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The Impact of Smart Tourism Technologies on Heritage Site Image and Destination Loyalty

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Abstract:
Despite the growing use of Smart Tourism Technologies (STTs) in heritage tourism, their effectiveness in shaping tourist experiences, heritage site image, and destination loyalty remains underexplored, particularly in Cambodia's UNESCO World Heritage Sites. This study examines how key STTs attributes—informativeness, accessibility, interactivity, personalization, and security—enhance tourists' experience with STTs and their loyalty with heritage destinations. It also examines the mediating role of heritage site image in this relationship. This study collected data on-site from 411 international tourists visiting all four of Cambodia's UNESCO World Heritage Sites. Smart-PLS 4.0 was used to evaluate the measurement and structural models. The results demonstrate that all STTs attributes positively enhance tourists perceived STTs experience. This perceived smart tourism experience subsequently impacts tourists' likelihood of returning to the heritage destinations and recommending them through word-of-mouth, which is partially mediated by the heritage site image. This study contributes to the limited body of research on the impact of STTs in heritage tourism by introducing a new conceptual model that positions heritage site image as a mediator between perceived STTs experience and destination loyalty. The findings offer practical insights for heritage stakeholders, including technology developers, by highlighting the critical role of informativeness, personalization, and interactivity in the design and implementation of STTs to enhance tourists' experiences and strengthen the global appeal of Cambodia's heritage sites.

Keywords:
Cambodia,
smart tourism technologies,
heritage site image,
PLS-SEM,
destination loyalty

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智慧旅游技术对遗产地形象与目的地忠诚度的影响

摘要：

尽管智慧旅游技术（STTs）在文化遗产旅游中的应用日益广泛，但它们在塑造游客体验、遗产地形象和目的地忠诚度方面的有效性仍然研究不足，尤其是在柬埔寨的联合国教科文组织世界遗产地。本研究探讨了关键的STTs属性—信息性、可及 性、互动性、个性化和安全性—如何增强游客对STTs的体验，并提高他们对文化遗产目的地的 忠诚度。此外，本研究还 分析了遗产地形象在这一关系中的中介作用。本研究在柬埔寨四个联合国教科文组织世界遗产地的现场收集了411名国际游客的数据，并使用 Smart-PLS 4.0 评估测量模型和结构模型。研究结果表明，所有 STTs 属性均能积极提升游客的感知STTs 体验，而这种智慧旅游体验的提升进一步影响了游客重游遗产地的意愿，并通过口碑推荐遗产地，而这一过程部分受到遗产地形象的中介作用。本研究通过引入一个新的概念模型，明确遗产地形象在感知 STTs 体验与目的地忠诚度之间的中介 作用，从而丰富了关于 STTs 在文化遗产旅游中影响的有限研究。本研究的发现为遗产利益相关者（包括技术开发者）提供 实践见解，强调了信息性、个性化和互动性在 STTs 的设计与实施中的关键作用，以提升游客体验并增强柬埔寨 遗产 地的全球吸引力。

关键词：柬埔寨, 智慧旅游技术, 遗产地形象, PLS-SEM, 目的地忠诚度

1. Introduction

Heritage tourism is one of the fastest-growing sectors in the tourism industry, attracting hundreds of millions of travelers annually (Su et al., 2020). Many developed and developing countries have effectively implemented marketing strategies and tools to attract tourists to cultural and historical sites. However, Cambodia presents a unique case where, despite having four UNESCO World Heritage Sites, its ability to attract heritage tourists remains limited compared to similar destinations in neighboring countries due to insufficient heritage tourism marketing efforts (Habtemariam, 2022).

Given this challenge, recent studies suggest that integrating Smart Tourism Technologies (STTs) into marketing strategies can address these limitations by enhancing visitor experiences and increasing the appeal of heritage sites to global audiences (Balakrishnan et al., 2021; Buonincontri & Marasco, 2017). Although STTs are increasingly being adopted in heritage tourism, their role in enhancing tourist experiences and shaping heritage site images to drive destination loyalty in Cambodia remains largely unexplored.

The effectiveness of an STT-enhanced experience depends on how well it is developed and implemented. Pai et al. (2020) examined tourists' perceptions of STTs and identified five key attributes that contribute to a positive perceived STT experience: informativeness, accessibility, interactivity, personalization, and security. Their findings suggested that a well-designed STTs experience can increase tourist happiness and the likelihood of revisiting a destination. Beyond visitor experiences, Jeong and Shin (2020) argued that the influence of STTs on destination image should also be examined, emphasizing that understanding how STTs impact heritage-site images is crucial for optimizing their effectiveness in attracting visitors. To address these research gaps, this study examines the effect of STTs attributes on tourists' perceived STTs experience and explores whether the smart tourism experience can enhance heritage site image, ultimately driving tourist loyalty towards Cambodia's heritage destinations. This research utilizes a quantitative approach employing structured surveys of international tourists to analyze these relationships and validate the findings using Partial Least Squares Structural Equation Modeling (PLS-SEM).

This study has three primary objectives.

1. Empirical examination of how the attributes of STTs influence international tourists' perceived experience with STTs.

2. Analyzing the direct effect of perceived experience with STTs on both destination loyalty and heritage site images.

3. Testing whether the perceived experience with STTs could indirectly affect destination loyalty through its impact on heritage site image.

The findings of this study offer valuable insights to heritage stakeholders, including tourism boards, heritage site managers, and technology developers. By identifying the attributes of STTs that have the most significant impact on tourists' perceived STTs experience, stakeholders can prioritize these features when developing or implementing STTs for heritage destinations to enhance visitor experiences and engagement. Additionally, this research highlights the importance of integrating STTs with destination marketing efforts, showing how the enhancement of a

heritage site image through technology can increase global appeal.

2. Literature Review

2.1. Enhancing Heritage Tourism Experiences with Smart Tourism Technologies

Creating heritage tourism products that meet modern travelers' expectations requires innovation and optimization, as traditional resources alone are insufficient to engage consumers (Zheng & Wu, 2023). Smart Tourism Technologies (STTs) offer solutions by providing diverse applications and tools that enhance tourist experiences, enable personalization, and offer additional benefits that make destinations more appealing (Huang et al., 2017; Neuhofer et al., 2015). STTs have also revolutionized traditional service delivery, offering tourists distinctive and immersive experiences (Orden-Mejias & Huertas, 2022).

Virtual Reality (VR) and Augmented Reality (AR) enable remote access to heritage sites and create immersive online virtual experiences, facilitating broader sharing of cultural heritage with a global audience (Rizvic et al., 2019; Guo et al., 2024). VR technology creates immersive three-dimensional environments, allowing users to explore and interact with virtual surroundings as if they were real (Schnack et al., 2019). This capability translates into experiences, such as virtual tours, where tourists can explore remote heritage sites as if they were physically present. AR enhances the experiences of tourists in cultural heritage tourism by overlaying digital data, such as informational text, historical images, 3D reconstructions, interactive guides, or historical videos, onto their physical surroundings using devices, such as cameras, mobile phones, or AR glasses (Basheer et al., 2023). This technology not only enriches the visual experience by adding virtual elements to actual monuments but also deepens visitors' understanding of a site's historical relevance and cultural context beyond what traditional texts can convey.

The advent of mobile devices, particularly smartphones, has led to their dominance because of their convenience, portability, and multifunctional capabilities, particularly during on-site activities (Buonincontri & Marasco, 2017). Smartphones enhance communication between tourists and tourism service providers by enabling seamless transactions, providing real-time navigation and assistance, and facilitating feedback (Pai et al., 2020; Tushar et al., 2022). In particular, social media serves as a crucial platform for cultural exchange, offering valuable insights into public sentiments and perceptions of heritage sites, thereby aiding the development of adaptive management strategies (Foroughi et al., 2023).

Big data is an extensive and complex process of collecting, storing, and analyzing vast amounts of historical and real-time data (Fan et al., 2018), often from diverse sources, such as social media, mobile devices, sensors, apps, and databases. It allows stakeholders to gain valuable insights into visitor behavior to enhance services, improve management, and make data-driven decisions, ultimately improving the visitor experience and appeal of cultural attractions.

2.2 Perceived Smart Tourism Technologies Experience

In this study, perceived STTs experience refers to tourists' perceptions and experiences of using various technological tools, such as smartphone apps, websites, and social media platforms, for activities such as reserving, coordinating transportation, using digital maps, purchasing tourism products, and their experiences with virtual reality (VR) and augmented reality (AR) technologies. The practicality and usefulness of STTs are based on five key characteristics: informativeness, accessibility, interactivity, personalization, and security (Pai et al., 2020). Each of these characteristics plays a significant role in shaping how tourists interact with and benefit from STTs. This study considered five key attributes for measuring perceived STTs experience.

2.2.1 Informativeness

In recent years, there has been a growing trend among tourism destinations to encourage tourists to use STTs as a primary source of information (Orden-Mejias & Huertas, 2022). One of the key factors in the effectiveness of STTs is their informativeness, which refers to their ability to provide reliable, relevant, and accurate information (Pai et al., 2020). By offering such information through STTs, destinations can enhance tourists' understanding and awareness (Torabi et al., 2022), enabling them to make informed decisions without the need to search for additional information.

2.2.2 Accessibility

Accessibility is the ease with which tourists can obtain and use tourism information sources via STTs without encountering difficulties (No & Kim, 2015; Jeong & Shin, 2020). By leveraging intelligent systems, such as internet-based platforms, STTs provide tourists with seamless access to real-time information (Domínguez Vila et al., 2019). When tourists have access to information and services through digital technology, they reduce the cognitive load associated with information processing and enhance their memorability of their visit (Huang et al., 2017).

2.2.3 Interactivity

The interactivity of STTs enables immediate action, including real-time feedback and active communication, facilitating information exchange between users and service providers (Zheng & Wu, 2023). STTs are perceived as interactive when they

demonstrate reciprocity, responsiveness, and promptness (Johnson et al., 2006). Interactivity enhances the relevance and reliability of information through active tourist participation, making tasks such as searching for information more efficient and enriching the overall travel experience (Zhang et al., 2022). When tourists engage in high levels of online interaction, they are more likely to use STTs for information and service searches and to provide feedback (Islam et al., 2021), enabling them to gather valuable data and offer tailored services (Jeong & Shin, 2020).

2.2.4 Personalization

Personalization allows STTs to distribute highly relevant and precise information tailored to individual preferences and specific needs (Jeong & Shin, 2020). By gathering data on individual preferences, behaviors, and habits, STTs can deliver highly tailored recommendations, services, and content (Pai et al., 2020; Zhang et al., 2022). Therefore, website personalization always provides a satisfactory user experience that motivates users to revisit the website (Balakrishnan et al., 2021).

2.2.5 Security

Although STTs offer significant advantages, they also have critical concerns regarding user privacy and cybersecurity. Therefore, trust in technological security is crucial for encouraging users to share personal information through STTs (Jeong & Shin, 2020). Security refers to the protection of personal information across diverse technologies employed in the tourism sector (Pai et al., 2020). By prioritizing security and data protection, STTs providers can build user trust and encourage their continued use.

2.3. Heritage Site Image

Heritage site images refer to tourists' perceptions of a heritage site's characteristics (Wong & Cheng, 2014). While initially focusing on the cognitive aspects of site characteristics, recent studies have emphasized the importance of emotional responses and feelings, suggesting a more comprehensive approach to understanding heritage site images. Apostolakis (2003) argues that nostalgia plays a significant role in motivating travel to heritage sites. Tourists who experience a sense of historical nostalgia are more likely to return to the site and share positive word-of-mouth (WOM) (Verma & Rajendran, 2021). Therefore, the emotional aspects of heritage tourism, including feelings associated with heritage sites, should not be overlooked. Building on Baloglu and McCleary (1999), this study adopts a comprehensive definition of heritage site image that integrates both cognitive and affective dimensions. Heritage site images are thus conceptualized as the amalgamation of an individual's thoughts, perceptions, expectations, and emotional responses to a heritage site (San Martín & Del Bosque, 2008).

Destination images comprise both positive and negative perceptions that influence tourists' decisions when selecting a destination from among potential travel alternatives (Gavurova et al., 2023). This study explores how perceived experience with STTs impacts the image of heritage sites and subsequently affects destination loyalty.

2.4. Destination Loyalty

Tourism loyalty is based on customer loyalty theory, which measures loyalty from two main perspectives: behavioral and attitudinal (Farooq & Moon, 2020). Behavioral loyalty involves consistent and frequent visits to a place over time (Cossío-Silva et al., 2019). According to two-dimensional motivation theory, tourists are driven by the desire to escape their daily routines or seek new experiences (Iso-Ahola, 1980). Therefore, not returning to a previously visited destination does not necessarily indicate a lack of loyalty, whereas frequent visits do not always signify loyalty from tourists. Thus, evaluating loyalty solely through a behavioral approach provides a limited view of tourists' complex behaviors. Attitudinal loyalty refers to the intention to revisit a destination and recommend it to others through WOM (Wang and Li, 2023). Repeat visitors are more likely than first-time visitors to prolong their stays, participate in tourist activities, and share positive experiences through WOM (Hung et al., 2021). The attitudinal approach, which includes the propensity to recommend as a key indicator of loyalty strength, offers a better measure of loyalty than the behavioral approach alone. This study adopted an attitudinal perspective on destination loyalty. Revisit intention is defined as an individual's inclination to return to the same place in the future, while WOM recommendations involve tourists' willingness to share and recommend their experiences to others through WOM (Torabi et al., 2023).

While Kim (2018) examined how memorable tourism experiences affect destination loyalty, there is a research gap regarding the impact of perceived STTs experience on destination loyalty. Some studies have found that destination image influences destination loyalty (Iordanova, 2016), but cognitive-affective heritage site image has not been specifically investigated.

3. Research Hypotheses Development

3.1 Relationship between Perceived STTs experience and Destination Loyalty

Despite extensive research on destination loyalty, questions remain regarding how to ensure that tourists remain loyal to specific destinations (Shakoori & Hosseini, 2019). According to Pai et al. (2020), a positive perceived experience with STTs enhances

tourists' overall happiness with the tourism experience and increases their intention to revisit. Specifically, STTs attributes, such as accessibility and interactivity, are key predictors influencing WOM recommendations and the likelihood of revisiting a destination (Torabi et al., 2022). The successful development of STTs depends on their attributes, as tourists' evaluations of them could shape their smart tourism experience, which fosters destination loyalty. Therefore, we propose the following hypothesis:

H1: There is a positive association between perceived STTs experiences and destination loyalty.

3.2 Relationship between Perceived STTs experience and Heritage Site Image

Heritage managers are increasingly focusing on visitor experiences as a key aspect of their marketing strategies. Recent research suggests that smart technologies can significantly improve visitors' experiences at cultural heritage sites (Buonincontri & Marasco, 2017). As perceived experience is more influential than any advertisement in shaping a positive brand image (Berry, 2000), a positive perceived experience with smart technologies can lead to a favorable impression of the heritage site among visitors. Therefore, we propose the following hypothesis:

H2: There is a positive association between perceived STTs experiences and heritage site images.

3.3 Relationship between Heritage Site Image and Destination Loyalty

According to Del Bosque and San Martín (2008), a positive impression of a destination is an important factor that affects whether people will remain loyal to that destination. Similarly, a study by Balakrishnan et al. (2021) involving 400 visitors to heritage sites in India found that positive perceptions of the sites significantly influenced tourists' intentions to revisit. Since loyalty is often operationalized as behavioral intentions such as revisiting and recommending (Rasoolimanesh et al., 2022), a favorable heritage site image not only encourages repeat visits but also promotes WOM recommendations. This study proposes the following hypothesis:

H3: There is a positive association between heritage-site image and destination loyalty.

3.4 The Mediating Role of Heritage Site Image

The impact of destination image on loyalty varies depending on the visitor experience. Tourists' positive or negative experiences with STTs can enhance or diminish their destination image, which in turn affects their future intentions (Azis et al., 2020). Destination image typically plays a mediating role between perceived STTs experience and destination loyalty. In the context of heritage tourism, Balakrishnan et al. (2021) demonstrated that heritage site images partially mediate the relationship between the STTs experience and revisit intention. However, few studies on heritage tourism have investigated the mediating effects of heritage-site images on the relationship between perceived STTs experience and destination loyalty. Therefore, this study suggests the following hypothesis:

H4: Heritage site image mediates the relationship between perceived STTs experience and destination loyalty.

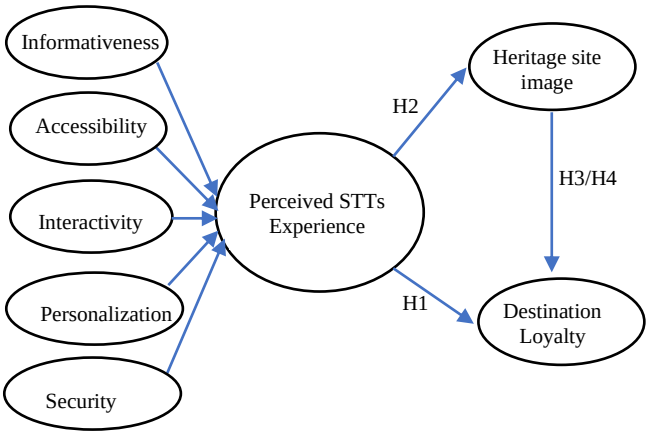

Figure 1. Conceptual model

4. Methodology

4.1 Data Collection

This research utilized a quantitative approach using structured questionnaires in English to gather data from tourists at four Cambodian heritage sites: Angkor, Preah Vihear, Sambor Prei Kuk, and Koh Ker. Before the main data collection, a pilot survey was conducted with 30 participants to test the questionnaire's clarity and identify any technical errors. The primary data collection involved self-administered face-to-face interviews with international tourists visiting each site. Tourists were chosen through screening questions, and those who expressed an interest in participating were given a survey questionnaire. A total of 450 tourists were approached to participate; after excluding invalid responses, 411 usable questionnaires remained.

4.2 Instrument/Measures

The questionnaire was created using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). All measurement items were taken from the existing literature and adjusted for this study. Three statement items were used to measure heritage site image, drawing from Huete Alcocer and López Ruiz (2020). The scale for destination loyalty comprises four items compiled from Nasseef et al. (2017). The perceived STTs experience was modeled as a second-order formative construct with five first-order reflective constructs as its components. The scale comprised 16 measurement items associated with five first-order constructs: informativeness, accessibility, interactivity,

personalization, and security adapted from Pai et al. (2021) and Huang et al. (2017). Together, these form a second-order construct of the perceived STTs experience.

4.3 Data Analysis

This study uses a comprehensive statistical approach to achieve the research objectives and test the hypotheses. First, statistical software was used for descriptive analysis. A common method bias test using Harman's single-factor test was conducted to assess the impact of common method bias in the PLS studies (Aguirre-Urreta & Hu, 2019). Our analysis revealed five dimensions from the 23 items, accounting for 65.835% of the total variance. As the first factor accounted for only 37.830% of the variance, below the 50% threshold, this indicates that common method bias is not a significant concern, confirming the suitability of the data for further analysis.

Next, PLS-SEM was used to assess measurement quality and hypothesized relationships using Smart PLS 4.0. This method was chosen because of its suitability for models with formative constructs, in which indicators cause the construct (Hair et al., 2017). This study modeled the perceived STTs experience as a second-order construct formed by five first-order components. It is important to note that the sample size of 411 in this study far exceeded the requirement for analysis according to the ten-times rule, where the sample size should be at least ten times the maximum number of arrows pointing to any latent variable in the study model (Sarstedt et al., 2021).

This study followed a disjoint two-step approach for analysis (Cheung et al., 2024). The measurement model was assessed using confirmatory factor analysis (CFA) to ensure the adequacy of the measurements. This step involves evaluating the factor structures and determining the reliability and validity of the constructs. Once the measurement model was validated, it was evaluated by estimating the hypothesized relationships between the constructs to determine the significance of the path relationships and R^2 values.

5. Results

5.1. Characteristic of Respondents

The characteristics of the respondents indicated that slightly more than half of them were female (59.4%). The largest age group was 25-34 years, followed by 35-44 years, suggesting that young to middle-aged adults were the primary visitors to heritage sites. Respondents were highly familiar with Smart Tourism Technologies (STTs), with the majority (84.9%) having more than a year of experience, while the remaining 15.1% had no prior experience. Among the STTs, social media platforms were the most widely used (27%), followed by websites (25.9%), and smartphone applications (25.5%).

5.2 Results of the Measurement Model

The measurement model was assessed for reliability, convergent validity (CV), and discriminant validity (DV). Reliability was assessed using Cronbach's alpha (α) and composite reliability (CR). As shown in Table 1, all seven constructs had α values above the recommended threshold of 0.7 (Nunnally & Bernstein, 1994), and CR values ranged from 0.826 to 0.941, exceeding the suggested criterion of 0.6 (Fornell & Larcker, 1981). These results indicate strong reliability and consistent measurements across all constructs.

The average variance extracted (AVE) values for each construct, displayed in Table 1, surpassed the 0.5 threshold, indicating an adequate CV (Hair et al., 2017).

Table 1. Reflective constructs and corresponding measurement items

Constructs	Measurement Items	Outer loadings	CR	α	AVE
Informativeness	INF1	0.863	0.901	0.853	0.695
	INF2	0.773			
	INF3	0.832			
	INF4	0.862			
Accessibility	ACC1	0.710	0.826	0.708	0.614
	ACC2	0.866			
	ACC3	0.767			
Interactivity	INT1	0.795	0.853	0.746	0.660
	INT2	0.860			
	INT3	0.780			
Personalization	PER1	0.847	0.883	0.802	0.716
	PER2	0.861			
	PER3	0.829			
Security	SEC1	0.830	0.834	0.703	0.627
	SEC2	0.749			
	SEC3	0.795			
Heritage site image	HI1	0.890	0.907	0.847	0.765
	HI2	0.878			
	HI3	0.856			
Destination Loyalty	DL1	0.909	0.941	0.916	0.798
	DL2	0.897			
	DL3	0.886			
	DL4	0.882			

Note: *** $p < 0.001$.

Furthermore, the square roots of the AVE values for all constructs were higher than their correlations with other constructs (Table 2), providing evidence of strong DV (Fornell & Larcker, 1981). In summary, the measurement model evaluation confirms the reliability and validity of all seven constructs, ensuring that the model accurately reflects the intended concepts and provides a strong basis for analyzing the hypothesized relationships.

Table 2. Discriminant validity test

Constructs	INF	ACC	INT	PER	SEC	HI	DL
1. INF	0.834						
2. ACC	0.486	0.784					
3. INT	0.661	0.493	0.813				
4. PER	0.553	0.420	0.630	0.846			
5. SEC	0.585	0.365	0.610	0.639	0.792		
6. HI	0.406	0.460	0.415	0.440	0.428	0.875	
7. DL	0.293	0.305	0.312	0.406	0.331	0.543	0.893

5.3 Assessment of Indicator's Collinearity

In a study involving a reflective-formative second-order construct, collinearity among first-order constructs could hinder the accurate assessment of their individual impacts on the underlying second-order construct (Tehseen et al., 2017). To address this issue, VIF values were used to identify collinearity among the constructs INF, ACC, INT, PER, and SEC, which were examined as potential predictors of perceived STT experience (PSTTs). In Table 3, all evaluated constructs exhibited VIF values below five, confirming the absence of collinearity issues and supporting the reliability of the constructs' formative indicators as predictors of PSTTs (Hair et al., 2017).

Table 3. Multicollinearity

Formative indicators	VIF values
Informativeness	2.087
Accessibility	1.424
Interactivity	2.358
Personalization	2.059
Security	2.036

5.4. Structural Model Analysis

In the two-stage process, five first-order constructs are initially used to evaluate the second-order construct. Smart PLS software (version 4.0) with bootstrapping (5,000 resamples) was used to determine the significance and relative importance of the five first-order constructs to the second-order construct using path coefficients and t-values. As shown in Table 4, all five STTs attributes were significantly associated with perceived STTs experience, with informativeness having the strongest impact (β = 0.330, t = 33.167), followed by personalization (β = 0.254, t = 24.531), interactivity (β = 0.242, t = 29.559), security (β = 0.219, t = 25.038), and accessibility (β = 0.190, t = 17.386).

Next, the hypothesized relationships between the study variables were assessed. Perceived STTs experience (PSTTs) was positively associated with both destination loyalty (DL) (β = 0.170, t = 3.264) and heritage site image (HI) (β = 0.540, t = 14.063), providing support for hypotheses H1 and H2.

Hypothesis H3 evaluated whether HI significantly affected DL. The results revealed that HI significantly affected DL (β = 0.456, t = 9.451), thus supporting H3. Additionally, the results showed a good fit of the model to the data, with R^2 values for the two dependent variables (heritage-site image and destination loyalty) of 0.291 and 0.320, respectively.

Table 4. Results of the first-order path and hypotheses tests

The first-order paths test				
Relationship	β	t-value	p-value	Result
INF → PSTTs	0.330	33.167	0.000	Supported
ACC → PSTTs	0.190	17.386	0.000	Supported
INT → PSTTs	0.242	29.559	0.000	Supported
PER → PSTTs	0.254	24.531	0.000	Supported
SEC → PSTTs	0.219	25.038	0.000	Supported
Hypotheses test				
Relationship	β	t-value	p-value	Decision
H1. PSTTs → DL	0.170	3.264	0.001	Supported
H2. PSTTs → HI	0.540	14.063	0.000	Supported
H3. HI → DL	0.456	9.451	0.000	Supported

Notes: Perceived STTs experience = PSTTs; Recommend values: t-values are greater than 3.29 (p < 0.001), 1.960 (p < 0.050), 2.58 (p < 0.010)

5.5 Mediation Analysis

After assessing the direct relationships, mediation analysis was performed to investigate how HI mediates the relationship between PSTTs and DL. To derive path coefficients, standard errors, and t-values for the indirect effects, bootstrapping with 5,000 resamples was employed. The results presented in Table 5 indicate a significant indirect effect of the PSTTs on DL (β = 0.246, t = 7.688). The total effect of the PSTTs on DL was significant (β = 0.416, t = 8.989). Even when accounting for the mediation effect, the direct effect of the PSTTs on DL remained significant (β = 0.170, t = 3.264). This indicates that HI partially mediates the relationship between the PSTTs and DL. Hence, H4 is supported.

Table 5. Mediation Results

Total effect (PSTTs-> DL)			**Direct effect (PSTTs-> DL)**			**Indirect Effect of PSTTs on DL**				
β	t-value	p-value	β	t-value	p-value	H4: PSTTs-> HI -> DL	β	SD	t-value	p-value
0.416	8.989	0.000	0.170	3.264	0.001		0.246	0.032	7.688	0.000

6. Discussion and Conclusion

This study reveals that all STTs attributes play a crucial role in heritage visitor acceptance for the services provided by STTs, which subsequently impacts destination loyalty in heritage tourism, with heritage site image acting as a partial mediator.

Among the STTs attributes, informativeness had the strongest influence on perceived STTs experience, followed by personalization, interactivity, security, and accessibility. This highlights the critical role of informativeness in tourist decision making and engagement. By delivering comprehensive, accurate, and contextually relevant information, STTs empower tourists to plan, navigate, and reflect on their heritage

experiences, aligned with Sustacha et al. (2023). This study also highlights personalization as a key determinant of tourists' STTs experiences, supporting Zheng and Wu's (2023) argument that tailored recommendations mitigate information overload and ensure relevance to visitors' cultural and personal preferences. Additionally, the study highlights a positive correlation between accessibility and smart tourism experiences, although the impact of this correlation is relatively low. Despite the availability of online tourism information, tourists face challenges accessing it promptly at Cambodian heritage sites.

Moreover, the findings affirm that a positive STTs experience enhances destination loyalty (H1), in line with Azis et al. (2020). Tourists who derive value from STTs are more likely to revisit heritage sites and recommend them to others. Furthermore, the perceived STTs experience strengthens heritage site image (H2), consistent with the findings of Balakrishnan et al. (2021). Given that tourists prefer destinations with stronger and more positive perceptions, experiences through STTs can enhance the sense of place and the image of a heritage site.

Hypothesis H3 indicates that heritage site image positively affects destination loyalty. This aligns with previous research suggesting that the cognitive and affective aspects of a destination can be powerful drivers of repeat visits and positive WOM recommendations (Iordanova, 2016).

Finally, this study investigated the mediating role of heritage site image in the relationship between perceived STTs experience and destination loyalty (H4). While the direct relationship between perceived STTs experience and destination loyalty (H1) remained significant, heritage site image emerged as a partial mediator in this association. This suggests that STTs contribute to destination loyalty not only directly but also indirectly by positively influencing the heritage site image.

6.1 Theoretical Implications

This study makes significant theoretical contributions. First, it investigates the impact of tourists' perceived STTs experience on destination loyalty in the heritage tourism context, while also examining the mediating role of heritage site image in this relationship. Second, the findings challenge previous studies that focused solely on the cognitive dimensions of heritage site images. Instead, this study highlights the need to consider both the cognitive and affective aspects, demonstrating that technology-driven engagement can strengthen emotional attachment to heritage sites. Finally, based on previous research, this study employs STTs attributes and finds that they can enhance STTs experience and destination loyalty.

6.2 Practical Implications

The findings of this study offer valuable insights for heritage site managers, tourism authorities, and digital technology developers in optimizing Smart Tourism Technologies (STTs) to enhance tourist engagement, strengthen site image, and improve destination loyalty. These findings highlight the importance of informativeness, personalization, and interactivity in enhancing tourists' experiences with STTs. This suggests that tourism apps, websites, and other digital platforms should prioritize these features. This study also recommends improving connectivity and user-friendly tourism information systems to facilitate navigation and smooth communication during site visits.

These findings suggest that STTs play a crucial role in enhancing a heritage site's sense of place and image, making it more attractive for tourism promotion and strengthening destination loyalty. Given that most Cambodian heritage sites exhibit incomplete remains, AR/VR storytelling and 3D reconstructions should be integrated into mobile apps and digital kiosks, allowing visitors to better visualize the historical significance and original appearance of these sites. While these technologies offer unique experiences that guidebooks and tour guides cannot achieve, they should be viewed as supporting tools rather than as the main content of heritage site experiences. Moreover, heritage tourism organizations should leverage targeted digital marketing strategies, including social media campaigns, influencer collaborations, and user-generated contentto enhance the visibility of Cambodia's heritage sites and increase visitor engagement.

By strategically integrating STTs, heritage sites can increase visitor satisfaction, strengthen site branding, and encourage destination loyalty, thereby making them more competitive in the global tourism market.

7. Limitations and Further Study

Future studies should address the limitations of this study. First, the survey questionnaire posed challenges for tourists with limited understanding of STTs. Future studies should improve clarity by using simpler language and providing detailed explanations of STTs within the survey to address this issue. Second, this study focused exclusively on UNESCO heritage sites in Cambodia. Future studies should conduct a comparative analysis across other sites in different countries or regions to explore the potential similarities and differences in how STTs affect heritage tourist experiences in driving destination loyalty.

Author Contributions

All authors were equally involved in every stage of the study, including the conceptualization, methodology, investigation, and manuscript preparation.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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