies due to familiarity. Gender differences become more prominent with age.The UTAUT-3 model (Farooq et al., 2017) includes several key constructs:- Performance Expectancy (PE): the perceived usefulness of a technology.- Effort Expectancy (EE): the ease of using mobile apps in tourism.- Social Influence (SI): pressure from peers to adopt technology.- Facilitating Conditions (FC): necessary infrastructure for technology use.- Hedonic Motivation (HM): enjoyment derived from using technology.- Price Value (PV): cost-benefit analysis of technology usage.- Habit (HB): previous experiences with technology.- Personal Innovativeness (PT): willingness to try new tech.- Behavioral Intention (BI): commitment to using technology, while actual usage measures reported behavior.

2.1 Augmented Reality in Tourism

Augmented Reality (AR) is considered a variant of Virtual Reality (VR), merging visual elements of the digital and physical worlds. By using mobile devices to interact with real objects, AR delivers additional information in real time, enhancing user experience through interactivity. It supports tourists by providing essential services like finding accommodations, restaurants, navigating transport, and accessing local information. The integration with social media fosters sharing among travelers. The COVID-19 pandemic's travel restrictions significantly impacted the tourism sector, leading to a surge in demand for mobile and web-based AR as a tool to revitalize the industry.

3. Research Methodology :

This quantitative study aims to propose and test a model based on UTAUT-3, using WarpPLS 7.01 for partial least square regression (SEM-PLS). The method was chosen due to non-normal data distribution and model complexity. The study will also analyze mean differences across age and experience groups using t-tests and one-way ANOVA. Hypotheses will be listed and supported by empirical studies in the subsequent section.

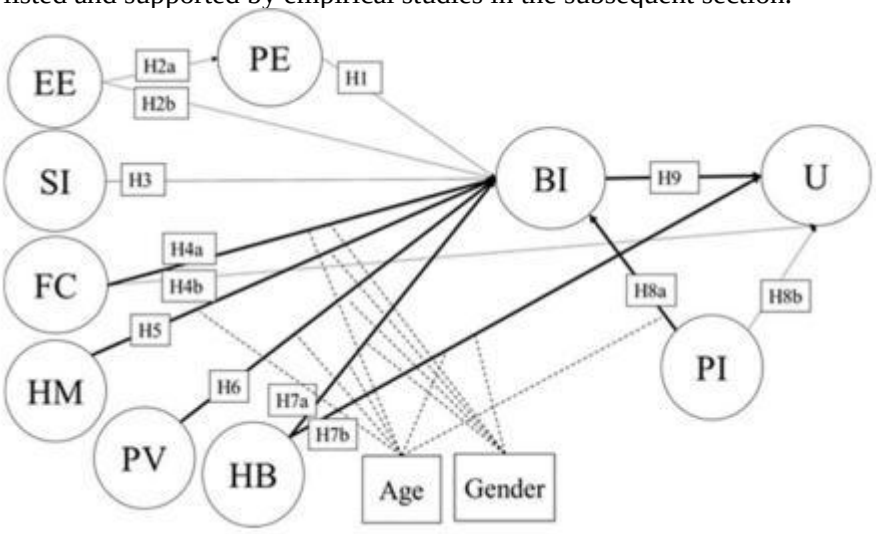

Figure 1: Research Model

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	Yes	172	86
MART	No	29	14

Table 2. Descriptive statistics and individual reliability for all items

Item	Mean	S.D.	λ	Item	Mean	S.D.	λ
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

4. Sample and data collection

An extensive literature review led to the development of a questionnaire distributed via social media to consumers in India. Participants' confidentiality and anonymity were guaranteed, and responses were collected using a 5-point Likert scale with voluntary participation. A pilot test with 20 responses was conducted, resulting in final adjustments. Harman's single factor test indicated no common method bias.

A random sample of 201 respondents from India was analyzed for SEM-PLS, meeting the minimum sample size requirement. Over 95% own sAugmented Realityphones or tablets with mobile internet, and 86% have experience with Augmented Reality. The demographic data shows that 61% are female, and 75% are under 41 years old, indicating a sample that reflects Augmented Reality users but not the general population of the city.

5. Results :

To accurately reflect the construct being measured, items must have an outer loading (λ) of at least 0.7; those below this threshold, such as U6 (0.676), were removed. Convergent validity was assessed using Composite Reliability (CR) and Cronbach's Alpha (ρT), both exceeding 0.8 across all constructs, indicating adequacy for applied research. Additionally, no key construct had an average variance extracted (AVE) below 0.5. Descriptive statistics indicated high levels of performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC), hedonic motivation (HM), behavioral intention (BI), and use (U), alongside moderate levels of social influence (SI), price value (PV), habit (HB), and performance impact (PI). Divergent validity was confirmed as the square root of the AVE for all factors was higher than their highest correlations.

Table 4 assesses the predictive power of latent endogenous variables using Explained Variance and the Stone-Geisser test. All Q2 values are above 0, and explained variance exceeds 0.1, indicating these variables possess reasonable predictive power. Moreover, all latent endogenous variables have an R2 over 0.1, further confirming their predictive capability.

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

	ρT	CR	AVE	PE	EE	SI	FC	HM	PV	HB	PI	BI	U	Gende r	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^2**	**Q^2**
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[2]

Hypothesis	***β***	***t***	***p*-value**	**Hypothesis**	***β***	***T***	***p*-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

Hypothesis

For a one-sided Student's t distribution with 200 degrees of freedom, critical t values are t(95%)=1.6525, t(99%)=2.3451, and t(99.9%)=3.131. Out of 24 hypotheses tested, 9 were not rejected at 95% confidence, indicating that only certain variables influence the use of Augmented Reality: facilitating conditions, hedonic motivations, and habit. Habit is identified as the most significant determinant of Augmented Reality use. While behavioral intention affects actual use, it operates indirectly through these key variables. Contrary to initial hypotheses, gender does not moderate relationships between variables, but age affects personal innovativeness and habit. Significant differences between men and women were found in performance expectancy and social influence. Experienced users of Augmented Reality demonstrate higher levels of various motivational factors compared to inexperienced users. A one-way ANOVA revealed that, generally, variables decline with age, except social influence, which increases, with Millennials showing the highest levels of intent and innovation.

Table 6. Model fit indicators (Kock, 2010)

Indicators	Values	Acceptable values
GoF	0.748	≥0.36
AFVIF	3.229	≤5
SPR	0.708	≥0.7
RSCR	0.930	≥0.9
SSR	1	≥0.7
NLBCDR	1	≥0.7
STDSR	0.824	≥0.7
STDCR	0.942	≥0.7
SMAR	0.076	≤0.1
SRMR	0.097	≤0.1

The assessment of our model's fit, as shown in table 6, reveals that all indicator values fall within acceptable ranges, indicating a good consistency with the data and negating the need for model re-specification. The Average Full Collinearity VIF (AFVIF) is below 3.3, indicating no multicollinearity issues. Figure 2 provides a summary of the estimated empirical model.

6. Conclusion:

The study testing the UTAUT3 model reveals that in India, the adoption of Augmented Reality is primarily influenced by facilitating conditions, hedonic motivations, and habit. Factors such as price, social influence, perceived effort, expectation of benefits, and early adoption tendencies do not significantly affect usage. The UTAUT3 independent variables account for 75% of the variance in behavioral intention (BI), while effort expectancy (EE) explains 53% of the variance in perceived enjoyment (PE). Additionally, BI, facilitating conditions (FC), habit (HB), and perceived influence (PI) account for 58% of the variance in Augmented Reality usage.

The study highlights key implications for tech and tourism companies regarding market segmentation, emphasizing the significant age-related differences in technology use and behavioral intentions. It finds that younger generations, particularly Gen Z and Millennials, show high intention to use mobile apps for navigation and dining, while older users (Gen X and Baby Boomers) exhibit greater actual usage. As technology enhances tourist experiences, there's a need to prioritize accessibility for older tourists, who may require more support. Gender differences are minimal, with notable disparities between experienced and non-experienced users across various indicators.

The research paper identifies limitations regarding the sample size and composition, which primarily consists of younger, urban, tech-savvy consumers from India, differing from the city's general population. This raises concerns about the generalizability of the findings. Additionally, the study relied on self-reported user behavior, suggesting that future research should involve monitoring actual app usage for more accurate data.

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