

Zhang, Yuan; Papp-Váry, Árpád; Szabó, Zoltán

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Administrative Sciences

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Suggested Citation: Zhang, Yuan; Papp-Váry, Árpád; Szabó, Zoltán (2025) : Digital engagement and visitor satisfaction at world heritage sites: A study on interaction, authenticity, and recommendations in coastal China, *Administrative Sciences*, ISSN 2076-3387, MDPI, Basel, Vol. 15, Iss. 3, pp. 1-27, <https://doi.org/10.3390/admsci15030110>

This Version is available at:

<https://hdl.handle.net/10419/321254>

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Article

Digital Engagement and Visitor Satisfaction at World Heritage Sites: A Study on Interaction, Authenticity, and Recommendations in Coastal China

Yuan Zhang ¹, Árpád Papp-Váry ² and Zoltán Szabó ^{1,*}

¹ Alexandre Lamfalussy Faculty of Economics, University of Sopron, H-9400 Sopron, Hungary; zhangyuan@phd.uni-sopron.hu

² Faculty of International Management and Business, Budapest Business University, H-1165 Budapest, Hungary; papp-vary.arpad@uni-bge.hu

* Correspondence: szabo.zoltan@uni-sopron.hu

Abstract: This study investigates the impact of digital transformation on visitor satisfaction, engagement, and recommendation intentions at World Heritage Sites in Chinese coastal cities. A survey-based quantitative research design was employed, collecting data from four hundred and two respondents across eight cities using systematic random sampling. structural equation modeling (SEM) was applied to analyze relationships among digital participation, perceived authenticity, visitor satisfaction, and recommendation behaviors. Results highlight that technologies such as VR and AR enhance satisfaction, engagement, and authenticity, driving recommendation behaviors. Extending Cultural Authenticity Theory and satisfaction–loyalty frameworks, the study emphasizes the dynamic interplay of digital tools and cultural narratives. Practical recommendations focus on implementing culturally sensitive, interactive digital strategies to strengthen heritage tourism's sustainability. Future research is encouraged to explore emerging technologies like AI and the metaverse.

Keywords: digital transformation; cultural authenticity; visitor satisfaction; heritage tourism; sustainable tourism



Received: 31 January 2025

Revised: 24 February 2025

Accepted: 26 February 2025

Published: 19 March 2025

Citation: Zhang, Y.; Papp-Váry, Á.; & Szabó, Z. (2025). Digital Engagement and Visitor Satisfaction at World Heritage Sites: A Study on Interaction, Authenticity, and Recommendations in Coastal China. *Administrative Sciences*, 15(3), 110. <https://doi.org/10.3390/admsci15030110>

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1. Introduction

Digital transformation is critical for enhancing visitor experiences and management efficiency at World Heritage Sites. Technologies like VR and AR enrich historical narratives, fostering visitor immersion and satisfaction while promoting sustainable development (Yersüren & Özal, 2024; Y. Zhang & Szabó, 2024). Despite rapid economic growth in China's coastal cities, research on AR and VR remains focused on Western sites, leaving gaps regarding Chinese destinations (Yu et al., 2024; Khalil et al., 2023). Unique sociocultural, behavioral, and policy factors in China necessitate examining how these technologies influence visitor experiences and outcomes. Given the high concentration of tourism activities, economic development, and international engagement in China's coastal heritage sites, understanding how digital transformation unfolds in these locations is crucial for both academic inquiry and practical implementation (Buhalis et al., 2023). While this study focuses on coastal heritage sites, previous research on non-coastal heritage sites has explored digital adoption under different contextual factors, such as accessibility, visitor demographics, and local policy support (Y. Li et al., 2024). Recognizing these distinctions, this study aims to provide insights specifically relevant to coastal heritage settings.

This study employs structured surveys and structural equation modeling (SEM) to explore how AR and VR enhance digital participation, authenticity perceptions, and satisfaction, ultimately driving recommendation behaviors (Y. Li et al., 2024; Polishchuk et al., 2023). The Stimulus–Organism–Response (SOR) framework links external stimuli (digital features) to internal responses (authenticity and satisfaction) and behavioral outcomes (recommendations), providing a theoretical basis for these relationships. While alternative frameworks in tourism research, such as the Technology Acceptance Model (TAM) or Expectation–Confirmation Model (ECM), could also explain technology adoption and visitor satisfaction, SOR is particularly suited for this study as it captures not only cognitive and emotional responses to digital features but also behavioral outcomes, which are crucial in understanding AR/VR-driven engagement in tourism contexts (Kim et al., 2020). Given that AR and VR experiences are designed to evoke psychological engagement and authenticity perceptions, SOR provides a more comprehensive approach than models that primarily focus on technology adoption or post-consumption satisfaction (Nam et al., 2023).

The conceptual model outlines core variables—perception of digital features, participation, authenticity, satisfaction, and recommendations—highlighting their interplay. Findings emphasize the importance of culturally sensitive digital tools in enhancing visitor experiences and supporting sustainable tourism (Buhalis et al., 2023; Genc & Gulertekin Genc, 2023). By extending Cultural Authenticity Theory, this research provides practical strategies for heritage managers and contributors to understand how digital transformation reshapes authenticity perceptions (McLean et al., 2023; Nam et al., 2023).

2. Literature Review

2.1. Digital Transformation in Heritage Tourism and Perceived Authenticity

The digitalization of heritage tourism integrates advanced technologies with cultural and natural heritage, creating dynamic and personalized visitor experiences (Bekele & Champion, 2019). Immersive technologies like VR, AR, digital guides, and mobile applications enhance interaction, accessibility, and engagement, transforming how tourists perceive and connect with heritage sites (Pisoni et al., 2021). These innovations bridge tangible heritage with modern visitor expectations, redefining educational and recreational experiences (Zandi, 2023). By leveraging interactive tools and digital storytelling, they not only improve visitor satisfaction but also strengthen perceptions of authenticity, fostering the emotional connections essential for meaningful and memorable experiences (Vrettakis et al., 2019; Benford et al., 2022). As digital technologies reshape global heritage tourism, their adoption in China reflects distinct sociocultural dynamics (Sharafuddin et al., 2024).

Under the framework of Chinese heritage tourism, existing studies broadly classify visitor experiences into two primary types: (1) conventional heritage tourism (R. Zhang, 2020) and (2) digitally integrated tourism (Liu, 2020). Conventional approaches, centered on static displays, physical artifacts, and guided tours, prioritize the preservation and education of cultural values while effectively conveying historical narratives (Jamal & Hill, 2013; Zidianakis et al., 2021). However, these methods often fail to meet the interactivity and personalization demands of modern tourists, limiting their engagement and emotional resonance (Egger et al., 2020). Digitally integrated tourism, by contrast, utilizes advanced technologies such as VR, AR, digital guides, and mobile applications to create participatory environments that enhance visitor engagement and foster deeper connections with cultural narratives (Singh et al., 2024). These tools serve two primary objectives: (1) enhancing tourist satisfaction by delivering immersive, personalized experiences (H. W. Huang et al., 2023) and (2) strengthening perceptions of authenticity through interactive and context-rich presentations of cultural heritage (Pescarin et al., 2024). By focusing on how visitors

interact with and perceive these digital features, digitally integrated tourism not only meets evolving visitor expectations but also lays the foundation for active participation and meaningful engagement (Kim et al., 2020).

Building upon these categorizations, research highlights the importance of digital features, participation, and authenticity in shaping tourist experiences and influencing behaviors (Verma et al., 2022). Interactive technologies have been shown to enhance engagement by enabling active interaction with cultural narratives, which significantly improves perceived authenticity (Petousi et al., 2022). The alignment between cultural content and technological presentation strongly influences tourists' acceptance and satisfaction, ensuring digital tools meet evolving expectations (Z. Chen et al., 2024). Furthermore, advanced technologies contribute to cognitive responses, perceived value, and overall satisfaction by providing contextually rich and dynamic interactions (Dwivedi et al., 2024). However, despite these advantages, the increasing reliance on digital technologies in heritage tourism has also raised concerns. Some scholars argue that excessive digitalization may lead to a form of "digital detachment", where visitors become more focused on technological mediation rather than the tangible cultural heritage itself (Egger et al., 2020). Additionally, the accuracy and authenticity of digital reconstructions remain a challenge, as certain technological interpretations might inadvertently distort historical narratives (Kim et al., 2020). These potential drawbacks highlight the need for a balanced approach that maximizes the benefits of digital tools while safeguarding the cultural and historical integrity of heritage sites.

In regions such as China's southeastern coast, recognized for their economic and cultural prominence, the integration of digital technologies plays a pivotal role in addressing the growing demands for immersive and personalized experiences while reinforcing the cultural and historical significance of heritage sites (Liu, 2020). Given these considerations, this study aims to explore how digital heritage tourism can enhance visitor engagement and authenticity perceptions while mitigating the risks associated with excessive technological mediation.

2.2. Adaptation of the SOR Framework for Tourist Behavior Analysis

The Stimulus–Organism–Response (SOR) model, first developed in environmental psychology (Mehrabian, 1974), has been widely applied to examine how external factors shape tourist perceptions and behaviors. This model was initially introduced to explore the relationship between external stimuli, internal mediating processes, and resulting behavioral outcomes (Wang & Li, 2023). Within the context of tourism research, the SOR model categorizes stimuli (S) as external factors, such as technological attributes, service environments, and cultural settings, that influence tourists' perceptions and experiences (Xiang et al., 2022). The organism (O) component captures internal mediating processes, including emotional engagement, cognitive evaluations, and perceptions of authenticity, which link external stimuli to specific behavioral outcomes (Kim et al., 2020). The response (R) dimension focuses on behavioral outcomes such as tourist satisfaction, loyalty, and recommendation intentions, providing insights into how external and internal factors interact to shape tourist experiences (Cardoso & Fraga, 2024).

While the SOR framework effectively explains how external stimuli influence tourist behavior, it is essential to contrast it with other behavioral models to clarify its applicability in digital heritage tourism. Compared to the Technology Acceptance Model (TAM), which primarily emphasizes perceived usefulness and ease of use in adopting new technology (Q. Huang et al., 2023), the SOR framework offers a more comprehensive approach by integrating emotional and cognitive responses into behavioral analysis. Additionally, while the Unified Theory of Acceptance and Use of Technology (UTAUT) focuses on performance

expectancy and facilitating conditions in technology adoption, it does not fully account for tourists' psychological and emotional engagement with heritage sites (Cardoso & Fraga, 2024). The SOR framework, by incorporating both rational and affective components, provides a more holistic understanding of how digital tools mediate visitor experiences and influence authenticity perceptions (Kim et al., 2020). This distinction justifies the use of SOR in this study to examine the impact of digital technologies on visitor satisfaction and behavioral intentions within heritage tourism settings.

The model illustrated (Figure 1) is developed based on the unifying SOR framework, aligning its components to represent the relationships among the study variables (Mehrabian, 1974). Perception of digital features represents the stimuli (S), encompassing technological factors such as interactivity, informativeness, and accessibility that initiate tourist engagement with heritage sites (Torabi et al., 2023). Digital participation and interaction, as well as authenticity of perception, function as organism-level mediators (O), capturing cognitive and emotional responses (Kim et al., 2020). Digital participation reflects active engagement with digital tools, while authenticity of perception evaluates the perceived genuineness of digital representations (Jo & Ahn, 2024). These mediators connect the stimuli to response (R) variables, including tourist satisfaction and recommendation intentions (Keshavarz & Jamshidi, 2018). Tourist satisfaction reflects the emotional fulfillment derived from meaningful digital experiences, while recommendation intentions signify the likelihood of promoting the site, indicating positive behavioral outcomes (Kim et al., 2020).

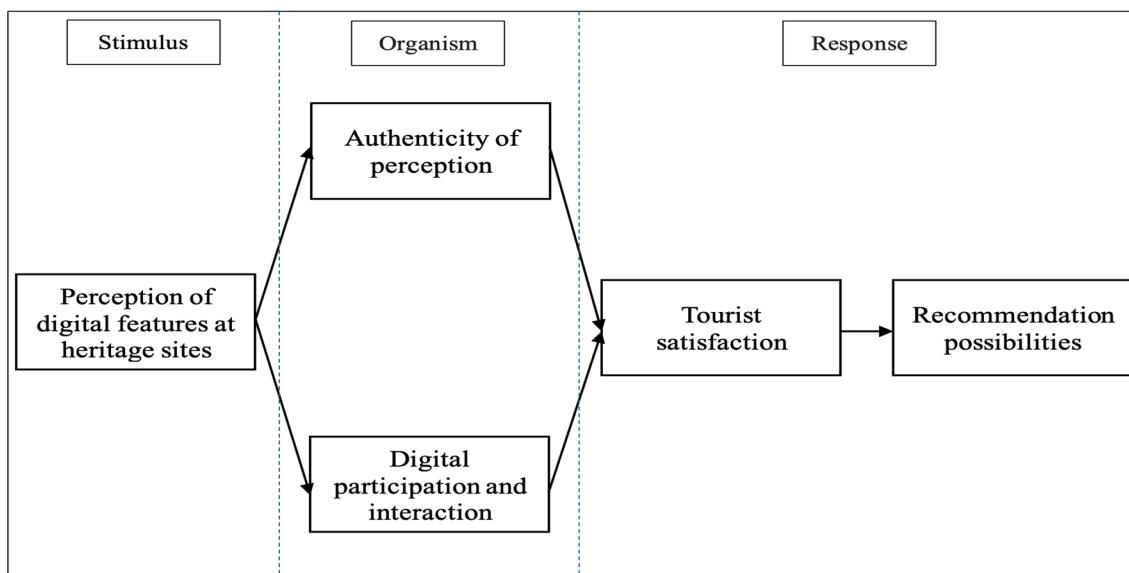


Figure 1. Research model. Source: author's research data.

2.3. Research Model and Hypotheses

The Role of Digital Transformation in Enhancing Tourism Experiences.

Expectation–Disconfirmation Theory (EDT) posits that visitor satisfaction emerges when actual experiences align with or surpass pre-visit expectations, resulting in positive disconfirmation (Cranmer et al., 2023; Y. Li et al., 2024). In the context of heritage tourism, digital tools such as virtual reality (VR) and augmented reality (AR) can significantly elevate visitor engagement by delivering immersive, expectation-surpassing experiences (Yu et al., 2024; Khalil et al., 2023). These technologies enrich the visitor journey by transforming passive observation into active participation (Cranmer et al., 2023; Yersüren & Özal, 2024).

“Digital features” in this study encompass technology-based elements like VR/AR demonstrations, digital guides, and mobile applications, which offer context-rich historical and cultural narratives (Cranmer et al., 2023). When visitors positively perceive these

digital features, they tend to exhibit higher levels of visitor engagement, characterized by deeper information processing and emotional immersion (Polishchuk et al., 2023). Hence, the following hypothesis is proposed:

H1. *Positive perceptions of digital features will enhance visitor engagement.*

The Impact of Digital Engagement and Interactivity on Visitor Satisfaction.

The incorporation of interactive digital technologies—such as mobile apps, digital displays, and interactive touchscreens—has become vital in enhancing the cultural heritage tourism experience (D. Park & Yun, 2023). These tools facilitate digital engagement and interactivity by providing on-demand, contextually relevant information, thus fostering a more meaningful and personalized visit (Cranmer et al., 2023; Ch'ng et al., 2023). Through deeper involvement with interactive features, visitors gain richer insights into the site's cultural narratives, which often leads to heightened visitor satisfaction (Polishchuk et al., 2023).

Additionally, when the digital features themselves are perceived as innovative, useful, and easy to use, visitors may transfer these positive perceptions onto the credibility and believability of the cultural content presented (Cranmer et al., 2023; Fisu et al., 2024). We thus propose two hypotheses:

H2. *Positive visitor perceptions of digital features will enhance their perception of digital content authenticity.*

H3. *Digital engagement and interactivity will positively influence visitor satisfaction.*

The Role of Perceived Authenticity in Enhancing Visitor Satisfaction.

Authenticity is pivotal in cultural heritage tourism, shaping visitors' emotional attachment and perceived value of heritage sites (Buhalis et al., 2023; H. W. Huang et al., 2023). Cultural Authenticity Theory holds that authenticity reflects the genuineness of experiences in conveying a site's cultural essence (Yuan & Hong, 2023). In the era of digital transformation, digital content authenticity signifies the extent to which visitors believe that technology-based presentations (e.g., VR reconstructions or AR overlays) faithfully represent the cultural and historical background (Nam et al., 2023; Bretos et al., 2023).

Recent studies highlight that high-quality, credible digital content can strengthen visitors' emotional engagement with a site, thereby improving satisfaction (Genc & Gulertekin Genc, 2023; Yu et al., 2024). When visitors perceive digital representations to be accurate and authentic, they tend to form stronger emotional bonds and exhibit a heightened sense of connection to the heritage context (Skinner et al., 2020). Accordingly, the following hypothesis is proposed:

H4. *Positive perceptions of digital content authenticity will enhance overall visitor satisfaction.*

The Relationship Between Visitor Satisfaction and Recommendation Intentions.

Visitor satisfaction has long been recognized as a significant predictor of word-of-mouth and recommendation intentions within tourism settings (S. Li & Jiang, 2023). Satisfaction Theory asserts that when experiences surpass visitors' expectations, they are more inclined to endorse and share them, thereby boosting the destination's reputation (Carvalho & Alves, 2023). In cultural heritage tourism, such positive experiences not only foster return visits but also contribute to the site's broader cultural and social appeal (Borges-Tiago et al., 2022).

Contemporary research underscores the role of immersive digital tools—such as AR/VR-based interactive exhibits—in amplifying visitor satisfaction, which, in turn, spurs visitors' willingness to recommend the site (Alyahya & McLean, 2022; Sia et al., 2023). Consequently, this study posits the following:

H5. *Higher overall visitor satisfaction will positively influence the intention to recommend the heritage site.*

Synthesis of Literature Controversies, Research Gap, and Study Contributions.

Despite growing interest in digital transformation within heritage tourism, several controversies and gaps persist:

1. Operationalizing Digital Authenticity: Previous research differentiates objective versus existential authenticity (Ning, 2017; Kolar & Zabkar, 2010), but fewer studies focus on the perceived authenticity of digitally rendered content and its influence on visitors' emotional and cognitive responses (Cranmer et al., 2023).
2. Engagement–Satisfaction Mechanisms: Although visitor engagement is generally linked to higher satisfaction, the precise mechanisms—particularly in technology-driven settings—are not fully understood. Some scholars argue that the novelty effect might overshadow genuine cultural engagement, thus complicating consistent satisfaction outcomes (Polishchuk et al., 2023; Fisu et al., 2024).
3. Recommendation Behavior and Technology: While immersive digital tools are recognized as catalysts for enhancing satisfaction, the extent to which these experiences translate into robust word-of-mouth or revisit intentions remains unclear (Buhalis et al., 2023). Questions linger regarding how authenticity perceptions mediate or moderate this process.

Addressing these issues, the present study develops a comprehensive model integrating digital features, visitor engagement, digital content authenticity, visitor satisfaction, and recommendation intentions. By examining how positive perceptions of digital tools shape visitors' engagement, authenticity appraisals, and subsequent satisfaction and recommendations, this research aims to (1) offer new insights into the role of digital transformation in heritage tourism and (2) provide actionable strategies for heritage site managers to enhance digital experiences and encourage sustainable visitor behaviors.

2.4. Synthesis of Literature Review and Research Gaps

Recent studies highlight the transformative impact of digitalization on cultural heritage tourism. Bekele and Champion (2019) demonstrated VR's role in enhancing immersion, Pisoni et al. (2021) examined interactive technologies' influence on authenticity perception, and Kim et al. (2020) validated the SOR framework in tourist behavior analysis. While digital tools significantly enhance visitor satisfaction, their effects on authenticity perception remain debated (Pescarin et al., 2024).

Key research gaps persist. First, digital authenticity remains underexplored, with studies focusing on objective and existential authenticity (Zidianakis et al., 2021) but overlooking tourists' subjective perceptions (Kim et al., 2020). Second, the interactivity–satisfaction link lacks clarity; while interactivity enhances satisfaction (H. W. Huang et al., 2023), its novelty effect in technology-driven contexts requires further validation (Polishchuk et al., 2023). Third, the role of authenticity in recommendation behavior remains ambiguous. While high-quality digital experiences drive recommendations (Keshavarz & Jamshidi, 2018), the mediating effect of authenticity perception is unclear (Yu et al., 2024).

Addressing these gaps, this study examines how digital tools shape authenticity perception and visitor satisfaction, contributing to sustainable heritage tourism strategies.

3. Methodology

This study employs a structured questionnaire to collect data on visitor perceptions of digital transformation at World Heritage Sites in Chinese coastal cities, focusing on key variables such as perceptions of digital features, digital participation and interaction, authenticity of perception, tourist satisfaction, and recommendation possibilities (Madzik et al., 2023; Abbasi et al., 2023; Rather et al., 2024; Dağ et al., 2023). Advanced statistical methods, including regression analysis and structural equation modeling (SEM), are used to analyze these data, reveal relationships, and construct a comprehensive interaction model (Preko et al., 2023; Balakrishnan et al., 2023).

3.1. Research Design

This study adopted a survey-based quantitative research design to explore relationships among key variables related to digital transformation at World Heritage Sites. This approach is widely recognized for its ability to generate standardized, comparable data and to test causal relationships using validated statistical methods (Q. Huang et al., 2023; Viglia & Dolnicar, 2020).

3.2. Data Collection Process

Data were collected via an online questionnaire distributed through wjx.cn between December 2023 and June 2024, leveraging the platform's proven reliability in cultural tourism studies (Balakrishnan et al., 2023; Y. Zhang & Szabó, 2024). The survey targeted visitors at twelve World Heritage Sites across eight coastal provinces: Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, and Guangxi. The cultural heritage sites include the Imperial Palace of the Qing Dynasty in Shenyang, the Chengde Mountain Resort and Outlying Temples, the Great Wall in Hebei, Mount Tai, the Classical Gardens of Suzhou in Jiangsu, sections of the Grand Canal in Jiangsu, the Fujian Tulou, Gulangyu in Fujian, and the Kaiping Diaolou and Villages in Guangdong. The natural heritage sites include the South China Karst in Guangxi and the Wuyi Mountains in Fujian. Meanwhile, the West Lake Cultural Landscape in Hangzhou is classified as a mixed heritage site, possessing both cultural and natural value, exemplifying the multidimensional appeal of China's coastal heritage (R. Zhang, 2020; Zhu et al., 2023).

The seven-month collection period strategically captured seasonal variations, with 58% of responses obtained during three peak tourism periods (Spring Festival, May Day Golden Week, summer vacations) and 42% during off-peak intervals, a temporal stratification approach validated by recent tourism seasonality studies (D. Park & Yun, 2023; Stantcheva, 2023). Geofencing technology restricted participation to individuals within 500 m of heritage cores during operational hours (8:00 a.m.–6:00 p.m.), following ethical protocols for location-based data collection (Stringam et al., 2023). Behavioral verification through site-specific photo identification questions excluded 83% of inattentive responses, a technique proven effective in enhancing data quality for digital tourism research (Fisu et al., 2024; Sharma et al., 2023).

From 2068 initial submissions, rigorous validation protocols excluded responses with geolocation errors exceeding 500 m (12.7%), inconsistent timestamps (9.3%), or logical contradictions (58.9%), yielding 402 valid cases. This 19.43% eligibility rate aligns with established thresholds for geo-fenced tourism studies (Madzik et al., 2023). Post hoc analysis confirmed the validation process's neutrality: excluded submissions showed non-significant demographic differences from the final sample in age ($t = 0.87, p = 0.38$), gender ($\chi^2 = 0.42, p = 0.52$), or education level (Fisher's exact $p = 0.67$), employing statistical methods recommended by Kline (2023).

3.3. Measurement Instrument

The structured questionnaire employed five-point Likert scales to measure five key variables:

- Perceptions of digital features;
- Digital participation and interaction;
- Authenticity of perception;
- Tourist satisfaction;
- Recommendation possibilities.

Each variable was measured using five items (Table 1). These items were derived from validated scales in the existing literature to ensure reliability and validity (Genc & Gulertekin Genc, 2023; Jiang et al., 2023). The range for the Likert scales was from “strongly disagree” to “strongly agree”, allowing for the nuanced understanding of visitor perceptions and attitudes. It provides specific details, including the number of items, example items, and sources for each variable.

Table 1. Measurement scales.

Variable	Number of Items	Source	Example Item
Perception of Digital Features	5	(Zheng & Wu, 2023)	Tourism websites and apps provide me with useful information about the travel destination(s) and the trip.
Digital Participation and Interaction	5	(S. Huang & Choi, 2019)	I thoroughly enjoyed exchanging small talk with other people during this cruise trip.
Authenticity of Perception	5	(E. Park et al., 2019)	I feel that the heritage site represents authentic historical and cultural values.
Tourist Satisfaction	5	(Zeng & Yi Man Li, 2021)	The MKT project meets tourists' expectations.
Recommendation Possibilities	5	(Ali et al., 2018)	I am satisfied with my decision to visit this theme park.

Source: author's research data.

3.4. Sample and Sampling Methods

Sample size determination adopted conservative parameters following Cohen's conventions for social science research, targeting 95% power to detect medium-sized effects ($f^2 = 0.15$) in planned multiple regression analyses (Kline, 2023; Sürütü et al., 2023). A priori power analysis (G*Power 3.1, $\alpha = 0.05$, $1 - \beta = 0.95$) for 15 predictors indicated a minimum requirement of 385 responses, with the final 402 participants providing 96.8% actual power—exceeding conventional thresholds in hospitality research (Elshaer & Marzouk, 2024). Sensitivity analysis confirmed the capability to detect smaller effects ($f^2 = 0.12$) at 90% power, addressing methodological concerns raised in the recent tourism literature (Woosnam & Ribeiro, 2023).

Geospatial stratification allocated questionnaires proportionally to each site's 2023 visitation volume, a methodology validated in cultural heritage tourism studies (Yi et al., 2023; Zhou et al., 2023). Allocations ranged from 28 participants (5.9%) at Kaiping Diaolou to 86 (21.3%) at West Lake Cultural Landscape, reflecting actual visitor distribution patterns documented by the Fan (2023). Daily dynamic adjustments through Ctrip's real-time visitor flow API maintained proportionality within $\pm 3.2\%$ of target allocations, adapting

platform integration techniques from cutting-edge smart tourism research (Buhalis et al., 2023; Z. Chen et al., 2024).

Demographic quotas replicated the Fan's (2023) China's cultural industry and tourism development report, achieving gender parity (50.2% female vs. 49.8% census) and age distribution alignment (18–24: 22.1% vs. 21.9%; 25–34: 31.7% vs. 32.1%) through adaptive sampling protocols (Rodrigues et al., 2023). Education levels mirrored national parameters (high school or below: 36.8% vs. 37.2%) using quota control mechanisms validated in recent hospitality studies (Carvalho & Alves, 2023). Standardized differences across all demographic variables remained below 0.08, satisfying rigorous balance criteria (Hamdy et al., 2024).

Temporal validity was ensured through quadruple stratification matching circadian visitation patterns (34% morning, 41% afternoon, 25% evening), utilizing temporal randomization techniques from experimental tourism research (Sia et al., 2023). Levene's tests confirmed variance homogeneity between peak-season ($n = 217$) and off-peak ($n = 185$) responses across all constructs ($p > 0.05$), addressing seasonality concerns raised in the destination management literature (Quang et al., 2024). Final representativeness was validated through equivalence testing (Lakens, 2017), with 90% confidence intervals for all demographic proportions fully contained within $\pm 3\%$ of census reference values, demonstrating methodological rigor comparable to leading heritage tourism studies (Genc & Gulertekin Genc, 2023; Yu et al., 2024).

4. Results

This study shows that digital features such as virtual and augmented reality significantly enhance visitor engagement, perceived authenticity, and overall satisfaction. Visitors with positive perceptions of these digital tools show increased participation, boosting satisfaction and the possibility of recommending the sites. Descriptive statistical analysis provides an overview of respondent demographics and perceptions, ensuring sample representativeness. Key demographics, such as gender, age, and education level, show a balanced distribution. The findings highlight high engagement with digital features, overall satisfaction, and a strong link between digital authenticity, participation, and recommendations, underscoring the importance of digital engagement in enhancing visitor experiences.

4.1. Sample Characteristics

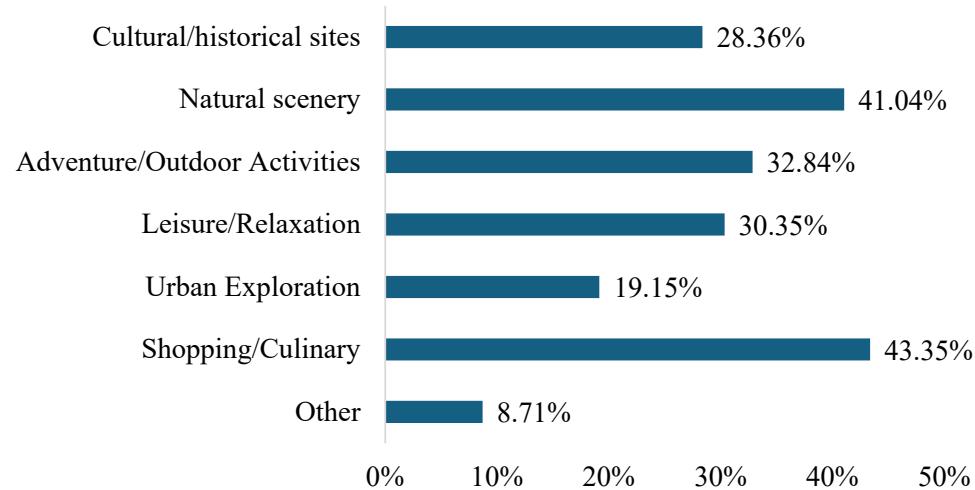
The sample exhibits a balanced demographic profile across critical variables. The gender and age distributions are nearly equal, with 49.25% male and 50.75% female respondents, predominantly aged 25–44 (Table 2). This demographic aligns well with the study's focus on digital tourism, as younger adults are primary users of digital engagement tools. Educational background further supports the study's relevance, with 91.29% holding a college degree or higher and representing fields such as humanities, STEM (Science, Technology, Engineering, and Math), and business, indicating an educated sample likely to engage with digital content in heritage tourism.

Travel Preferences and Cultural Identification data indicate a strong preference for shopping and food-related activities (43.53%), followed by natural scenery (41.04%) and adventure activities (32.84%) (Figure 2). Respondents show high levels of cultural identification, with multicultural identification scoring highest (mean = 3.61), reflecting an openness to diverse cultural experiences compatible with digital engagement in heritage tourism (Table 3).

Table 2. Basic characteristics of respondents.

Item	Options	Frequency	Percentage
Biological gender	Male	198	49.25%
	Female	204	50.75%
Age	18–24	52	12.94%
	25–34	144	35.82%
	35–44	115	28.61%
	45–54	64	15.92%
	55 and over	27	6.72%
Educational level	High school and below	35	8.71%
	College/Undergraduate	281	69.90%
	Graduate student and above	86	21.39%
Type of education	STEM (Science, Technology, Engineering, and Math)	107	26.62%
	Humanities and arts	114	28.36%
	Business and economics	88	21.89%
	Social sciences	93	23.13%
	Students	12	2.99%
Occupation	Educators	80	19.90%
	Corporate employee	188	46.77%
	Freelancers	114	28.36%
	Retired	8	1.99%
	Less than CNY 3000	38	9.45%
Average monthly income	CNY 3000–5000	109	27.11%
	CNY 5001–8000	151	37.56%
	CNY 8001–12,000	85	21.14%
	Above CNY 12,000	19	4.73%

Source: author's research data.

**Figure 2.** Analysis of respondents' tourism preferences. Source: author's research data.**Table 3.** Cultural identity of respondents.

Item	Very Little	Somewhat Little	Moderate	Quite a Lot	Very Much	Average
Local Culture	23 -5.72%	39 -9.70%	104 -25.87%	178 -44.28%	58 -14.43%	3.52
International Culture	16 -3.98%	43 -10.70%	100 -24.88%	180 -44.78%	63 -15.67%	3.57
Multiculturalism	15 -3.73%	46 -11.44%	87 -21.64%	185 -46.02%	69 -17.16%	3.61

Source: author's research data.

Analysis of Variances

Based on an in-depth analysis of the research data regarding differences in perceptions of digital services among tourists of varying ages, income levels, and cultural backgrounds, significant intergroup disparities were identified. In terms of age, a one-way ANOVA revealed a stepwise decline in evaluations of digital marketing activities with increasing age ($F = 12.43, p < 0.001$). The 25–34 age group demonstrated the highest approval of digital marketing ($M = 3.81$), significantly exceeding the lowest ratings from the 55+ age group ($M = 2.59$). This divergence likely stems from younger groups' inherent affinity for digital technologies, whereas older populations may face barriers to technology adoption, leading to lower evaluations. Regarding income, high-income tourists (monthly income $> 12,000$ RMB) exhibited markedly higher satisfaction with digital services ($M = 4.26$) compared to low-income groups ($M = 2.66$), with extremely significant intergroup differences ($F = 15.82, p < 0.001$). This suggests that financial capacity may influence experience evaluations through factors such as device accessibility or service expectations.

The impact of cultural background was equally pronounced. Using educational discipline as a proxy for cultural orientation, STEM (Science, Technology, Engineering, and Mathematics)-educated individuals rated the usability of digital guides significantly higher ($M = 3.78$) than those in humanities and arts ($M = 3.30$), business and economics ($M = 3.16$), and social sciences ($M = 2.81$) ($F = 8.95, p < 0.001$). This disparity may reflect disciplinary training's role in shaping technological acceptance—STEM groups might prioritize functional logic, while humanities and social science groups emphasize cultural coherence. Further analysis showed that STEM-background tourists also expressed stronger endorsements of the value of digital experiences (e.g., "digital tools enhance cultural understanding") compared to other groups ($p < 0.05$), indicating an interaction between technological literacy and content perception.

Collectively, tourists' perceptions of digital experiences are systematically moderated by demographic characteristics. Younger, high-income, and technically educated groups exhibit greater receptivity to digital transformation, with positive evaluations potentially rooted in technological familiarity and resource advantages. Conversely, older, low-income, and non-technical groups demonstrate higher experiential thresholds. These findings suggest that heritage sites should optimize digital service design for segmented populations—for instance, simplifying interfaces for elderly visitors or enhancing cultural narratives in digital content for humanities-oriented users. Notably, the study's limitations include small sample sizes for specific subgroups (e.g., 55+ age group, monthly income $> 12,000$ RMB), necessitating expanded sampling in future research to validate generalizability. Additionally, multidimensional measurements of cultural background (e.g., actual cultural practices rather than educational discipline) could refine the understanding of differential mechanisms.

Travel Frequency and Destination Knowledge highlight active travel behaviors, with over half (51.49%) traveling multiple times per year, underscoring a highly engaged sample (Figure 3). Knowledge levels across cultural, historical, and geographical dimensions are rated medium to high, with cultural knowledge rated highest on average (Table 4), emphasizing a strong baseline for informed, culturally immersive travel.

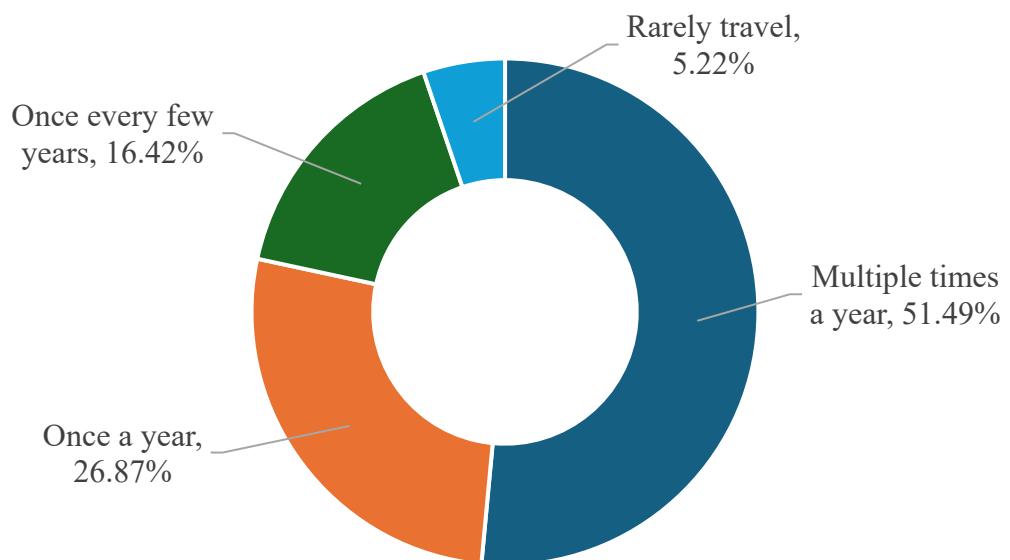


Figure 3. Frequency of travel by respondents. Source: author's research data.

Table 4. Respondents' level of knowledge about tourist destinations.

Item	Very Superficial	Somewhat Superficial	Moderate	Quite in-Depth	Very in-Depth	Average
Understanding of destination culture	14 (3.48%)	41 (10.2%)	112 (27.86%)	172 (42.79%)	63 (15.67%)	3.57
Knowledge of the destination's history	16 (3.98%)	53 (13.18%)	101 (25.12%)	173 (43.03%)	59 (14.68%)	3.51
Knowledge of destination geography	18 (4.48%)	48 (11.94%)	99 (24.63%)	181 (45.02%)	56 (13.93%)	3.52

Source: author's research data.

Factors Influencing Destination Choice reveal a prioritized focus on safety, uniqueness, and convenience, which score consistently high among respondents (Table 5). These preferences underline a desire for secure and distinct travel experiences, reinforcing their influence on satisfaction and recommendation intentions.

Table 5. Factors considered in choosing a tourist destination.

Item	No Impact	Little Impact	Moderate Impact	Significant Impact	Very Significant Impact	Average
Word of reputation/Recommendation	13 (3.23%)	54 (13.43%)	87 (21.64%)	188 (46.77%)	60 (14.93%)	3.57
Price/cost	12 (2.99%)	50 (12.44%)	94 (23.38%)	180 (44.78%)	66 (16.42%)	3.59
Safety of the travel destination	17 (4.23%)	48 (11.94%)	89 (22.14%)	176 (43.78%)	72 (17.91%)	3.59
The uniqueness of the travel destination	16 (3.98%)	47 (11.69%)	88 (21.89%)	190 (47.26%)	61 (15.17%)	3.58
The convenience of the travel destination	14 (3.48%)	47 (11.69%)	94 (23.38%)	177 (44.03%)	70 (17.41%)	3.6

Source: author's research data.

World Heritage Site Preferences show that respondents are equally interested in cultural, natural, and mixed sites. For example, 83.08% utilize digital guides or apps during visits, favoring third-party over official sources (Table 6). Usability and experience enhancement ratings for digital tools are moderate, pinpointing specific opportunities to improve digital service quality.

Table 6. Analysis of digital tour guide applications.

Item	Options	Frequency	Percentage
Type of World Heritage Site	Cultural world heritage	136	33.83%
	Natural world heritage	168	41.79%
	Mixed world heritage	98	24.38%
Usage of digital tour guides or apps	Yes	334	83.08%
	No	68	16.92%
Digital tour guides or apps supply sources	Officially	153	38.06%
	Third-party	249	61.94%
Availability of digital guides or apps	Very poor	15	3.73%
	Poor	101	25.12%
	Average	105	26.12%
	Good	118	29.35%
	Very good	63	15.67%
Evaluation of the quality of digital guides or apps	Very poor	16	3.98%
	Poor	105	26.12%
	Average	101	25.12%
	Good	116	28.86%
	Very good	64	15.92%
Digital guides or apps enhance the experience	Strongly disagree	17	4.23%
	Disagree	114	28.36%
	Neutral	77	19.15%
	Agree	125	31.09%
	Strongly agree	69	17.16%

Source: author's research data.

Finally, learning channels and digital marketing effectiveness data reflect a high reliance on online platforms, with 82.59% using digital sources for heritage site information (Table 7). However, satisfaction with digital marketing effectiveness and online reputation management is moderate, suggesting areas for optimization to engage digital-savvy heritage tourists fully.

Table 7. Analysis of online marketing of World Heritage Sites.

Item	Options	Frequency	Percentage
Learn about World Heritage Sites online	Yes	332	82.59%
	No	70	17.41%
Digital marketing campaign results for World Heritage Sites	Very ineffective	11	2.74%
	Ineffective	115	28.61%
	Moderate	95	23.63%
	Effective	111	27.61%
	Very effective	70	17.41%
Satisfaction with online reputation management of heritage sites	Very dissatisfied	15	3.73%
	Dissatisfied	106	26.37%
	Neutral	99	24.63%
	Satisfied	118	29.35%
	Very satisfied	64	15.92%

Source: author's research data.

4.2. Reliability and Validity Analysis

The reliability and validity of the measurement instruments were evaluated to ensure suitability for hypothesis testing. Reliability was assessed using Cronbach's Alpha, with coefficients ranging from 0.921 to 0.925, indicating high internal consistency across constructs (Table 8).

Table 8. Reliability coefficient analysis of the questionnaire.

Item	Correlation of Corrected Items to Totals	Cronbach's Alpha, After Deleting Items	Cronbach's Alpha
Q18	0.524	0.922	
Q19	0.544	0.922	
Q20	0.546	0.922	
Q21	0.54	0.922	
Q22	0.547	0.922	
Q23	0.506	0.923	
Q24	0.526	0.922	
Q25	0.551	0.922	
Q26	0.533	0.922	
Q27	0.498	0.923	
Q28	0.593	0.921	
Q29	0.571	0.922	
Q30	0.594	0.921	0.925
Q31	0.606	0.921	
Q32	0.573	0.922	
Q33	0.556	0.922	
Q34	0.535	0.922	
Q35	0.536	0.922	
Q36	0.516	0.923	
Q37	0.536	0.922	
Q38	0.583	0.922	
Q39	0.575	0.922	
Q40	0.556	0.922	
Q41	0.573	0.922	
Q42	0.569	0.922	

Source: author's research data.

Item–total correlations mostly fell between 0.5 and 0.6, demonstrating moderate correlation strength. Alpha values remained stable (0.921–0.923) after item deletion, confirming that each item contributed positively to overall reliability.

Validity was examined using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity to confirm structural validity. The KMO coefficient was 0.926, and Bartlett's test produced a chi-square value of 5501.643 (Sig. = 0.000 < 0.01) (Table 9), both of which meet the standards for high validity. These results validate the questionnaire's structural consistency and suitability for further analysis.

Table 9. Validity analysis of the questionnaire.

KMO and Bartlett's Test			
Kaiser–Meyer–Olkin Measure of Sampling Adequacy			0.926
Bartlett's Test of Sphericity	Approx. Chi-Square		5501.643
	df		300
	Sig.		0

Source: author's research data.

4.3. Exploratory Factor Analysis

Exploratory factor analysis (EFA) was conducted to elucidate the latent structure of the measurement items, confirming distinct factor groupings and no cross-loading, as all factor loadings in the rotated component matrix exceeded the recommended threshold of 0.6 (Table 10). Five primary factors emerged from the analysis. The first factor, “positive impact of digital transformation and willingness to recommend”, includes items related to perceptions of digital transformation’s advantages and the possibility of recommending the experience. The second factor, “digital perception”, captures respondents’ assessment of the value and convenience offered by digital features. The third factor, labeled “authenticity and cultural communication”, reflects items related to the authenticity and cultural accuracy of digital exhibits. The fourth factor, “visitor satisfaction”, encompasses items measuring satisfaction and expectations toward digital services. Lastly, the fifth factor, “digital interaction and engagement”, includes items indicating respondents’ active engagement with digital elements.

Table 10. Exploratory factor analysis.

Item	Factors				
	1	2	3	4	5
40. I think digital transformation is good for the long-term attractiveness of World Heritage Sites	0.805				
38. I would recommend that World Heritage Sites continue their digital development in the future	0.787				
39. I would be more inclined to visit again if more digital elements were added to the World Heritage site	0.785				
41. I would recommend this destination to others based on the heritage site’s digital services	0.781				
42. Digital transformation enhances the overall image of World Heritage Sites	0.78				
21. Digital experiences at World Heritage Sites are just as valuable as traditional visits		0.797			
22. Digital services have made it easier to visit World Heritage Sites		0.79			
20. High quality of digitized content at World Heritage Sites		0.784			
19. Digital tools have increased my interest in World Heritage Sites		0.777			
18. Digital displays make the history of World Heritage Sites more accessible		0.755			
36. I think the digitized exhibits are just as authentic as the traditional exhibits at the World Heritage site			0.789		

Table 10. *Cont.*

Item	Factors				
	1	2	3	4	5
37. Digital interactions enhanced my understanding of the culture of the World Heritage Site			0.777		
34. I think the digital content accurately conveys the culture and history of the World Heritage site			0.773		
33. The digital experience maintains the authenticity and originality of the World Heritage Site			0.766		
35. Digital tools do not distract me from the original character of World Heritage Sites			0.764		
32. I think digital services add value to World Heritage Sites			0.781		
28. I am satisfied with the digitization services provided by the World Heritage Site			0.766		
30. I would recommend to others to use the digitization services of the World Heritage Site			0.752		
29. I think digital transformation has improved my overall visit experience			0.746		
31. The digital experience at the World Heritage Site met my expectations			0.73		
23. World Heritage Sites offer fun digital interactive activities			0.789		
25. Digital Engagement at World Heritage Sites Increased My Engagement			0.789		
27. Digital content at World Heritage Sites is relevant to my interests			0.746		
24. I was able to use the digital tools of the World Heritage Site easily			0.736		
26. I appreciate the virtual reality (VR) or augmented reality (AR) experiences offered by World Heritage Sites			0.727		

Source: author's research data.

Most items exhibited strong loadings above 0.7 within their assigned factors, underscoring high internal consistency and robust structural validity. These results establish a sound factor structure, forming a basis for confirmatory factor analysis and subsequent hypothesis testing.

4.4. Validation Factor Analysis

The structural validity test results (Figure 4) yielded model fit values of $CMIN/DF = 1.250$, $GFI = 0.937$, $NFI = 0.941$, $IFI = 0.988$, and $RMSEA = 0.025$. These indices meet standard thresholds, confirming that the questionnaire scale has strong structural validity.

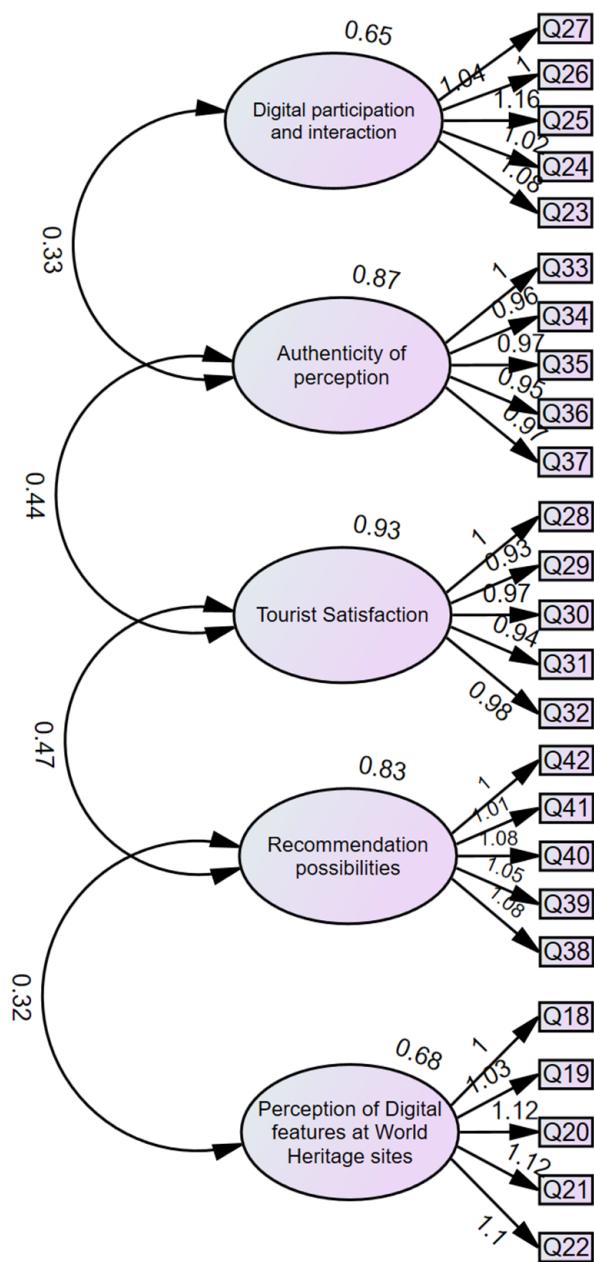


Figure 4. Results of validated factor analysis of questionnaire scales. Source: author's research data.

4.5. Correlation Analysis

To examine the relationships among core study variables, correlation analysis was performed, with significant correlations at $p < 0.01$ marked by (**), indicating robustness against chance (Table 11). Results reveal several key associations aligned with the study's hypotheses.

Table 11. Results of correlation analysis.

Factors	Perception of Digital Features at World Heritage Sites	Digital Participation and Interaction	Tourist Satisfaction	Authenticity of Perception	Recommendation Possibilities
Perception of digital features at World Heritage Sites	1				
Digital participation and interaction	0.409 **	1			
Tourist satisfaction	0.441 **	0.432 **	1		
Authenticity of perception	0.360 **	0.380 **	0.434 **	1	
Recommendation possibilities	0.377 **	0.382 **	0.472 **	0.409 **	1

Source: author's research data.

The perception of digital features exhibits moderate to strong positive correlations with digital engagement ($r = 0.409$), visitor satisfaction ($r = 0.441$), perceived authenticity ($r = 0.360$), and recommendation intentions ($r = 0.377$). These relationships suggest that favorable digital perceptions are associated with greater engagement, satisfaction, and perceived authenticity, as well as a higher possibility of recommending the experience.

Digital engagement is also positively correlated with visitor satisfaction ($r = 0.432$), perceived authenticity ($r = 0.380$), and recommendation intentions ($r = 0.382$), supporting hypotheses that greater engagement enhances satisfaction, authenticity, and the potential for positive recommendations.

Visitor satisfaction demonstrates strong positive correlations with both perceived authenticity ($r = 0.434$) and recommendation intentions ($r = 0.472$), the latter being the highest correlation in the analysis. This finding underscores satisfaction's central role in influencing recommendation behaviors. Furthermore, perceived authenticity and recommendation intentions are positively correlated ($r = 0.409$), reinforcing the hypothesis that authenticity perceptions bolster recommendation potential.

Collectively, these significant positive correlations support the hypothesized model, indicating that perceptions of digital features, engagement, authenticity, and satisfaction contribute substantially to recommendation intentions within the heritage tourism context.

4.6. Linear Regression Analysis

To examine the hypothesized relationships among key variables, a linear regression analysis was conducted, focusing on the effects of perception of digital features (F), digital participation (P), tourist satisfaction (S), and perceived authenticity (A) on recommendation intentions (R). The analysis revealed that these factors collectively explain 30.9% of the variance in recommendation intentions, as indicated by an R -squared value of 0.309 (Table 12). The model's significance is confirmed by an F -value of 89.849 ($p < 0.001$), suggesting that perceptions of digital features, engagement, satisfaction, and authenticity collectively have a meaningful impact on recommendation likelihood. The model formula is

$$R = 0.702 + 0.14F + 0.151P + 0.275S + 0.2A$$

Each independent variable demonstrated a significant positive effect on recommendation intentions, supporting the hypothesized relationships. The perception of digital features yielded a regression coefficient of 0.14 ($t = 2.684$, $p < 0.01$), indicating that favorable

perceptions of digital characteristics enhance the likelihood of recommendation. Digital participation showed a coefficient of 0.151 ($t = 2.825, p < 0.01$), demonstrating that increased digital engagement positively influences recommendations. Tourist satisfaction, with a coefficient of 0.275 ($t = 5.355, p < 0.001$), emerged as a particularly strong predictor, affirming its central role in recommendation behavior. Similarly, perceived authenticity exhibited a coefficient of 0.2 ($t = 3.969, p < 0.001$), confirming that authenticity perceptions contribute significantly to recommendation intentions.

Table 12. Regression analysis.

Dependent Variable	Independent Variable	Unstandardized Coefficients		t	Sig	Collinearity Statistics	
		B	Std. Error			Tolerance	VIF
Recommendation possibilities	(Constant)	0.702	0.201	3.489	0.001		
	Perception of digital features at World Heritage Sites	0.14	0.052	2.684	0.008	0.729	1.372
	Digital participation and interaction	0.151	0.054	2.825	0.005	0.726	1.377
	Tourist satisfaction	0.275	0.051	5.355	0	0.677	1.476
	Authenticity of perception	0.2	0.05	3.969	0	0.748	1.337
R^2		0.309					
F		$F = 44.333, p = 0.000$					

Source: author's research data.

Model diagnostics further confirm robustness. All VIF values are under 5, indicating no multicollinearity, and a Durbin–Watson statistic of 2.146 suggests no autocorrelation. These results collectively support the hypothesized model, highlighting the importance of digital features, engagement, satisfaction, and authenticity in driving recommendation intentions within heritage tourism.

4.7. Structural Equation Modeling

This study utilized Amos 26.0 to construct a structural equation model (SEM) that investigates the influence pathways among perception of digital features, digital participation, visitor satisfaction, perceived authenticity, and recommendation intentions within digitally transformed World Heritage Sites in Chinese coastal cities. Observed variables were included to examine path coefficients and weightings relevant to recommendation intentions, and the results are illustrated in Figure 5.

The model demonstrated a strong fit with the data, as indicated by the fit indices: $\chi^2/df = 1.452$, GFI = 0.927, AGFI = 0.912, CFI = 0.977, RMSEA = 0.034, TLI = 0.975, IFI = 0.977, and NFI = 0.931 (Table 13). These values meet the standard thresholds, affirming the model's suitability for examining the specified hypotheses.

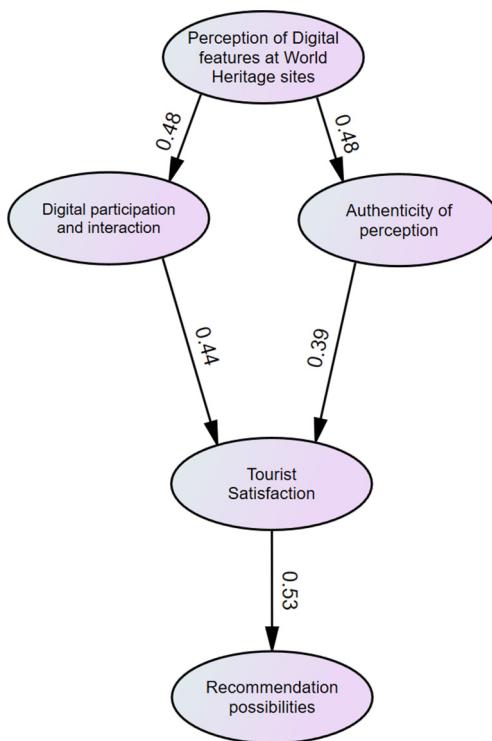


Figure 5. Structural equation modeling of factors affecting the recommendation probability. Source: author's research data.

Table 13. Path coefficients between variables.

Variable	Relation	Variable	Estimate	S.E.	C.R.	p	Hypotheses No.	Hypotheses
Digital participation and interaction	<---	Perception of digital features at World Heritage sites	0.466	0.06	7.85	***	H1	Accept
Authenticity of perception	<---	Perception of digital features at World Heritage sites	0.471	0.07	7.21	***	H2	Accept
Tourist satisfaction	<---	Digital participation and interaction	0.307	0.07	4.53	***	H3	Accept
Tourist satisfaction	<---	Authenticity of perception	0.305	0.06	5.41	***	H4	Accept
Recommendation possibilities	<---	Tourist satisfaction	0.532	0.06	9.57	***	H5	Accept

***. At the 0.001 level, significant correlation. Source: author's research data.

Each path estimate represents the strength of influence between variables, with the standard error (S.E.) reflecting the precision of these estimates; lower S.E. values suggest higher reliability. The critical ratio (C.R.), obtained by dividing the estimate by S.E., tests the significance of each relationship, where *p*-values below 0.05 indicate statistical significance.

Results for hypothesis testing indicate the following relationships:

- H1. *Perception of digital features exerts a significant positive influence on digital participation (path coefficient = 0.466, C.R. = 7.853, p < 0.001), supporting the hypothesis that enhanced perceptions of digital features facilitate greater engagement.*
- H2. *Perception of digital features positively impacts perceived authenticity (path coefficient = 0.471, C.R. = 7.205, p < 0.001), confirming that favorable digital perceptions reinforce perceptions of cultural authenticity.*

H3. *Digital participation has a significant positive effect on visitor satisfaction (path coefficient = 0.307, C.R. = 4.525, p < 0.001), indicating that active engagement with digital features enhances visitor satisfaction.*

H4. *Perceived authenticity significantly influences visitor satisfaction (path coefficient = 0.305, C.R. = 5.411, p < 0.001), supporting the role of authenticity perceptions in enhancing satisfaction levels.*

H5. *Visitor satisfaction strongly predicts recommendation intentions (path coefficient = 0.532, C.R. = 9.568, p < 0.001), validating satisfaction as a crucial determinant of recommendation likelihood.*

In conclusion, all hypothesized pathways were supported, establishing that the perception of digital features contributes to engagement, authenticity, and satisfaction, which subsequently drive recommendation intentions. These results emphasize that enhancing digital features at heritage sites fosters satisfaction and loyalty, promoting word-of-mouth recommendations and further engagement.

5. Discussion

Digital transformation significantly impacts visitor satisfaction and recommendation possibility at World Heritage Sites. This study's model highlights both direct and indirect effects of digital feature perceptions, engagement, and perceived authenticity on visitor outcomes, underscoring the critical role of high-quality digital content in shaping positive experiences. Findings stress the need for strategic digital tool optimization and ongoing innovation to enhance operational efficiency and support sustainable tourism development. The study also provides a robust theoretical foundation for future research, encouraging exploration into digital transformation's varied impacts across cultural and global contexts in tourism.

5.1. The Impact of Digital Feature Perception on Digital Participation

This study confirms that positive perceptions of digital features significantly enhance digital participation, as evidenced by H1. Visitors engage more actively with heritage content when digital tools are intuitive, immersive, and user-friendly. This finding underscores the transformative role of digital tools in bridging heritage tourism with the expectations of modern, tech-savvy visitors (S. Chen et al., 2024; Nam et al., 2023). Compared to previous studies that emphasized the functionality of digital tools, this research highlights the importance of user perceptions in fostering deeper engagement.

By extending Expectation–Disconfirmation Theory (EDT), this study shifts the focus from satisfaction as an outcome to engagement as a precursor, providing a more dynamic perspective on visitor interactions (Cranmer et al., 2023; Y. Zhang & Szabó, 2024). This theoretical advancement is particularly relevant in non-Western cultural contexts, such as Chinese heritage sites, where digital transformation has distinct socio-cultural implications compared to Western models.

To maximize engagement, heritage managers should invest in interactive technologies, such as AR-enabled on-site tours or gamified apps that merge cultural narratives with visitor participation. For example, the Palace Museum in Beijing successfully integrates AR-enhanced experiences, allowing visitors to interact with historical artifacts digitally, deepening engagement. Policymakers can prioritize digital infrastructure development in underfunded regions through grants or tax incentives, ensuring that heritage sites in rural areas can compete with urban attractions in offering advanced digital experiences (Polishchuk et al., 2023; Genc & Gulertekin Genc, 2023).

5.2. The Influence of Digital Feature Perception on Perceived Authenticity

The findings confirm that positive perceptions of digital features significantly enhance perceived authenticity, validating H2. Visitors view heritage experiences as more culturally authentic when digital tools deliver accurate, context-sensitive, and immersive narratives (Nam et al., 2023; Yuan & Hong, 2023). This dual role of digital tools—as mediators of engagement and authenticity—underscores their importance in shaping meaningful visitor experiences.

This study enriches Cultural Authenticity Theory by demonstrating that authenticity is not a fixed attribute but a dynamic perception shaped through interactions with digital tools. By focusing on Chinese heritage sites, the research highlights how digital tools can strengthen cultural narratives, challenging the assumption that digitalization undermines cultural authenticity. In non-Western contexts, digital representations of heritage often carry deeper cultural and emotional meanings, making accuracy and context even more critical (Y. Zhang & Szabó, 2024; Cranmer et al., 2023).

Heritage managers should collaborate with cultural historians and anthropologists to design digital content that accurately reflects historical and cultural contexts. For example, the Mogao Caves in Dunhuang have successfully implemented high-resolution digital projections and interactive AR experiences, allowing visitors to explore fragile cave murals while preserving the original artifacts. Such initiatives enhance authenticity perceptions while deepening cultural understanding (Quang et al., 2024; Polishchuk et al., 2023). Policymakers should establish evaluation standards for cultural authenticity in digital tools to prevent commercialized misrepresentations of heritage.

5.3. The Relationship Between Digital Participation and Visitor Satisfaction

Digital participation significantly enhances visitor satisfaction, as demonstrated by H3. Active interaction with digital tools fosters emotional and cognitive connections, transforming passive consumption into a dynamic, participatory experience (Y. Zhang & Szabó, 2024; Yu et al., 2024). This finding aligns with growing trends in heritage tourism, where visitors increasingly seek meaningful engagement rather than surface-level observation.

By integrating participation into the EDT framework, this study expands its scope, emphasizing that engagement is not merely a precursor to satisfaction but a transformative process that redefines the visitor experience (Nam et al., 2023; Skinner et al., 2020). These insights provide a foundation for further research into how engagement shapes long-term satisfaction and loyalty behaviors.

Heritage managers should create participatory experiences that actively involve visitors, such as immersive VR storytelling that allows users to “experience” historical events or AR-based scavenger hunts that encourage exploration. The Louvre Museum’s AR treasure hunts exemplify this approach, offering visitors an interactive and educational journey through the museum. Digital literacy initiatives funded by policymakers could ensure that diverse demographics, including older visitors, can effectively engage with these tools, enhancing inclusivity in heritage tourism (Elshaer & Marzouk, 2024; Buhalis et al., 2023).

5.4. The Role of Perceived Authenticity in Enhancing Visitor Satisfaction

Perceived authenticity plays a pivotal role in enhancing visitor satisfaction, validating H4. Visitors are more likely to report positive experiences when digital content aligns with cultural expectations and reflects emotional and historical accuracy (Buhalis et al., 2023; Nam et al., 2023). Authenticity thus emerges as a critical factor in deepening emotional connections with heritage sites.

This study advances Cultural Authenticity Theory by positioning authenticity as a mediator between engagement and satisfaction. By illustrating the evolving nature of

authenticity in digitally mediated heritage contexts, the research provides a framework for understanding how digital tools redefine cultural narratives and visitor perceptions (Rodrigues et al., 2023; Khalil et al., 2023).

Heritage managers must prioritize culturally sensitive digital tools that align with the historical narratives of their sites. For example, the British Museum's interactive digital reconstructions of ancient Mesopotamian artifacts allow visitors to explore historical narratives while preserving authenticity. Training programs for developers should emphasize cultural sensitivity and historical accuracy to ensure digital content enhances, rather than distorts, authenticity (ur Rehman et al., 2024; Y. Li et al., 2024).

5.5. The Effect of Visitor Satisfaction on Recommendation Intentions

Visitor satisfaction strongly predicts recommendation intentions, as evidenced by H5. Satisfied visitors are more likely to recommend heritage sites, amplifying positive word-of-mouth effects and enhancing the site's reputation (Z. Chen et al., 2024; Y. Zhang & Szabó, 2024). This finding reinforces the importance of creating seamless, integrated visitor experiences that combine digital and physical interactions.

By linking satisfaction to recommendation behaviors, this study extends satisfaction-loyalty frameworks to heritage tourism, emphasizing the role of technology in fostering advocacy behaviors. Future research could explore how post-visit digital engagement—such as personalized follow-ups or virtual memberships—sustains long-term loyalty (Nam et al., 2023; Yu et al., 2024).

Heritage managers should implement post-visit strategies to maintain visitor satisfaction and advocacy. Personalized follow-ups, such as digital keepsakes or targeted content recommendations, can strengthen visitor connections. For example, the Smithsonian Institution engages visitors post-visit through customized digital archives and interactive learning modules, extending engagement beyond the physical visit (Jiang et al., 2023; Cranmer et al., 2023). Policymakers should integrate satisfaction metrics into evaluations of heritage tourism initiatives, ensuring they reflect both short-term and long-term impacts (Elshaer & Marzouk, 2024; Yersüren & Özal, 2024).

5.6. Future Directions and Broader Implications

This study raises critical questions about balancing technological innovation with cultural preservation. An overemphasis on digitalization risks commodifying heritage, while insufficient adoption may fail to attract younger audiences. Policymakers and managers must strike a balance, ensuring that digital tools enhance, rather than overshadow, the cultural and historical value of heritage sites.

Emerging technologies such as AI and the metaverse offer new possibilities for heritage tourism. For instance, AI-driven personalization could tailor cultural narratives to individual preferences, creating deeply engaging and emotionally resonant experiences. The metaverse could democratize access to cultural heritage by virtually recreating endangered or inaccessible sites. However, these innovations also pose ethical challenges, including cultural ownership, representation, and data privacy. Future research should critically evaluate these technologies to ensure that their adoption aligns with principles of inclusivity and cultural sensitivity.

6. Conclusions

This study highlights the transformative role of digital engagement in enhancing visitor satisfaction and recommendation intentions at World Heritage Sites in Chinese coastal cities. By validating the importance of perceived authenticity, digital participation, and satisfaction, the findings extend Cultural Authenticity Theory and satisfaction-loyalty frame-

works into the context of digitally mediated heritage tourism. These insights emphasize the potential of digital tools, such as VR and AR, to create engaging and culturally meaningful experiences that bridge traditional narratives with modern technological expectations.

From a practical perspective, heritage managers should prioritize the adoption of culturally sensitive, interactive digital tools that align with the historical and cultural contexts of their sites. Collaborations with cultural experts and iterative visitor feedback can ensure authenticity and enhance visitor loyalty. Policymakers, on the other hand, can support these efforts through funding initiatives and digital infrastructure development, especially for underfunded rural heritage sites. An example of successful implementation can be seen in sites like the Dunhuang Mogao Caves, where digital projections and VR tours have effectively preserved cultural narratives while engaging modern audiences.

Future research could explore the longitudinal impact of digital engagement on visitor behaviors, including repeat visits and sustained advocacy. Additionally, methodological approaches such as mixed-method studies or experimental designs could provide deeper insights into the causal relationships between digital engagement and visitor outcomes. Emerging technologies such as AI and the metaverse present opportunities to deepen engagement while raising critical questions about cultural representation and ethical adoption. Addressing these challenges will be pivotal for ensuring the sustainable integration of digital tools in heritage tourism.

Author Contributions: Conceptualization, Y.Z. and Z.S.; methodology, Y.Z. and Z.S.; software, Y.Z.; validation, Y.Z., Á.P.-V. and Z.S.; formal analysis, Y.Z., Á.P.-V. and Z.S.; investigation, Y.Z., Á.P.-V. and Z.S.; resources, Y.Z. and Z.S.; data curation, Y.Z.; writing—original draft preparation, Y.Z., Á.P.-V. and Z.S.; writing—review and editing, Y.Z., Á.P.-V. and Z.S.; visualization, Y.Z.; supervision, Y.Z., Á.P.-V. and Z.S.; project administration, Y.Z. and Z.S.; funding acquisition, Y.Z., Á.P.-V. and Z.S. All authors have read and agreed to the published version of the manuscript.

Funding: This article was supported by the RRF-2.1.2-21-2022-00011 project, financed by the Government of Hungary within the framework of the Recovery and Resilience Facility.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets generated and analyzed during this study contain sensitive user information, including IP addresses that may directly or indirectly identify individuals under applicable data protection laws (e.g., GDPR Article 4(1), China's PIPL Article 4). To comply with legal obligations and ethical commitments to participants, these data are not publicly available. De-identified subsets may be provided upon reasonable request to the corresponding author, subject to a signed data use agreement and approval by our institutional ethics review board.

Conflicts of Interest: The authors declare no conflict of interest.

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