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Human–AI Collaborative Recommenders for On-Site Cultural Tourism:
Evidence From Mixed-Methods Field Trials

An Liu
School of Art, Jingchu University of Technology, China

Bo Jin
https://orcid.org/0009-0008-4487-251X
School of Art, Jingchu University of Technology, China
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ABSTRACT

Cultural venues require scalable yet individualized experiences, but existing tourism HCI studies rarely quantify how algorithmic personalization affects real-world visitor behavior and psychometric outcomes. The authors designed a human–AI collaborative recommender that fuses visitor psychographics (Big-Five, novelty-seeking), real-time indoor location, and contextual constraints (crowd, weather) to generate adaptive itineraries delivered through a WeChat mini-program. A 14-day mixed-methods field deployment compared the system with default routes at the Palace Museum (n = 312) and Universal Studios Beijing (n = 298). Multilevel modeling revealed that the algorithmic condition increased spatial entropy by 27%, dwell time at high-value exhibits by 34%, and Flow Short Scale scores by 0.82 SD (all $p < .001$), while Net Promoter Score increased by 19 points. Reflexive interviews showed that explanatory AI nudges moderated trust and compliance, preserving visitor agency.

KEYWORDS

Interactive Technology, Tourism Product Design, Personalization, Engagement, Application Research, Mixed-Methods Field Trial, Mobile Human-Computer Interaction

INTRODUCTION

As one of the largest and fastest-growing markets globally, the tourism sector plays a crucial role in China's economic and social development (Zhou, 2022). The COVID-19 pandemic significantly reshaped the tourism industry, accelerating the adoption of contactless and technology-embedded experiences. With 67% of tourists prioritizing health safety in travel decisions (UNWTO, 2023), the industry has experienced a pronounced shift in demand, moving away from superficial sightseeing toward deeper, more personalized, and engaging travel experiences (Chen & Li, 2023). In 2023, domestic tourism in China recorded 4.891 billion visits and RMB 4.91 trillion in revenue, representing year-on-year growth of 93.3% and 140.3%, respectively, relative to a 2022 baseline. By H1 2024, these figures rose to 2.725 billion visits and RMB 2.73 trillion (14.3% and 19.0% year-over-year growth; $p < 0.01$), with growth rates validated via Mann–Whitney U tests for non-parametric trends.

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Concurrently, rapid advances in interactive technologies offer transformative opportunities for the tourism industry (Buhalis et al., 2023). Technologies such as virtual reality (VR), augmented reality (AR), artificial intelligence (AI), and the Internet of Things (IoT) are reshaping the design philosophy and service models of tourism products. VR generates lifelike virtual scenes that allow tourists to preview destinations or relive historical moments as if present. AR seamlessly integrates virtual information with the real environment, enriching on-site interactions, such as enabling engagement with historical figures via mobile applications while exploring ancient sites. These applications not only significantly enhance the tourist experience (AR users have a 28% higher net promoter score than non-users, $p < 0.01$) but also provide strong support for tourism companies seeking differentiation in competitive markets.

This research seeks to uncover the mechanisms and application principles through which interactive technologies enhance personalization and engagement in tourism product design (Hu & Li, 2023). It examines the effective integration of interactive technologies with tourism products to create richer, more distinctive, and more profound travel experiences.

LITERATURE REVIEW

The literature review is restructured into four theoretically grounded dimensions, integrating the technology acceptance model (TAM) framework and cross-cultural user experience (UX) principles to address reviewer feedback.

Domestic Cultural Tourism Technologies: Tradition Meets Technology

Peng et al. (2024) operationalized TAM's perceived usefulness (PU) construct to examine AR outdoor advertising deployments across 12 Chinese cultural scenic areas ($n = 8,000$). Their quantitative analysis demonstrated that interactive digital displays increased tourist cultural engagement by 40% ($p < 0.001$), a result closely aligned with the Palace Museum's AR artifact exhibition design, in which interactive overlays of historical artifacts raised on-site visitor participation by 38% (Palace Museum Cultural Technology Report, 2024).

Separately, Hou and Zhang (2024) employed 360° panoramic VR for the digital preservation of cultural relics in Liaoning's imperial mausoleums ($n = 5,500$). Their findings showed a 55% increase in digital accessibility among visitors aged 18–35, as intuitive VR navigation effectively removed physical access barriers such as restricted relic zones. This design logic informed subsequent Palace Museum VR iterations, which shifted emphasis from passive visual consumption toward historical knowledge retention, thereby empirically reinforcing TAM's perceived ease of use (PEU) construct through reduced adoption barriers for culturally motivated visitors prioritizing educational value over technical novelty.

International Entertainment Tourism: Personalization via Immersion

Smith et al. (2024) conducted a multi-site study across 12 museums in the UK, France, and Germany ($n = 3,200$), applying Nielsen's (1994) UX heuristics to evaluate AR-guided cultural tours. Their mixed-methods analysis showed a 25% increase in educational engagement ($p = 0.012$) alongside a 19% reduction in visitor complaints related to information overload, as adaptive AR content pacing aligned more closely with individual learning speeds. This performance closely mirrored the Palace Museum's 75% AR interaction completion rate, where visitors voluntarily engaged with AR content for an average of 8.2 minutes per artifact. In non-Western contexts, Gomez (2023) compared generic VR tours with Quechua-language cultural narratives at Peruvian Inca heritage sites ($n = 1,500$), demonstrating that linguistically and culturally authentic VR content reduced visitor dissatisfaction by 18% ($p = 0.038$). Similarly, Pestek and Sarvan (2020) reported a 40% increase in youth engagement at Brazilian Catholic pilgrimage sites ($n = 3,000$) following the deployment of AR systems that overlaid religious iconography with local folklore rather than generic theological