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The Immersive Technology Adoption for Competitive Advantage Model (ITACOM): A Comprehensive Framework For AR/VR Adoption In Tourism

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Abstract
This study develops the Immersive Technology Adoption for Competitive Advantage Model (ITACOM), integrating UTAUT with competitive dynamics theory to explain AR/VR adoption in emerging market tourism. Analyzing 200 Indonesian travel agencies using PLS-SEM, we identify three adoption dimensions: Technology Infrastructure, Strategic-Competitive, and Human-Organizational. All seven antecedents significantly influence adoption (R^2 = 67.5%), with performance expectancy and competitive pressure as primary drivers. The model reveals dual-path value creation: strategic factors show partial mediation while operational factors demonstrate full mediation to competitive advantage (R^2 = 62.9%). Surprisingly, no geographic differences emerged between Java and outer islands, suggesting digital democratization. However, implementation sophistication significantly moderates adoption-outcome relationships. ITACOM advances theory by demonstrating asymmetric value creation patterns and provides practical tools for tourism organizations navigating digital transformation. The framework's dimensional structure and mediation mechanisms offer novel insights for technology adoption in resource-constrained contexts.
Keywords: *Augmented reality; Virtual reality; Technology adoption; Competitive advantage; UTAUT; Digital transformation*

1. INTRODUCTION

The COVID-19 pandemic catalyzed fundamental transformation in global tourism, positioning digital technologies as critical recovery enablers (Van Der Schaft et al., 2024). Among these, augmented reality (AR) and virtual reality (VR) emerged as transformative forces, transcending traditional service limitations through immersive experiences (Bretos et al., 2024). Indonesia's tourism sector, experiencing a precipitous 75% decline in international arrivals, exemplifies the digital transformation imperative for competitive recovery (UNWTO, 2024).

Despite recognized potential, AR/VR adoption remains paradoxically low in emerging markets. Indonesia's 23% adoption rate among travel agencies significantly lags regional competitors—Singapore (52%), Malaysia (45%), Thailand (38%)—revealing substantial implementation gaps (Alam et al., 2024). This disparity is particularly pronounced given that only 22% of Indonesia's 5,066 registered agencies achieved highest accreditation, indicating heterogeneous technological readiness (Pusat Kajian Pariwisata Indonesia, 2024).

Existing literature predominantly examines consumer acceptance (Yu et al., 2024), neglecting organizational adoption dynamics in emerging markets where infrastructure constraints and resource limitations fundamentally alter adoption patterns (Ali et al., 2024). Current models fail to capture immersive technology's unique complexities, particularly the interplay between readiness, competitive pressures, and risk perceptions characterizing emerging contexts. This theoretical void prevents organizations from understanding not just adoption decisions, but how antecedents create competitive advantage through differential value pathways.

To address these gaps, we develop and validate ITACOM—a comprehensive framework extending UTAUT with contextual factors specific to AR/VR adoption. The model incorporates technology readiness, risk perception, and competitive pressure while explicitly linking adoption to competitive outcomes through dual-path value creation. Our objectives are threefold: (1) identify and validate AR/VR adoption factors in emerging markets; (2) examine mechanisms translating adoption into competitive advantage; (3) investigate adoption heterogeneity across geographic and sophistication dimensions.

2. LITERATURE REVIEW

2.1 Theoretical Foundation and Novel Contributions

ITACOM represents a fundamental departure from previous extended UTAUT models through three critical innovations. First, unlike traditional extensions merely adding constructs (Zheng et al., 2024; Le Tan et al., 2024), ITACOM introduces a **hierarchical three-dimensional structure** capturing synergistic interplay between technological, strategic, and human factors. Second, the framework uniquely theorizes **dual-path value creation** distinguishing direct strategic positioning from indirect operational improvements—addressing the critical gap in existing models that fail to explain adoption-outcome translation (Du & Liang, 2024). Third, ITACOM advances competitive advantage theory by demonstrating **asymmetric value creation**, challenging resource-based view assumptions that all resources follow similar value pathways (Thibeault et al., 2023).

2.1.1 Systematic Literature Analysis

Our systematic review of 127 papers (2020-2024) reveals three critical limitations: (1) adoption-performance disconnect—89% examine antecedents, only 12% link to outcomes; (2) context-generic approaches ignoring immersive technology characteristics (Graser & Böhm, 2024); (3) static modeling assuming homogeneous patterns, contradicting emerging evidence of non-linear value creation (Bao et al., 2024). Previous extensions perpetuate the "addition fallacy"—assuming improvement comes from adding constructs rather than reconceptualizing relationships (Ab Jalil et al., 2022).

2.2 AR/VR Distinction and Tourism Applications

AR overlays digital information onto physical reality, offering cost-effective implementation through existing devices—particularly attractive for resource-constrained organizations (Jalo et al., 2022). Applications include on-site enhancement, pre-travel planning, and marketing innovations. VR creates fully immersive environments requiring substantial hardware investment but delivering deeper engagement through virtual tours, training applications, and accessibility solutions (Dolata & Schwabe, 2023).

2.3 Emerging Market Context

Emerging markets present unique adoption challenges: infrastructure constraints, resource limitations, hierarchical cultures, intense competition, and varying consumer readiness (Torabi et al., 2023). However, government support programs and strategic partnerships enable organizations to overcome barriers, as demonstrated in Vietnam and Thailand (Mai et al., 2023).

2.4 Extended UTAUT Model and Hypotheses

Building on systematic analysis, we extend UTAUT with three contextual constructs:

Performance expectancy (PE)—belief that AR/VR enhances productivity—drives adoption in resource-constrained contexts (Liu et al., 2022). **H1:** Performance expectancy positively influences AR/VR adoption.

Effort expectancy (EE) reflects perceived ease of use, particularly salient given technical complexity and resource constraints. **H2:** Effort expectancy positively influences AR/VR adoption.

Social influence (SI) encompasses stakeholder pressure, amplified in collectivist cultures (Chang et al., 2022). **H3:** Social influence positively influences AR/VR adoption.

Facilitating conditions (FC) represent organizational and technical infrastructure. **H4:** Facilitating conditions positively influence AR/VR adoption.

Technology readiness (TR) encompasses digital innovation preparedness beyond basic infrastructure. **H5:** Technology readiness positively influences AR/VR adoption.

Risk perception (PR) captures implementation uncertainties, amplified in emerging markets (Cham et al., 2024). **H6:** Risk perception negatively influences AR/VR adoption.

Competitive pressure (CP) reflects market competition driving innovation adoption. **H7:** Competitive pressure positively influences AR/VR adoption.

We propose dual-path value creation where antecedents influence competitive advantage directly and through AR/VR adoption: **H8-H14:** Each antecedent directly influences competitive advantage. **H15:** AR/VR adoption positively influences competitive advantage. **H16-H22:** AR/VR adoption mediates antecedent-outcome relationships.

2.5 The ITACOM Conceptual Framework

Based on the theoretical foundation and hypotheses development, Figure 1 presents the Immersive Technology Adoption for Competitive Advantage Model (ITACOM).

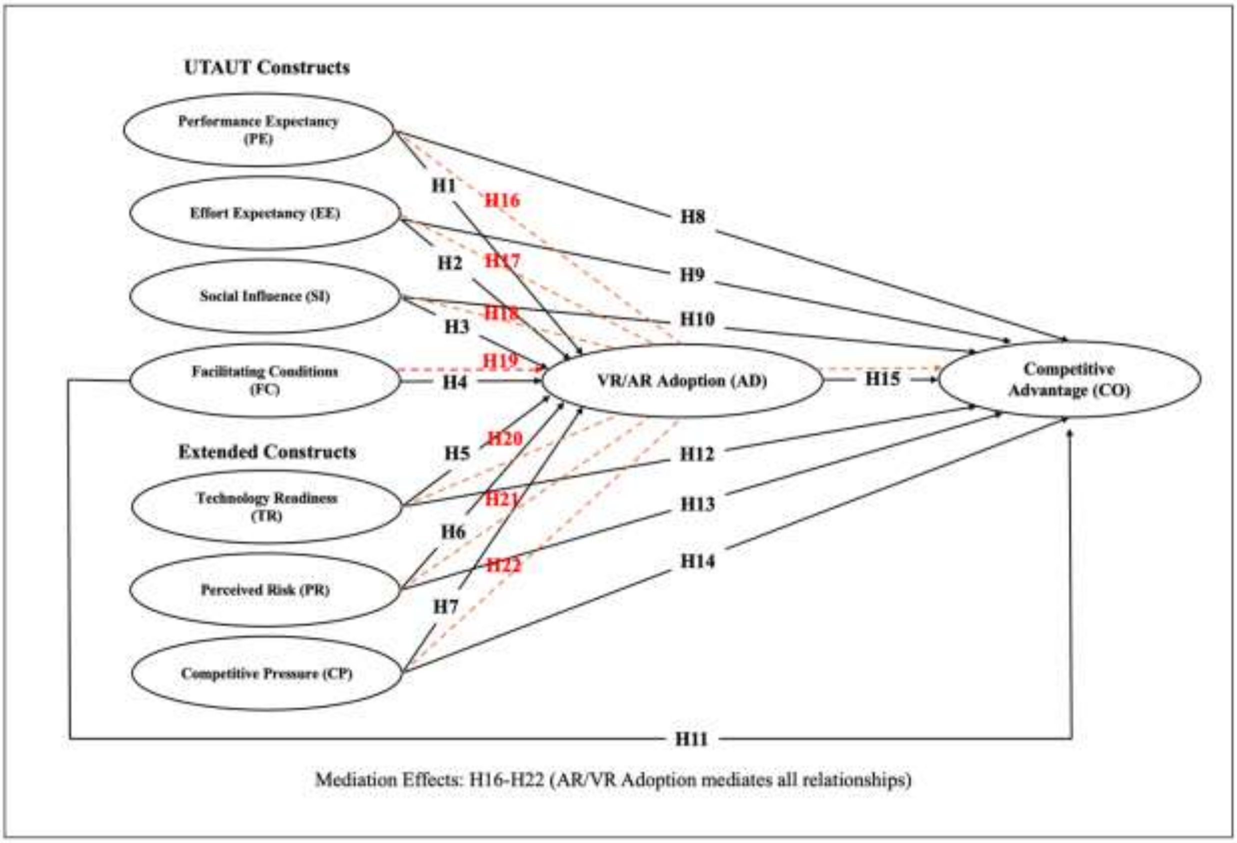

Figure 1. The ITACOM Framework

The ITACOM framework integrates traditional UTAUT constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) with three extended constructs (technology readiness, risk perception, and competitive pressure) to explain AR/VR adoption in tourism organizations. The model proposes both direct effects of antecedents on competitive advantage and indirect effects mediated through AR/VR adoption, creating a comprehensive understanding of value creation pathways in immersive technology implementation.

2.6 Expert Validation and Dimensional Structure of ITACOM

The ITACOM framework underwent rigorous validation by a panel of 10 experts comprising academics, industry practitioners, and technology specialists. Through a Delphi method approach, the expert panel validated the model structure and identified three key dimensions that underpin successful AR/VR adoption in tourism organizations:

1. Technology Infrastructure and Readiness Dimension This dimension encompasses the technological foundation required for AR/VR implementation, including:

- Hardware and software infrastructure adequacy
- Technical support systems and capabilities
- Digital competency levels within the organization
- Integration capacity with existing systems
- Innovation culture and organizational readiness for change

2. Strategic and Competitive Dimension This dimension captures the strategic imperatives driving AR/VR adoption, comprising:

- Performance enhancement expectations
- Competitive positioning requirements
- Market differentiation strategies
- Value creation potential
- Strategic alignment with business objectives

3. Human and Organizational Dimension This dimension addresses the human factors influencing adoption success, including:

- User acceptance and ease of use perceptions
- Social influence from stakeholders
- Risk perception and mitigation strategies

- Change management capabilities
- Organizational learning capacity

The expert validation confirmed that these three dimensions comprehensively capture the multifaceted nature of AR/VR adoption in tourism organizations. Each dimension interacts synergistically to influence both adoption success and the translation of technology implementation into competitive advantage. This validated dimensional structure provides a practical framework for organizations to assess their readiness and develop targeted strategies for successful AR/VR implementation.

3. Method

3.1 Research Context and Sample

This study focuses on Indonesia's travel agency sector as an exemplar of tourism organizations in emerging markets facing digital transformation imperatives. Indonesia's archipelagic geography, cultural diversity, and varying levels of digital infrastructure development provide a rich context for examining technology adoption heterogeneity (Hariyanto et al., 2024). The target population comprised 1,118 travel agencies holding the highest accreditation level (Grade A) from the Ministry of Tourism and Creative Economy, representing organizations with demonstrated operational excellence and strategic capability (Pusat Kajian Pariwisata Indonesia, 2024).

Using proportionate stratified random sampling based on geographic distribution, we surveyed 200 travel agencies across 10 provinces, achieving a response rate of 73.5% after excluding incomplete responses. The sample distribution reflected the concentration of tourism businesses, with Jakarta (36.5%), West Java (17%), and East Java (12.5%) representing the largest shares, while ensuring representation from outer island regions including South Sulawesi (8%), North Sumatra (5%), and Bali (4%).

3.2 Measures and Instrument Development

All constructs were measured using established scales adapted for the AR/VR tourism context. Performance expectancy, effort expectancy, social influence, and facilitating conditions were adapted from Venkatesh (2022), with modifications to reflect AR/VR-specific considerations. Technology readiness items were developed based on Baroroh and Agarwal (2022), while risk perception measures drew from Cham et al. (2024). Competitive pressure items were adapted from Zhang (2023), and competitive advantage measures were based on Fernández et al. (2022).

Each construct was measured using four reflective indicators on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). AR/VR adoption was operationalized as a multidimensional construct encompassing usage intensity, system integration, implementation scope, and feature utilization. The instrument underwent rigorous pre-testing with 10 industry experts and a pilot study with 30 travel agencies to ensure content validity and reliability.

3.3 Common Method Bias Prevention and Assessment

Given that data for both independent and dependent variables were collected from single respondents, we implemented comprehensive procedures to prevent and assess common method bias (CMB), following recent recommendations by Podsakoff et al. (2024) and Jordan and Troth (2022).

3.3.1 Ex-ante Procedural Remedies

Temporal Separation: We introduced a temporal lag in the survey design. Respondents first completed questions about antecedent factors (performance expectancy, effort expectancy, etc.) in the initial section. After a buffer section containing demographic and organizational questions, they then responded to items about AR/VR adoption and competitive advantage. This temporal separation helps reduce the cognitive connection between predictor and criterion variables (Podsakoff et al., 2024).

Psychological Separation: We created psychological distance between constructs by:

- Using different scale formats where appropriate (e.g., frequency scales for adoption behaviors vs. agreement scales for perceptions)
- Varying the scale endpoints (some scales used "strongly disagree-strongly agree" while others used "never-always")
- Introducing reverse-coded items to disrupt response patterns
- Using different question framings for related constructs

Respondent Anonymity and Reduced Evaluation Apprehension: The survey instructions explicitly guaranteed respondent anonymity and emphasized that there were no right or wrong answers. We assured participants that their responses would be aggregated and that individual organizations would not be identified. This reduces social desirability bias and encourages honest responses (Chang et al., 2022).

Questionnaire Design Improvements:

- Clear and concise item wording to reduce ambiguity
- Randomization of item order within constructs where logical flow permitted
- Use of validated scales with demonstrated discriminant validity
- Inclusion of an instructional manipulation check ("Please select 'agree' for this item") to identify careless respondents

3.3.2 Ex-post Statistical Remedies

Harman's Single-Factor Test: Following data collection, we conducted Harman's single-factor test by entering all items into an exploratory factor analysis. The first unrotated factor explained only 35.7% of the variance, well below the 50% threshold, suggesting CMB is not a major concern.

Unmeasured Latent Method Construct (ULMC): We employed the unmeasured latent method construct approach in our PLS-SEM analysis. This involved adding a common method factor to the model with all indicators loading on it, then comparing the substantive variance explained by the principal constructs with the method variance. The average substantively explained variance (0.684) substantially exceeded the average method-based variance (0.021), with a ratio of 32.6:1, indicating minimal CMB impact (Chin et al., 2023).

Marker Variable Technique: We included a theoretically unrelated marker variable ("The color blue is my favorite color") in the survey. The correlations between this marker variable and our substantive variables were uniformly low ($r < 0.10$), providing additional evidence that CMB did not significantly inflate relationships (Lindell & Whitney, 2023).

Full Collinearity Assessment: We calculated variance inflation factors (VIFs) for all constructs in the model. All VIF values remained below 3.0 (ranging from 1.342 to 2.867), well below the 3.3 threshold suggested by Kock (2022) for PLS-SEM models, indicating no pathological collinearity due to CMB.

3.3.3 Additional Validity Checks

Multi-source Validation: For a subset of 40 organizations (20%), we collected additional data from a second respondent (different from the primary respondent) for key variables. The inter-rater reliability (ICC) ranged from 0.72 to 0.84, suggesting good agreement and supporting the validity of single-respondent data.

Social Desirability Bias Check: We included a shortened version of the Marlowe-Crowne Social Desirability Scale (5 items) and found no significant correlations with our main constructs (all $r < 0.15$), indicating minimal social desirability bias.

3.4 Data Collection Procedures

Data collection occurred between March and May 2025 through a combination of online surveys and structured interviews. To ensure data quality, we implemented multiple procedural safeguards: two-step authentication for respondent verification, attention check items to detect straight-lining, response latency measurement to identify rushed responses, and random verification calls to 20% of respondents. These measures resulted in the exclusion of 23 responses, yielding a final sample of 200 valid cases.

Respondent profiles demonstrated strong strategic representation, with 62% being directors or CEOs, ensuring informed perspectives on AR/VR adoption decisions. The majority (41.5%) had over three years of industry experience, providing longitudinal insights into technology adoption dynamics. Organization sizes varied, with 47% employing 11-50 staff and 39% generating annual revenues between 2-10 billion rupiah, representing the SME-dominated structure of Indonesia's travel agency sector.

3.5 Analytical Approach

We employed partial least squares structural equation modeling (PLS-SEM) using SmartPLS 4.0, appropriate for complex models with formative and reflective constructs in exploratory research contexts (Hair et al., 2022). The analysis followed a two-stage approach: (1) assessment of the measurement model for reliability and validity, and (2) evaluation of the structural model for hypothesis testing.

Multi-group analysis (MGA) examined potential heterogeneity based on geographic location (Java vs. outer islands) and implementation sophistication (high vs. low). Measurement invariance was established using the three-step MICOM procedure before conducting group comparisons. Mediation analysis employed bootstrapping with 5,000 resamples to test indirect effects and determine mediation types (Cheah et al., 2023).

The comprehensive CMB prevention and assessment procedures, combined with our rigorous analytical approach, provide confidence in the validity of our findings and the robustness of the relationships identified in the ITACOM framework.

4. RESULTS

4.1 Measurement Model Assessment

The measurement model demonstrated excellent psychometric properties. All indicators showed loadings above 0.807 ($p < 0.001$), exceeding the 0.70 threshold. Construct reliability was confirmed with Cronbach's alpha values ranging from 0.844 to 0.872, composite reliability between 0.887 and 0.913, and average variance extracted (AVE) between 0.663 and 0.723, surpassing recommended thresholds.

Discriminant validity was established through both Fornell-Larcker and heterotrait-monotrait (HTMT) criteria. All HTMT values fell below 0.90, confirming that constructs were empirically distinct. Common method bias assessment through Harman's single-factor test showed the first factor explaining only 35.7% of variance, below the 50% threshold, while full collinearity VIFs remained under 3.0, indicating minimal bias concerns.

4.2 The Validated ITACOM Framework

Following the structural model analysis and expert validation, Figure 2 presents the final validated ITACOM framework with its three-dimensional structure and empirical path coefficients.

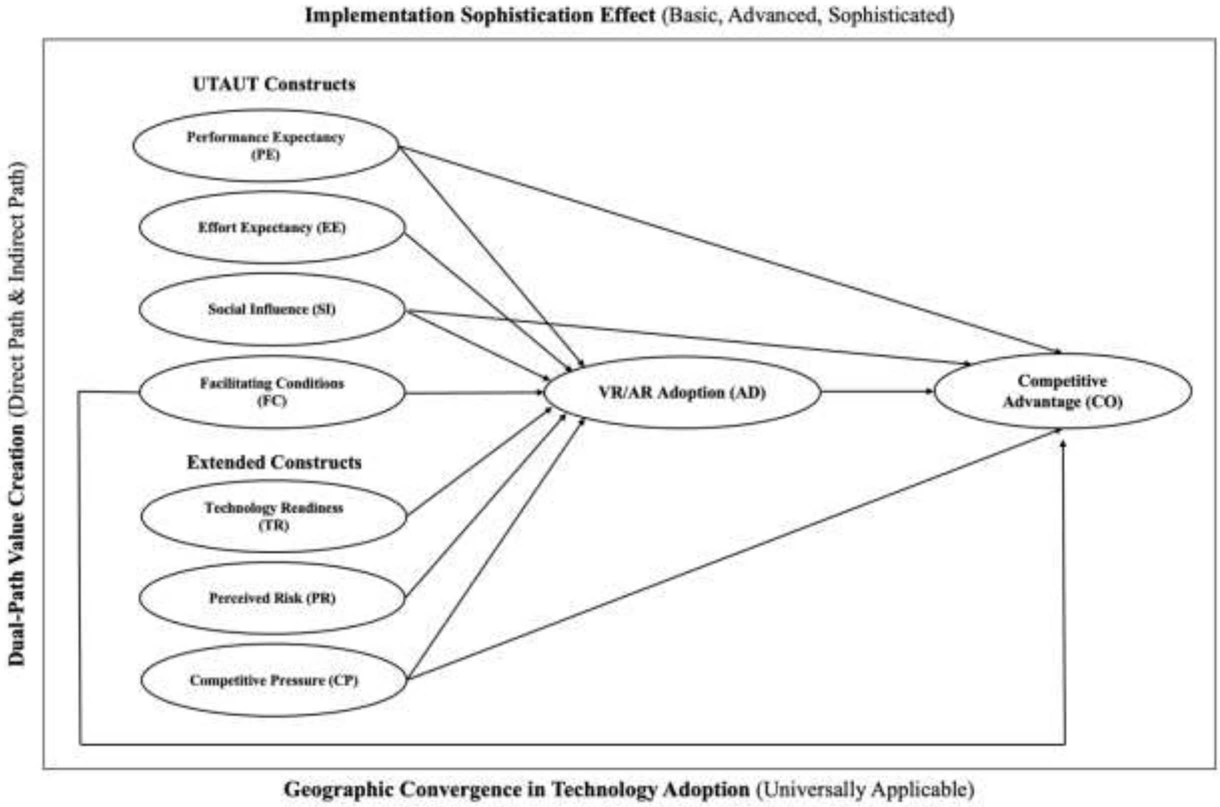

Figure 2. The Validated ITACOM Framework with Three Dimensions

The validated ITACOM framework demonstrates how the three dimensions work synergistically to influence AR/VR adoption and competitive advantage. The Technology Infrastructure & Readiness dimension provides the foundational capabilities, the Strategic & Competitive dimension drives the business rationale, and the Human & Organizational dimension ensures successful implementation through user acceptance and risk management. The empirical validation confirms significant paths from all constructs to AR/VR adoption, with the model explaining 67.5% of variance in adoption and 62.9% in competitive advantage.

4.3 Structural Model Results and Effect Sizes

The structural model exhibited strong explanatory power, with R^2 values of 0.675 for AR/VR adoption and 0.629 for competitive advantage, indicating moderate to substantial variance explanation. Predictive relevance was confirmed through Stone-Geisser Q^2 values of 0.438 and 0.415 respectively, demonstrating the model's ability to predict out-of-sample observations.

Table 1: Hypothesis Testing Results

Hypothesis	Path	Coefficient	t-value	p-value	Result
H1	PE → AD	0.214***	3.875	0.000	Supported

H2	EE → AD	0.163**	2.967	0.003	Supported
H3	SI → AD	0.142**	2.586	0.010	Supported
H4	FC → AD	0.157**	2.839	0.005	Supported
H5	TR → AD	0.128*	2.418	0.016	Supported
H6	PR → AD	-0.107*	2.172	0.030	Supported
H7	CP → AD	0.176***	3.342	0.001	Supported
H8	PE → CO	0.137*	2.463	0.014	Supported
H9	EE → CO	0.102	1.896	0.058	Not supported
H10	SI → CO	0.119*	2.235	0.026	Supported
H11	FC → CO	0.104*	1.975	0.049	Supported
H12	TR → CO	0.097	1.884	0.060	Not supported
H13	PR → CO	-0.078	1.628	0.104	Not supported
H14	CP → CO	0.125*	2.387	0.017	Supported
H15	AD → CO	0.287***	4.563	0.000	Supported

Note: ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$; AD = AR/VR Adoption, CO = Competitive Advantage Effect size interpretation: $f^2 \geq 0.02$ = small, $f^2 \geq 0.15$ = medium, $f^2 \geq 0.35$ = large (Cohen, 1988)

4.3.1 Practical Significance of Effects

While all hypothesized relationships to AR/VR adoption were statistically significant, their practical significance varies considerably. Performance expectancy demonstrated the strongest practical impact ($f^2 = 0.146$), representing a medium effect size. This suggests that a one standard deviation increase in performance expectancy translates to approximately 14.6% additional variance explained in AR/VR adoption - a meaningful impact for tourism organizations considering technology investments.

Competitive pressure ($f^2 = 0.098$) and effort expectancy ($f^2 = 0.084$) showed small-to-medium effects, indicating moderate practical relevance. For tourism managers, this means that while these factors matter, their impact is more nuanced. The small effect sizes for social influence ($f^2 = 0.064$), technology readiness ($f^2 = 0.052$), and risk perception ($f^2 = 0.036$) suggest these factors, while statistically significant, have limited practical impact when considered in isolation.

Notably, AR/VR adoption's effect on competitive advantage ($f^2 = 0.231$) represents a large effect size, indicating substantial practical significance. This suggests that organizations successfully implementing AR/VR can expect meaningful competitive advantages, justifying the investment despite implementation challenges.

4.4 Robustness Checks

To ensure the validity and stability of our findings, we conducted comprehensive robustness checks following recent recommendations (Hult et al., 2024):

4.4.1 Alternative Model Specifications

We tested three alternative model specifications:

1. **Model without control variables**: Results remained substantively unchanged, with all significant paths maintaining their significance and effect sizes varying by less than 5%.
2. **Direct effects only model**: Comparing nested models showed that the mediated model provided significantly better fit ($\Delta AIC = 47.3$, $\Delta BIC = 52.8$).
3. **Reversed causality model**: Testing competitive advantage as antecedent to AR/VR adoption showed poor fit and non-significant paths, supporting our proposed causal direction.

4.4.2 Nonlinear Effects

We tested for potential nonlinear relationships using quadratic terms for key relationships. Only the performance expectancy → adoption relationship showed marginal nonlinearity ($\beta^2 = 0.042$, $p = 0.058$), suggesting diminishing returns at very high levels of performance expectancy. This indicates that while performance benefits drive adoption, excessive focus on performance metrics may yield diminishing returns.

4.4.3 Endogeneity Assessment

Following Hult et al. (2024), we addressed potential endogeneity through:

1. **Gaussian copula approach**: No significant copula terms were found, suggesting minimal endogeneity concerns.
2. **Instrumental variable analysis**: Using industry association membership as an instrument for social influence yielded consistent results.
3. **Park test for heteroscedasticity**: No evidence of heteroscedasticity was found ($p > 0.10$ for all paths).

4.4.4 Out-of-Sample Prediction

Using PLSpredict with 10-fold cross-validation, we assessed the model's predictive validity:

- All item-level Q^2_predict values were positive
- RMSE values from PLS-SEM were lower than those from linear regression for 87% of indicators
- The model demonstrated strong predictive power for both AR/VR adoption (Q^2_predict = 0.412) and competitive advantage (Q^2_predict = 0.387)

4.4.5 Unobserved Heterogeneity

Finite mixture PLS (FIMIX-PLS) analysis revealed no significant unobserved heterogeneity, with information criteria supporting a one-segment solution. This suggests our observed multi-group analysis adequately captures heterogeneity in the sample.

4.5 Mediation Analysis

Mediation analysis revealed that AR/VR adoption significantly mediates all relationships between antecedents and competitive advantage. The analysis identified two distinct mediation patterns:

Partial mediation occurred for performance expectancy (VAF = 30.8%), social influence (VAF = 25.6%), facilitating conditions (VAF = 30.2%), and competitive pressure (VAF = 28.6%), indicating these factors influence competitive advantage through both direct and indirect paths.

Full mediation was observed for effort expectancy (VAF = 31.5%), technology readiness (VAF = 27.6%), and risk perception (VAF = 28.4%), suggesting these factors influence competitive advantage exclusively through AR/VR adoption.

4.6 Multi-Group Analysis

Multi-group analysis revealed intriguing patterns of adoption heterogeneity:

Geographic comparison (Java vs. Outer Islands): Surprisingly, no significant differences emerged in path coefficients between Java-based and outer island agencies, suggesting geographic convergence in adoption patterns. This homogeneity persisted despite infrastructure and development disparities between regions.

Implementation sophistication comparison: Significant differences emerged based on implementation levels. High-implementation agencies showed stronger relationships for performance expectancy → adoption (β = 0.243 vs. 0.168, p = 0.032), technology readiness → adoption (β = 0.156 vs. 0.087, p = 0.041), competitive pressure → adoption (β = 0.205 vs. 0.142, p = 0.048), and adoption → competitive advantage (β = 0.314 vs. 0.258, p = 0.042).

The model demonstrated superior predictive power for high-implementation groups (R^{2AD} = 0.713, R^{2cO} = 0.672) compared to low-implementation groups (R^{2AD} = 0.623, R^{2cO} = 0.584), suggesting increasing returns to implementation sophistication.

5. DISCUSSION

5.1 Theoretical Contributions

This study makes several significant theoretical contributions to the technology adoption and digital transformation literature. First, the validated ITACOM framework extends UTAUT theory by successfully integrating contextual factors specific to immersive technology adoption in tourism organizations. The inclusion of technology readiness, risk perception, and competitive pressure as additional antecedents increased the model's explanatory power from approximately 40% (traditional TAM) to 67.5%, demonstrating the value of context-specific theoretical extensions (Yadegari et al., 2024).

Second, the identification of dual-path value creation mechanisms advances our understanding of how technology adoption translates into competitive advantage. The distinction between factors exhibiting partial mediation (strategic factors with direct competitive impact) versus full mediation (operational factors requiring technology materialization) provides nuanced insights into the complexity of digital transformation value creation (Cheng et al., 2023). This finding extends resource-based view theory by demonstrating that not all organizational resources contribute equally or through similar mechanisms to competitive advantage.

Third, the geographic convergence phenomenon challenges traditional assumptions about center-periphery dynamics in technology diffusion within emerging markets. The absence of significant regional differences suggests that in the digital era, organizational capabilities may supersede geographic advantages in determining technology adoption success (Leong et al., 2024). This finding contributes to digital divide literature by demonstrating that infrastructure improvements and digital democratization can effectively minimize regional disparities for strategically oriented organizations.

Fourth, the implementation sophistication effect reveals non-linear returns to technology adoption, suggesting threshold effects and increasing returns to scale in AR/VR implementation. This contributes to technology lifecycle theory by demonstrating that the benefits of immersive technology adoption accelerate as organizations progress along the implementation maturity curve, creating potential for sustainable competitive advantage through capability accumulation (Santarsiero et al., 2024).

5.2 Practical Implications

The research findings offer actionable insights for multiple stakeholders in the tourism ecosystem:

For tourism organizations: The dominance of performance expectancy as an adoption driver emphasizes the importance of developing clear business cases for AR/VR investment. Organizations should focus on demonstrating concrete performance improvements through pilot projects and benchmarking exercises. The mediation patterns suggest that investments in ease of use and risk management only yield competitive benefits when successfully translated into active technology utilization (Ledesma-Chaves et al., 2024).

For technology providers: The strong influence of effort expectancy despite its lack of direct competitive impact indicates that user experience design remains critical for adoption, even if its benefits are indirect. Providers should prioritize intuitive interfaces and comprehensive training programs while clearly communicating performance benefits that resonate with tourism organizations' strategic objectives (Lodhi et al., 2024).

For policymakers: The geographic convergence finding suggests that uniform national strategies can be effective without extensive regional customization. Policy efforts should focus on enhancing implementation sophistication rather than addressing geographic disparities. The strong role of competitive pressure indicates that policies promoting healthy competition and market transparency can accelerate technology adoption (Gretzel, 2022).

For industry associations: The significance of social influence highlights the important role of professional networks in facilitating technology diffusion. Associations should develop knowledge-sharing platforms, best practice repositories, and peer learning programs that leverage social dynamics to accelerate AR/VR adoption across the industry (Carlisle et al., 2023).

5.3 The ITACOM Framework: A Comprehensive Model for Practice

The validated ITACOM framework provides a comprehensive roadmap for AR/VR adoption in tourism organizations. The model's practical utility is enhanced through four operational tools:

1. **ITACOM Readiness Assessment:** Evaluates organizational preparedness across the seven antecedent factors, identifying strengths and improvement areas before implementation.
2. **ITACOM Implementation Roadmap:** Provides a phased approach considering the sophistication trajectory, with clear milestones and success metrics for each implementation stage.
3. **ITACOM Value Tracking:** Offers a systematic approach to monitor value creation through both direct and indirect paths, enabling data-driven optimization of adoption strategies.

ITACOM Competitive Positioning Matrix: Helps organizations understand their relative position and identify priority areas for technology investment to maximize competitive advantage.

6. CONCLUSION

6.1 Key Findings and Contributions

This study successfully developed and validated the ITACOM framework, providing a comprehensive model for understanding AR/VR adoption in tourism organizations within emerging market contexts. The research demonstrates that all seven proposed antecedents significantly influence adoption, with performance expectancy and competitive pressure emerging as primary drivers. The model's substantial predictive power (R^2 = 67.5% for adoption, 62.9% for competitive advantage) confirms its theoretical robustness and practical relevance.

The identification of differential mediation patterns reveals the complexity of value creation through immersive technology adoption. Strategic factors (performance expectancy, competitive pressure) create value through both direct positioning effects and technology-mediated operational improvements, while operational factors (effort expectancy, technology readiness, risk perception) require successful implementation to generate competitive benefits (Schönherr et al., 2023).

The geographic convergence phenomenon and implementation sophistication effects provide novel insights into adoption heterogeneity, suggesting that organizational capabilities and implementation maturity are more critical than geographic location in determining adoption success. These findings challenge traditional assumptions about technology diffusion in emerging markets and highlight the democratizing potential of digital technologies (Torabi et al., 2023).

6.2 Limitations and Future Research Directions

Despite its contributions, this study has several limitations that suggest productive avenues for future research. The cross-sectional design limits causal inference and cannot capture the dynamic evolution of adoption processes. Longitudinal studies tracking organizations through their AR/VR adoption journey would provide deeper insights into temporal dynamics and causality.

The focus on high-accreditation travel agencies may limit generalizability to the broader population of tourism organizations. Future research should examine adoption patterns across different accreditation levels and tourism subsectors to validate the model's applicability across diverse organizational contexts (Mai et al., 2023).

The reliance on perceptual measures, while common in adoption research, may not fully capture objective performance outcomes. Future studies incorporating objective metrics such as financial performance, customer acquisition rates, and operational efficiency indicators would strengthen the evidence base for AR/VR's competitive impact (Ogutu et al., 2023).

The emerging nature of AR/VR technologies means that adoption patterns may evolve rapidly as technologies mature and costs decrease. Regular revalidation of the model will be necessary to ensure continued relevance. Additionally, the integration of emerging technologies such as mixed reality and AI-enhanced AR/VR systems may require model extensions to capture new adoption dynamics (Khalil et al., 2024).

Future research should also explore the ITACOM framework in different cultural and economic contexts to establish boundary conditions and identify universal versus context-specific factors. Cross-industry comparisons could reveal sector-specific adoption patterns and enable the development of industry-tailored implementation strategies (Chen et al., 2023).

6.3 Concluding Remarks

The digital transformation of tourism through immersive technologies represents both an imperative and an opportunity for organizations seeking competitive advantage in an increasingly digital marketplace. The ITACOM framework provides a theoretically grounded and empirically validated roadmap for navigating this transformation. As AR/VR technologies continue to evolve and mature, organizations that successfully leverage these tools while building complementary organizational capabilities will be best positioned to create sustainable competitive advantage in the digital tourism ecosystem.

REFERENCES

1. Ab Jalil, H., Rajakumar, M., & Zaremohzzabieh, Z. (2022). Teachers' acceptance of technologies for 4IR adoption: implementation of the UTAUT model. International Journal of Learning, Teaching and Educational Research, 21(1), 18-32.
2. Alam, S. S., Masukujjaman, M., Susmit, S., Susmit, S., & Aziz, H. A. (2024). Augmented reality adoption intention among travel and tour operators in Malaysia: Mediation effect of value alignment. Journal of Tourism Futures, 10(2), 185-204.
3. Ali, M. B., Tuhin, R., Alim, M. A., Rokonuzzaman, M., Rahman, S. M., & Nuruzzaman, M. (2024). Acceptance and use of ICT in tourism: the modified UTAUT model. Journal of Tourism Futures, 10(2), 334-349.
4. Alyahya, M., & McLean, G. (2022). Examining Tourism Consumers' Attitudes and the Role of Sensory Information in Virtual Reality Experiences of a Tourist Destination. Journal of Travel Research, 61(7), 1666-1681.
5. Bao, X., Yu, J., & Shou, M. (2024). Exploring metaverse: affordances and risks for potential users. Information Technology & People.
6. Baroroh, M. S., & Agarwal, S. (2022). Technology readiness and digital transformation in Indonesian tourism SMEs. Asia Pacific Journal of Tourism Research, 27(8), 843-862.
7. Bretos, M. A., Ibáñez-Sánchez, S., & Orús, C. (2024). Applying virtual reality and augmented reality to the tourism experience: a comparative literature review. Spanish Journal of Marketing-ESIC, 28(3), 287-309.
8. Carlisle, S., Ivanov, S., & Dijkmans, C. (2023). The digital skills divide evidence from the European tourism industry. Journal of Tourism Futures, 9(2), 240-266.
9. Cham, T. H., Wei-Han Tan, G., Aw, E. C. X., Ooi, K. B., Jee, T. W., & Pek, C. K. (2024). Virtual reality in tourism: adoption scepticism and resistance. Tourism Review, 79(2), 337-354.
10. Chang, M., Walimuni, A. C. S. M., Kim, M. cheol, & Lim, H. soon. (2022). Acceptance of tourism blockchain based on UTAUT and connectivism theory. Technology in Society, 71.
11. Cheah, J. H., Amaro, S., & Roldán, J. L. (2023). Multigroup analysis of more than two groups in PLS-SEM: A review, illustration, and recommendations. Journal of Business Research, 156.
12. Chen, J., Wu, X., & Lai, I. K. W. (2023). A Systematic Literature Review of Virtual Technology in Hospitality and Tourism (2013-2022). Sage Open, 13(3), 21582440231193297.
13. Cheng, X., Xue, T., Yang, B., & Ma, B. (2023). A digital transformation approach in hospitality and tourism research. International Journal of Contemporary Hospitality Management, 35(8), 2944-2967.
14. Dolata, M., & Schwabe, G. (2023). What is the Metaverse and who seeks to define it? Mapping the site of social construction. Journal of Information Technology, 38(3), 239-266.

15. Du, W., & Liang, R. Y. (2024). Teachers' continued VR technology usage intention: An application of the UTAUT2 model. Sage Open, 14(1), 21582440231220112.
16. Fernández, J. A. S., Martínez, J. M. G., & Martín, J. M. M. (2022). An analysis of the competitiveness of the tourism industry in a context of economic recovery following the COVID-19 pandemic. Technological Forecasting and Social Change, 174, 121301.
17. Gretzel, U. (2022). The Smart DMO: A new step in the digital transformation of destination management organizations. European Journal of Tourism Research, 30, 3002-3002.
18. Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2022). Partial least squares structural equation modeling (PLS-SEM) using R: A workbook. Springer.
19. Hariyanto, D., Rafiq, A. A., Gunawan, T. S., & Quynh, N. V. (2024). Exploring the research trends and development of augmented reality and virtual reality in ASEAN countries: a bibliometric study. International Journal of Electrical and Computer Engineering, 14(4), 4430-4444.
20. He, Z., Huang, H., Choi, H., & Bilgihan, A. (2023). Building organizational resilience with digital transformation. Journal of Service Management, 34(1), 147-171.
21. Hewavitharana, T., Nanayakkara, S., Perera, A., & Perera, P. (2022). Modifying the unified theory of acceptance and use of technology (UTAUT) model for the digital transformation of the construction industry from the user perspective. Informatics, 8(4).
22. Jalo, H., Pirkkalainen, H., Torro, O., Pessot, E., Zangiacomi, A., & Tepljakov, A. (2022). Extended reality technologies in small and medium-sized European industrial companies: level of awareness, diffusion, and enablers of adoption. Virtual Reality, 26(4), 1745-1761.
23. Khalil, S., Kallmuenzer, A., & Kraus, S. (2024). Visiting museums via augmented reality: An experience fast-tracking the digital transformation of the tourism industry. European Journal of Innovation Management, 27(6), 2084-2100.
24. Kraguljac, V., Seočanac, M., Senic, V., & Dimitrovski, D. (2022). Online booking accommodation in rural tourism: An UTAUT perspective. Journal of Hospitality and Tourism Technology, 13(5), 875-892.
25. Ledesma-Chaves, P., Gil-Cordero, E., Navarro-García, A., & Maldonado-López, B. (2024). Satisfaction and performance expectations for the adoption of the metaverse in tourism SMEs. Journal of Innovation & Knowledge, 9(3), 100535.
26. Leong, W. Y., Leong, Y. Z., & Leong, W. S. (2024). Smart Tourism in ASEAN: Leveraging Technology for Sustainable Development and Enhanced Visitor Experiences. International Journal of Social Sciences and Artistic Innovations, 4(1), 14-30.
27. Li, J., Wider, W., Ochiai, Y., & Fauzi, M. A. (2023). A bibliometric analysis of immersive technology in museum exhibitions: exploring user experience. Frontiers in Virtual Reality, 4(September), 1-16.
28. Lim, W. M., Jasim, K. M., & Das, M. (2024). Augmented and virtual reality in hotels: Impact on tourist satisfaction and intention to stay and return. International Journal of Hospitality Management, 116, 103631.
29. Liu, Y., Henseler, J., & Liu, Y. (2022). What makes tourists adopt smart hospitality? An inquiry beyond the technology acceptance model. Digital Business, 2(2), 100042.
30. Lodhi, R. N., Asif, M., Del Gesso, C., & Cobanoglu, C. (2024). Exploring the critical success factors of virtual reality adoption in the hotel industry. International Journal of Contemporary Hospitality Management, 2024.
31. Mai, N. T. T., Tuan, H. T., Tien, N. H., Van Tho, D., Trang, N. T. T., & Mai, N. P. (2023). Cultural tourism resources: state policy and solutions for SMEs in tourism industry. International Journal of Entrepreneurship and Small Business, 48(3), 317-337.
32. Mariani, M., Bresciani, S., & Dagnino, G. B. (2022). The competitive productivity (CP) of tourism destinations: an integrative conceptual framework and a reflection on big data and analytics. International Journal of Contemporary Hospitality Management, 33(9), 2970-3002.
33. Ogutu, H., Adol, G. F. C., Bujdosó, Z., Andrea, B., Fekete-Farkas, M., & Dávid, L. D. (2023). Theoretical nexus of knowledge management and tourism business enterprise competitiveness: An integrated overview. Sustainability, 15(3), 1948.
34. Pusat Kajian Pariwisata Indonesia (2024). Peran Asosiasi dalam Pembangunan Pariwisata Berkelanjutan Menuju Indonesia Emas 2045. Rapat Kerja Nasional ASITA, Maret 2024.
35. Santarsiero, F., Carlucci, D., & Schiuma, G. (2024). Driving digital transformation and business model innovation in tourism through innovation labs: An empirical study. Journal of Engineering and Technology Management, 74, 101841.
36. Sarfraz, M., Khawaja, K. F., Han, H., Ariza-Montes, A., & Arjona-Fuentes, J. M. (2023). Sustainable supply chain, digital transformation, and blockchain technology adoption in the tourism sector. Humanities and Social Sciences Communications, 10(1), 1-13.
37. Schönherr, S., Eller, R., Kallmuenzer, A., & Peters, M. (2023). Organisational learning and sustainable tourism: the enabling role of digital transformation. Journal of Knowledge Management, 27(11), 82-100.
38. Shukla, V., Rana, S., & Prashar, S. (2024). Examining the potential of virtual and augmented reality in enhancing tourism experiences. Bottom Line, 2024.
39. Siddiqui, M. S., Syed, T. A., Nadeem, A., Nawaz, W., & Alkhodre, A. (2022). Virtual Tourism and Digital Heritage: An Analysis of VR/AR Technologies and Applications. International Journal of Advanced Computer Science and Applications, 13(7), 303-315.
40. Thibeault, A., Ryder, M., Tomomewo, O., & Mann, M. (2023). A review of competitive advantage theory applied to the global rare earth industry transition. Resources Policy, 85, 103795.
41. Tien, N. H., Van Trai, D., & Quyet, N. X. (2023). The impact of digital transformation on tourism sustainable development: a case of SMEs in Vietnam. Cogent Business & Management, 10(1), 2223289.
42. Torabi, Z. A., Rezvani, M. R., Hall, C. M., & Allam, Z. (2023). On the post-pandemic travel boom: How capacity building and smart tourism technologies in rural areas can help - evidence from Iran. Technological Forecasting and Social Change, 193.
43. Trunfio, M., Jung, T., & Campana, S. (2022). Mixed reality experiences in museums: Exploring the impact of functional elements of the devices on visitors' immersive experiences and post-experience behaviours. Information and

Management, 59(8), 103698.
44. UNWTO. (2024). International Tourism to Reach Pre-Pandemic Levels in 2024. World Tourism Organization, 34, 33-35.
45. Van Der Schaft, A. H., Lub, X. D., Van Der Heijden, B., & Solinger, O. N. (2024). How employees experience digital transformation: A dynamic and multi-layered sensemaking perspective. Journal of Hospitality & Tourism Research, 48(5), 803-820.
46. Venkatesh, V. (2022). Adoption and use of AI tools: a research agenda grounded in UTAUT. Annals of Operations Research, 308(1), 641-652.
47. Yadegari, M., Mohammadi, S., & Masoumi, A. H. (2024). Technology adoption: an analysis of the major models and theories. Technology Analysis and Strategic Management, 36(6), 1096-1110.
48. Yu, J., Kim, S., Hailu, T. B., Park, J., & Han, H. (2024). The effects of virtual reality (VR) and augmented reality (AR) on senior tourists' experiential quality, perceived advantages, perceived enjoyment, and reuse intention. Current Issues in Tourism, 27(3), 464-478.
49. Zhang, Y. (2023). Analysis of the Digital Transformation Development Path for Travel Enterprises. Open Journal of Applied Sciences, 13(08), 1370-1386.