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SMART TOURISM TECHNOLOGY AS A DRIVER OF SUSTAINABLE RELIGIOUS TOURISM AND VISITOR LOYALTY: EVIDENCE FROM PAKISTAN

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Abstract
This study examines how smart tourism technology (STT) can enhance the sustainability of religious tourism destinations and foster visitor loyalty in Pakistan. Drawing on the Technology Acceptance Model (TAM) and related theories, we develop a conceptual framework in which key attributes of STT (informative, accessibility, interactivity, personalization, security) influence tourists' technology adoption, perceived enjoyment, sustainable tourism behavior, and revisit intentions. A quantitative survey of 499 visitors at major religious heritage sites in Pakistan was conducted, and the proposed relationships were tested using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results demonstrate that all five STT attributes significantly contribute to positive technology-supported tourist experiences, which in turn lead to higher technology adoption and perceived enjoyment. STT usage shows a direct positive effect on both sustainable tourism practices ($\beta \approx 0.24$, $p<0.001$) and revisit intention ($\beta \approx 0.20$, $p<0.001$). Moreover, technology adoption mediates the effect of STT on sustainable tourism, while perceived enjoyment mediates the impact of STT on revisit intention. A multi-group analysis of moderating factors reveals that memorable travel experiences significantly enhance the effect of enjoyment on revisit intention, whereas differences in tourist behavior and preferences do not substantially alter the relationship between adoption of sustainability and enjoyment. These findings underscore the pivotal role of smart technologies in enhancing pilgrim experiences, promoting eco-friendly behaviors, and fostering visitor loyalty within the context of religious tourism. The paper concludes with theoretical contributions to the literature on smart tourism and religious tourism, as well as practical recommendations for destination managers on leveraging technology to achieve sustainable and loyalty-driven outcomes.

Introduction

Tourism is one of the fastest-growing global industries, with international tourist arrivals exceeding 1.3 billion in recent years (World Tourism Organization (UNWTO, 2024). This growth has spurred interest in specialized tourism segments, including religious tourism, which involves travel for pilgrimage, worship, and spiritual fulfillment. Religious tourism is among the oldest forms of travel and remains immensely popular – destinations such as Mecca, the Vatican, and Jerusalem draw millions of pilgrims annually, generating substantial economic benefits and cultural exchange (Raj & Griffin, 2015). In Pakistan, a country rich with Islamic heritage sites and diverse spiritual traditions, religious tourism has significant potential to contribute to socio-economic development and interfaith harmony. Major pilgrimage sites, such as Data Darbar (Lahore), the Shrine of Lal Shahbaz Qalandar (Sehwan Sharif), the Shrine of Bibi Jawindi (Uch Sharif), and the Hinglaj Mata Temple (Balochistan), attract large numbers of domestic and international visitors. The Pakistani government's initiatives, such as the opening of

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the Kartarpur Corridor to facilitate Sikh pilgrims, reflect a growing recognition of the importance of religious tourism for the national economy and cultural diplomacy.

Parallel to these trends, a digital transformation has occurred in how tourists experience and engage with destinations. The rise of smart tourism technology (STT), encompassing mobile applications, Internet of Things (IoT) devices, augmented and virtual reality (AR/VR), artificial intelligence, and big data, is reshaping the tourism landscape (Gretzel, Sigala, Xiang, & Koo, 2015). STTs enable destinations to offer personalized, real-time services and interactive content to visitors, enhancing convenience and enjoyment while also improving destination management. For example, many popular destinations now offer smart city features for tourists, including AI-powered chatbots, digital guides, location-based services, and cashless payment systems. In the context of religious tourism, technology has begun to play a role in managing pilgrim flows and enriching the visitor experience. Saudi Arabia's "smart Hajj" initiatives – including biometric registration, digital ID cards, and real-time crowd monitoring demonstrate how technology can improve the safety and logistics of large-scale pilgrimages while maintaining the sanctity of the experience. These global developments present both an opportunity and a challenge for countries like Pakistan: leveraging modern technology to improve tourist experiences and sustainability at religious sites, despite resource constraints and traditionally low-tech operations.

Concurrently, achieving sustainable tourism has become a paramount goal for destinations worldwide. Sustainable tourism entails managing tourism growth in a manner that balances economic gains with environmental protection and social and cultural integrity (UNWTO, 2022). In religious tourism, sustainability issues include preventing environmental degradation at sacred sites, avoiding overcrowding that could damage heritage structures or disrupt worship, and ensuring that local communities benefit from tourism. There is growing evidence that today's travelers, including pilgrims, are increasingly conscious of sustainability and seek meaningful, low-impact travel experiences. Destinations are thus encouraged to adopt eco-friendly practices and interpretive programs that educate visitors on cultural and environmental stewardship. Smart technologies offer novel tools to advance these sustainability goals. For instance, smartphone apps can provide visitors with guidelines on respectful behavior and waste reduction. Smart sensors can manage resource use (e.g., water, energy) at pilgrimage facilities, and online platforms can spread awareness about heritage conservation. By integrating technology with sustainability initiatives, religious tourism sites can not only protect their sanctity and environment but also elevate visitor satisfaction and loyalty.

Despite the intuitive synergy between smart tourism technology and sustainable religious tourism, there is a lack of empirical research examining their interaction, especially in developing country contexts. Pakistan's religious tourism industry has traditionally been characterized by minimal use of digital tools, ad-hoc visitor management, and limited marketing beyond word-of-mouth. Visitors often encounter issues such as inadequate information, subpar service quality, and overcrowding during peak pilgrimage times. These pain points can undermine both the visitor experience and the long-term sustainability of sites. To address these gaps, our study investigates whether implementing smart tourism technologies can simultaneously enhance visitor loyalty, as manifested in revisit intention, and promote sustainable tourist behaviors in Pakistan's religious tourism sector. Specifically, we ask: *How do tourists' acceptance and use of smart tourism technologies influence their likelihood of revisiting religious destinations and engaging in sustainable tourism practices?* By answering this question, we aim to contribute to the literature

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on smart tourism and religious tourism, providing actionable insights for practitioners and policymakers seeking to modernize pilgrimage destinations sustainably.

The conceptual basis for this research is grounded in theories of technology acceptance and experience-driven behavior. We draw upon the well-established Technology Acceptance Model (TAM) (Davis, 1989) as a framework to understand tourists' adoption of new technologies at destinations. TAM posits that users' perceived usefulness and perceived ease of use of a technology determine their attitude toward usage and eventual adoption. In leisure and tourism contexts, scholars have extended TAM by including constructs like perceived enjoyment the intrinsic pleasure of using technology as an important determinant of adoption and continued use (Davis, Bagozzi, & Warshaw, 1992). We integrate these ideas with tourism-specific theories on satisfaction and loyalty. Positive tourist experiences, especially those that are memorable and enjoyable, are known to increase satisfaction and repeat visitation (Kim, Ritchie, & McCormick, 2012). Therefore, if STTs can enhance the pilgrimage experience (for example, by providing rich information or interactive features that deepen spiritual engagement), visitors may not only be more inclined to use the technology but also more likely to return in the future and to recommend the experience to others. Additionally, given that religious travel often has strong emotional and meaningful components, delivering a memorable tourism experience (MTE) through smart technology could be a key to fostering loyalty.

Based on this background, we developed a comprehensive research model that links STT attributes, tourist responses, and outcomes in the context of religious tourism. In brief, we propose that Smart Tourism Technology at religious sites – characterized by its *Informative* content quality, *Accessibility* (ease of access and use), *Interactivity*, *Personalization*, and *Security* (trust and safety) will positively influence tourists' technology-supported experiences. In turn, greater acceptance and use of the technology (Technology Adoption) and the Enjoyment derived from it will lead to beneficial outcomes: improved Sustainable Tourism behaviors (such as respecting the environment and culture during visits) and stronger Revisit Intentions (visitor loyalty). We also investigate whether individual differences play a role, specifically whether tourists' underlying behavioral tendencies and preferences moderate the effect of technology adoption on sustainable behavior, and whether the memorability of the travel experience moderates the effect of enjoyment on revisit intention. The following section reviews relevant literature and presents the hypotheses in detail.

Literature Review

Smart Tourism Technology (STT) and Tourist Experience

Smart Tourism Technologies (STTs) refer to the range of digital tools and systems that deliver services and information to tourists in an interconnected, often real-time manner (Gretzel et al., 2015). They are a core component of the broader concept of smart tourism, which applies smart city principles to tourism destinations to enhance efficiency, sustainability, and the quality of the experience. Buhalis and Amaranggana (2015) identify key functional attributes of STT that enrich tourist experiences: (1) *Informative* – providing accurate and comprehensive information (e.g. about attractions, routes, facilities), (2) *Accessibility* – ensuring tourists can easily access information and services (e.g. via mobile devices and user-friendly interfaces), (3) *Interactivity* – enabling two-way communication and engagement (for instance, interactive maps, AR/VR exhibits, or social media sharing), and (4) *Personalization* – tailoring recommendations or content to the user's preferences and context. A fifth attribute often considered is (5) *Security* – both in terms of data privacy and physical safety features, which builds user trust in the technology.

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Together, these attributes define the quality of a tourist's experience with smart technology at a destination.

Numerous studies have demonstrated that when STTs are implemented effectively, they can significantly enhance tourist satisfaction and perceived value. For example, mobile applications with real-time informative features (such as live updates on event schedules, queue lengths, or prayer times at a shrine) reduce uncertainty and allow visitors to plan their activities better (No & Kim, 2015). Accessibility through ubiquitous connectivity (free Wi-Fi, universal app platforms) lowers barriers to use, which is crucial in places like remote heritage sites or for less tech-savvy pilgrim demographics. Interactivity features like virtual tours, online forums for pilgrims, or gamified treasure hunts at heritage sites can increase engagement and emotional investment in the visit. These engaging experiences can generate a sense of enjoyment and learning, making the trip more memorable. Research by Huang, Goo, Nam, and Yoo (2017) suggests that tourists tend to balance *exploration* and *exploitation* of information when using smart technologies for travel planning – meaning they appreciate both the breadth of information and the ability to drill down into personalized content. This aligns with the idea that personalization in STT (e.g., receiving tailored suggestions for religious sites or rituals based on one's interests or faith background) enhances satisfaction by meeting individual needs. Finally, security features such as secure payment systems, data protection, and emergency response information in apps help in building trust, which is especially important for older or international pilgrims who might worry about safety in unfamiliar environments.

Incorporating STT into religious tourism settings has unique implications. Pilgrimage is often a deeply personal and spiritual journey; thus, technology must be deployed in a way that augments rather than distracts from the spiritual experience. When done thoughtfully, STT can actually deepen the experience for instance, an augmented reality guide could allow pilgrims at a historic mosque to visualize how it looked in ancient times, or a mobile app could provide translations of prayers and the history behind rituals, thereby enhancing understanding and reverence. Such technology-supported experiences can elicit positive emotional responses (interest, awe, inspiration) that contribute to an overall memorable pilgrimage. On the flip side, if technology is cumbersome or intrusive (e.g., complicated apps or unwelcome surveillance), it may diminish enjoyment and even deter usage. According to the Technology Acceptance Model (TAM), users will embrace a new technology if they find it useful and easy to use (Davis, 1989). In tourism, perceived ease of use can be linked to the accessibility and intuitive design of STT, while perceived usefulness relates to how informative and helpful the technology is in enhancing the visit. An extension of TAM includes perceived enjoyment as a key factor essentially capturing the idea that if using the technology is fun and pleasurable, people are more likely to use it (Davis et al., 1992). We anticipate that in the religious tourism context, when STT provides rich, user-friendly and enjoyable content, visitors will feel their experience is improved and will be inclined to continue using the technology throughout their visit and in future trips.

Sustainable Tourism and Visitor Loyalty in Religious Destinations

Sustainable tourism is defined by the UNWTO (2005, 2022) as tourism that meets the needs of present tourists and host regions while protecting and enhancing opportunities for the future. In practice, this means minimizing the negative environmental and social impacts of tourism and maximizing its positive contributions to destination communities and conservation (UNWTO, 2022). For religious tourism sites, sustainability has several dimensions. Environmentally, it involves protecting sacred natural areas (such as holy rivers, forests around temples) from

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pollution and degradation, managing waste from tourism (disposable offerings, plastic bottles from pilgrims, etc.), and controlling crowd sizes to prevent wear-and-tear on ancient structures. Culturally, sustainability requires respecting religious traditions and ensuring that tourism does not commercialize or trivialize the sacred rituals. It also means providing equitable economic benefit for instance, local residents and service providers (like guides, artisans, transport operators) should gain from the tourism revenue, fostering community support for conservation of the site.

Visitor behavior is a critical component of sustainable tourism outcomes. If visitors engage in responsible behaviors such as properly disposing of waste, conserving water, following dress codes and rules at shrines, and being mindful of local customs the negative impacts can be greatly reduced. Education and awareness are key to encouraging such behavior. This is where STT can play an enabling role: smart technologies can disseminate sustainability messages effectively, remind tourists of guidelines in real time, and even incentivize good behavior (for example, an app could reward tourists with points or badges for eco-friendly actions during their trip). Furthermore, STT can help manage visitor flows by providing pre-trip information on peak times or offering virtual queue systems, thereby mitigating overcrowding at sensitive sites.

The notion of visitor loyalty in tourism is often measured by revisit intention and willingness to recommend the destination (Chen & Gursoy, 2001). In the religious tourism context, loyalty is particularly interesting because many pilgrimages are repeat in nature devotees often aim to return annually or on significant life occasions to their holy sites. A satisfying pilgrimage experience can thus translate into a strong emotional attachment and commitment to revisit. Prior research indicates that tourist loyalty is influenced by overall satisfaction and memorable experiences (Kim et al., 2012; Oh, Fiore, & Jeoung, 2007). The more a trip fulfills or exceeds a visitor's expectations whether spiritually, emotionally, or in terms of service quality – the more likely they are to come back.

Memorable Tourism Experience (MTE) has emerged as a construct to explain the kind of profound, positively remembered experiences that drive future travel behavior (Kim et al., 2012). MTEs are characterized by components such as hedonism (enjoyment), novelty, local culture, refreshment, meaningfulness, and involvement. Religious trips often naturally have many of these components: they can be deeply meaningful and emotionally intense, involve unique cultural rituals, and provide a sense of refreshment or renewal for the soul. Introducing smart technologies into this mix should be done in a way that enhances these positive aspects. If STT features can increase the hedonic value (enjoyment, fun) and novelty (e.g., learning new insights through interactive content) of the trip without detracting from its meaningfulness, they likely contribute to making the experience more memorable. We posit that perceived enjoyment gained from using STT during the trip can enhance tourists' affective evaluation of the destination, thereby boosting their revisit intentions (loyalty).

It is also worth considering that not all tourists respond to technology uniformly. Tourist behavior and preferences vary widely. Some pilgrims may be very tech-savvy and eager to use apps and devices during their journey. In contrast, others may prefer traditional methods (such as guidebooks, personal guidance from clerics, or even a deliberate digital detox for spiritual reasons). Tourists with a strong preference for digital interaction may derive greater benefits from STT (and thus be more influenced in their sustainability behavior by it) compared to those who are less inclined to use technology. Hence, we explore whether the relationship between technology use and sustainable behavior is moderated by tourists' behavioral tendencies (e.g., enthusiasm for using new technology, or predisposition towards eco-friendly behavior). Similarly,

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the impact of enjoyment on loyalty might be more substantial if the trip stands out as an exceptional and memorable experience. For instance, a pilgrim who had a uniquely engaging visit due to an interactive museum exhibition might have a higher likelihood of returning than one whose visit was ordinary. We consider memorable travel experience (MTE) as a moderating factor that could amplify the effect of enjoyment on the desire to revisit.

Conceptual Framework and Hypotheses

Bringing together the above arguments, we propose the conceptual model illustrated in Figure 1. At the core of the model is the role of smart tourism technology (STT) in shaping tourism outcomes. We conceptualize STT in terms of five key dimensions adapted from Buhalis and Amaranggana (2015): Security (S), Informative (Inf), Accessibility (A), Interactivity (Int), and Personalization (P). These dimensions collectively define the quality of the STT experience for visitors at a religious site. Tourists' overall evaluation of STT is reflected in their smart-technology-supported experience, which essentially captures how positively they view the use of these technologies during their visit.

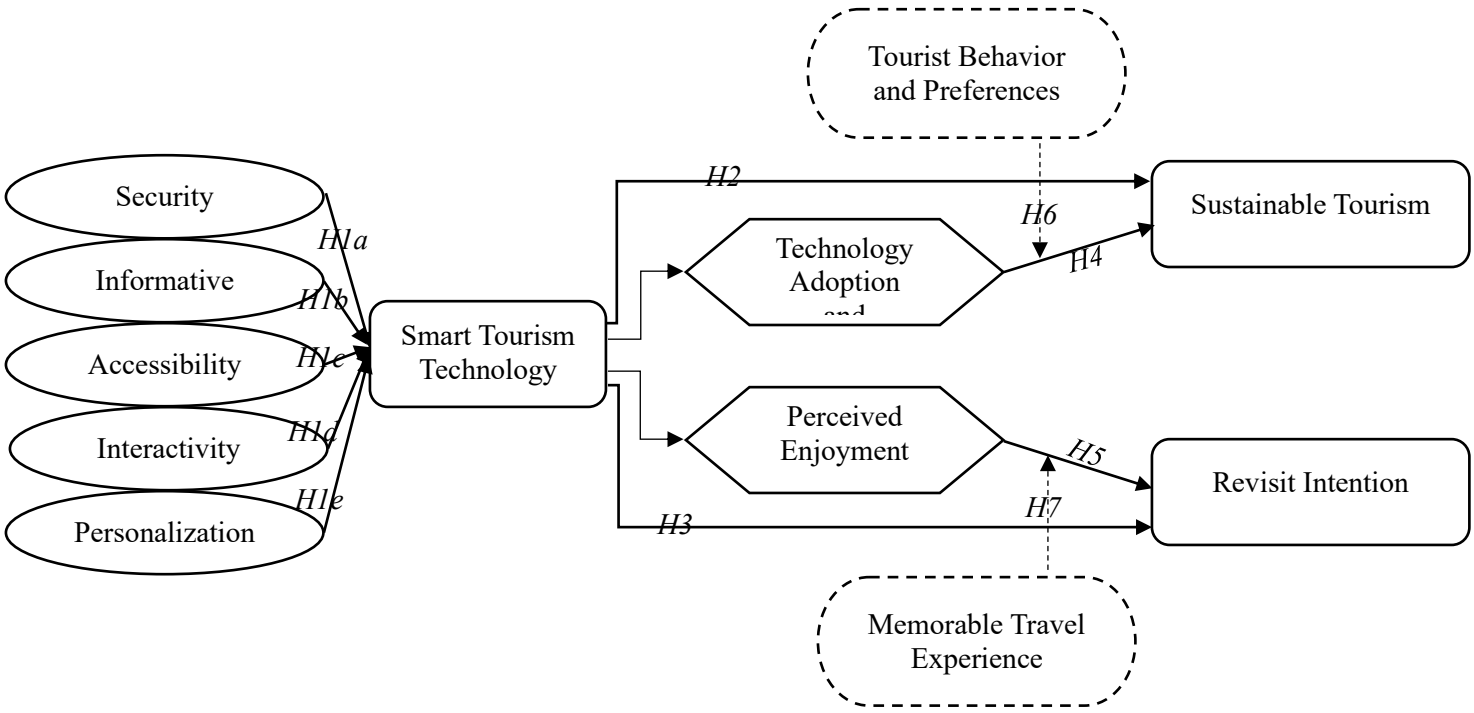

Figure 1: Conceptual Framework

We posit the following hypotheses for direct effects of STT attributes:

- H1a–H1e: Each attribute of smart tourism technology Security (H1a), Informative content (H1b), Accessibility (H1c), Interactivity (H1d), and Personalization (H1e) has a significant positive impact on the overall smart technology-supported tourist experience in

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visitor attractions. In other words, higher levels of each attribute will lead tourists to perceive greater value and satisfaction from using STTs during their trip.

We further hypothesize that a positive STT-supported experience will influence two critical outcome variables:

- H2: Smart Tourism Technology usage positively affects Sustainable Tourism (ST). Tourists who effectively engage with STTs are more likely to adopt sustainable behaviors (e.g., following conservation guidelines, supporting heritage preservation) during their visit. The rationale is that useful and persuasive technology can inform and motivate visitors to act in eco-friendly and culturally respectful ways.
- H3: Smart Tourism Technology usage positively affects Revisit Intention (RI). A beneficial experience with STT (e.g., making the visit more convenient, informative, and enjoyable) will increase the likelihood that tourists intend to return to the destination in the future (visitor loyalty). This aligns with the idea that technological enhancements can boost overall satisfaction and create a modern image of the destination, encouraging repeat visits.

We incorporate two mediating variables that represent the mechanisms through which STT influences the outcomes:

- H4: Technology Adoption and Implementation (TA) by tourists mediates the relationship between STT and sustainable tourism. Even if STT is available, its impact on sustainability will be realized more fully when tourists actually accept and use the technology (e.g., using a site's app to learn about conservation efforts or to plan off-peak visits). Thus, STT's effect on sustainable behavior is partly indirect through the degree of technology adoption by visitors.
- H5: Perceived Enjoyment (PE) mediates the relationship between STT and revisit intention. This means that one reason STT can lead to loyalty is that using the technology makes the experience more enjoyable or fun. If tourists feel delight and entertainment from interactive guides or other tech features, those positive emotions translate into favorable attitudes towards the destination and a desire to revisit.

Finally, we test two moderation hypotheses concerning the interplay of personal factors with the mediated paths:

- H6: Tourist Behavior and Preferences (TBP) significantly moderate the relationship between technology adoption and sustainable tourism. Specifically, we expect that the positive effect of TA on sustainability outcomes might vary depending on tourists' predispositions. For example, tech-forward or environmentally conscious tourists might translate their adoption of STT into sustainable actions more readily than others. If this moderation is significant, it suggests customization of strategies for different tourist segments.
- H7: Memorable Travel Experience (MTE) significantly moderates the relationship between perceived enjoyment and revisit intention. We hypothesize that when a trip is highly memorable, the link between enjoyment and the intention to return becomes even stronger. A memorable pilgrimage (perhaps due to unique events or profound personal impact) combined with enjoyment will likely cement loyalty, whereas if the trip is not memorable, even enjoyment might not be enough to ensure repeat visitation.

In summary, our research model integrates elements of TAM (perceived usefulness/ease via technology adoption, and enjoyment) with tourism outcomes of sustainability and loyalty, all within the context of religious tourism. The model reflects an understanding that smart tourism technology can be a double-edged sword; it has tremendous potential to improve experiences and outcomes. Still, its success depends on user acceptance and appropriate integration into the unique

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spiritual atmosphere of pilgrimage sites. The following section describes the methodology employed to test this model empirically.

Methodology

Research Design and Sample

This study followed a quantitative, deductive research design, using a structured survey to collect data from visitors and applying statistical modeling to test the hypotheses. The target population was tourists and pilgrims visiting prominent religious tourism sites in Pakistan. We selected multiple sites across different regions to ensure a diverse and representative sample: Uch Sharif and Multan in Punjab (known for Sufi shrines and Islamic heritage), Sehwan Sharif in Sindh (site of the famous Sufi saint Lal Shahbaz Qalandar's shrine), and Hinglaj Mata Temple in Balochistan (a major Hindu pilgrimage site). These sites collectively attract a wide range of visitors in terms of religious background (predominantly Muslim pilgrims for the shrines and Hindu pilgrims for the temple, along with cultural tourists), age, and educational levels. Data collection took place over several weeks in 2024, covering both peak pilgrimage periods (to capture serious religious visitors) and regular days (to include casual tourists).

Using convenience and purposive sampling at the sites, field researchers approached visitors. They explained the study objectives, assuring them of anonymity and that the study would not include any sensitive personal questions beyond their perceptions of technology and tourism experiences. A total of 800 survey questionnaires were distributed in person. Out of these, 499 valid responses were received, representing an effective response rate of about 62.4%. This is a robust sample size for the analysis method (PLS-SEM) and falls within acceptable response rate ranges for on-site tourist surveys. It also mitigates concerns of non-response bias; however, to be cautious, we compared early and late respondents on key demographics and found no significant differences, suggesting non-response bias was minimal.

Sample Profile: The demographic profile of respondents indicates a majority of pilgrims were male (76.6%) and 23.4% female. This gender skew is common at certain Pakistani shrines due to cultural norms about travel and participation. The age distribution was fairly broad: about 43% were under 35 (21% in the 18–25 range, 22% in 26–35), nearly 49% were middle-aged (36–45 years), and around 8% were above 45. Thus, most visitors were young to middle-aged adults. In terms of occupation, respondents included students (26%), government employees (31%), private sector employees (17%), business owners (10%), and others (17%), comprising retirees and homemakers, reflecting a diverse mix of socio-economic backgrounds. A notable portion (approximately 55%) traveled with family, while others traveled solo (24%) or with friends or in groups. This implies many pilgrimages are family-oriented trips. The educational level was not directly asked in the survey. Still, based on occupation and conversations, a sizeable subset had at least college-level education, which could influence their comfort with technology. We also gathered some trip characteristics: roughly half of the sample (49%) used air travel to reach the site (particularly those coming from far provinces or overseas), whereas others arrived by personal car (24%) or public bus (16%). The variety in the sample improves the generalizability of our findings across different types of religious tourists in Pakistan.

Survey Instrument and Measures

Data were collected via a self-administered questionnaire available in English (with clarifications in Urdu given verbally if needed). The questionnaire was structured into sections corresponding to the major constructs in our model, using multi-item Likert scales adapted from prior research to ensure content validity. All items were measured on a 5-point Likert scale (1 = Strongly Disagree,

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5 = Strongly Agree), asking respondents to rate their agreement with statements about their experience during the visit.

- ***Smart Tourism Technology Attributes***: Five subconstructs – Informative (Inf), Accessibility (A), Interactivity (Int), Personalization (P), and Security (S) were each measured by 3 or 4 items. We adapted these items from existing literature on smart tourism and information systems (e.g., Buhalis and Amaranggana (2015); No and Kim (2015). Sample items include *"The digital resources (apps, kiosks, websites) at this site provided up-to-date and useful information"* (Informative), *"It was easy for me to access the tourism information or services via my smartphone or other devices during this visit"* (Accessibility), *"I could interact with the site's digital services (e.g., ask questions, customize information) effectively"* (Interactivity), *"The technology provided suggestions or content that were tailored to my personal interests or needs"* (Personalization), and *"I felt secure in using the digital services here (e.g., I trust the system's safety and privacy)"* (Security).
- ***Smart Technology-Supported Experience***: We operationalized this as a reflective construct capturing the overall quality of the tourist's experience with the site's technology. Items (3 total) addressed whether the STT made the visit more enjoyable, convenient, and worthwhile. This measure was somewhat novel, so we pilot-tested it for clarity and reliability.
- ***Technology Adoption and Implementation (TA)***: This construct represents the extent of the visitor's acceptance and use of STT during their visit. It was measured by a multi-item scale (adapted from technology acceptance studies and tailored to tourism) assessing how frequently and extensively the respondent utilized the available tech features (e.g., *"I actively used the official tourism app or website during my visit"*, *"I adopted the available smart services (audio guides, information kiosks, etc.) as part of my tour here"*). A higher score indicates greater integration of STT into their visit activities.
- ***Perceived Enjoyment (PE)***: We measured enjoyment using a scale originally from Davis et al. (1992) and later applied in tourism technology contexts. It captures the intrinsic pleasure of using the technology, with items like *"I found using the smart tourism features at this site to be enjoyable"* and *"Using the technology was fun and entertaining in its own right, aside from what I learned from it."*
- ***Sustainable Tourism Behaviors (ST)***: Since sustainable tourism can be broad, we focused on the behavioral aspect – actions or intentions of the visitors that contribute to sustainability at the destination. Respondents indicated their agreement with statements such as *"During my visit, I took care to minimize any negative impact (e.g., avoided littering, respected the sanctity of the site)"* and *"I am willing to support conservation or upkeep efforts for this site (e.g., through donations or positive word-of-mouth)"*. This scale was informed by sustainability attitude measures and tailored to religious site etiquette and conservation.
- ***Revisit Intention (RI)***: This was measured with a standard loyalty intention scale (Chen & Gursoy, 2001), using three items: *"I intend to revisit this site in the future", "I would like to come back to this destination for another pilgrimage or visit,"* and *"I will recommend this religious site to friends or relatives".* Although recommendation is a slightly different construct (word-of-mouth), it is highly correlated with revisit intention in tourism loyalty research, and including it provided a fuller picture of loyalty.
- ***Tourist Behavior and Preferences (TBP)***: This moderating construct was measured by capturing respondents' general orientation towards travel and technology. We used a set of items to profile whether tourists are more tech-oriented or traditional, and their openness to

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new experiences. For example, *"I often use mobile apps or internet resources when I travel"*, *"I prefer planning trips using digital tools rather than traditional means"*, and *"I value authentic, low-tech experiences over high-tech facilitated ones"* (reverse-coded). Additionally, we gauged general environmental attitudes (such as "I normally try to be environmentally responsible when traveling") as part of their behavioral inclination, since this could influence sustainable actions regardless of technology. These items were synthesized into an index where higher scores indicate a propensity to embrace technology and sustainability in travel, essentially characterizing the kind of tourist who might get the most out of STT.

- ***Memorable Travel Experience (MTE)***: We asked respondents to reflect on how memorable and emotionally impactful their visit was. The scale (Kim et al., 2012) included items like *"This travel experience was one I will remember for a long time," "I had moments during this trip that were very special or unforgettable,"* and *"The overall experience is meaningful to me personally."* A high score on MTE suggests the visit stood out strongly in the tourist's mind. This serves as our moderator to see if it changes the strength of enjoyment → loyalty linkage.

The questionnaire also collected background information such as the visitor's gender, age group, origin (domestic or foreign tourist), and previous visits to the site. Prior visit frequency was noted to control for the possibility that repeat visitors might inherently have higher loyalty or familiarity with technology at the site.

Before full deployment, the survey instrument was pre-tested with 30 individuals, including academic peers and a few target respondents, at a local shrine. Minor wording adjustments were made for clarity (mainly to ensure that less tech-savvy pilgrims could understand terms like "digital services" or "interactive features"). The pilot data also allowed us to assess the initial reliability of the scales, which proved acceptable (Cronbach's $\alpha > 0.7$ for primary constructs, except for one or two items in the accessibility scale, which we revised slightly).

Data Analysis Procedure

We employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the data, utilizing SmartPLS 4 software for support. PLS-SEM is suitable for our study for several reasons: (1) our model includes a relatively large number of constructs and indicators, some of which form higher-order structures (STT attributes forming the overall STT experience) and involves mediation and moderation paths, (2) PLS makes minimal assumptions about data distributions and is robust in exploratory predictive modeling, which fits our aim to predict loyalty and sustainability outcomes, and (3) our sample size (499) is adequate but not extremely large, and PLS-SEM can handle complex models efficiently without requiring the sample size that covariance-based SEM would demand for equivalent complexity (Afthanorhan, Awang, & Aimran, 2020).

The analysis followed a two-step approach: measurement model assessment and structural model assessment (Chin, 1998). In the measurement model stage, we evaluated the reliability and validity of all constructs. Internal consistency reliability was checked via Cronbach's α and Composite Reliability (CR). Convergent validity was assessed by examining indicator loadings and the Average Variance Extracted (AVE) for each construct (Fornell & Larcker, 1981 criteria: AVE ≥ 0.50). We also tested discriminant validity using the Fornell-Larcker criterion (ensuring each construct's AVE square root exceeds its inter-construct correlations) and the Heterotrait-Monotrait (HTMT) ratio (Henseler's criterion, requiring HTMT < 0.90). We paid special attention to the STT second-order construct: it was modeled reflectively based on its dimensions (assuming the five attributes covary as manifestations of an underlying "smart experience" factor). To model this in

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PLS, we used the two-stage approach where attribute scores (first-order latent variable scores) feed into the second-order latent construct.

After confirming the measurement model's adequacy, we proceeded to the structural model. We tested the hypothesized direct effects (H1a–H3), the mediation paths (H4–H5), and the moderation effects (H6–H7). Bootstrapping with 5,000 resamples was performed to determine the significance of path coefficients (reporting β coefficients, *t*-values, and *p*-values). We also report the variance explained (R^2) for each endogenous construct as an indicator of model fit and predictive power. Additionally, we computed the effect sizes (f^2) to gauge the contribution of each predictor to an outcome (Cohen's thresholds: 0.02 small, 0.15 medium, 0.35 large effect) and predictive relevance (Q^2) using the blindfolding procedure to ensure the model has out-of-sample predictive capability. Finally, for moderation, we created interaction terms in PLS (mean-centered) between the moderator and relevant predictor (TBP × TA for H6, MTE × PE for H7) and examined their significance. We also probed any significant interactions by plotting simple slopes to interpret how different levels of the moderator change the relationship.

Common method variance (CMV) was a potential concern since all data were self-reported in the same survey. We implemented procedural remedies (assuring anonymity, mixing question order, etc.) and a statistical check using Harman's single-factor test which did not indicate a dominant single factor. Additionally, the correlation matrix did not show excessively high inter-correlations that would signal CMV. These checks suggest CMV was not a severe issue.

Results

Measurement Model Assessment

The measurement model demonstrated good reliability and validity for the constructs. Table 1 summarizes the key indicators for internal consistency and convergent validity for each construct. All multi-item constructs achieved Composite Reliability (CR) values between 0.834 and 0.925, which is well above the recommended threshold of 0.70, indicating strong internal consistency. Cronbach's α coefficients were also mostly above 0.70, except for the Accessibility scale (α = 0.693), which is slightly below the conventional cutoff; however, this is still acceptable given the exploratory nature of that scale and the fact that CR for Accessibility was 0.834, indicating adequate reliability. The Average Variance Extracted (AVE) for each construct exceeded the 0.50 benchmark, confirming convergent validity (each construct's indicators share more than half their variance on average). For instance, Informative had an AVE of 0.803, meaning its three items were highly cohesive in measuring that concept. The lowest AVE was for Tourist Behavior & Preferences (AVE = 0.568), which is reasonable given that TBP was a broader construct with varied item content.

Table 1: Measurement Model Reliability and Convergent Validity

Construct	Cronbach's α	CR	AVE
Accessibility (STT attribute)	0.693	0.834	0.632
Informative (STT attribute)	0.878	0.925	0.803
Interactivity (STT attribute)	0.753	0.860	0.672
Personalization (STT attribute)	0.821	0.893	0.737
Security (STT attribute)	0.731	0.844	0.643
Technology Adoption (TA)	0.904	0.925	0.639

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Perceived Enjoyment (PE)	0.826	0.897	0.743
Sustainable Tourism (behavior)	0.718	0.842	0.608
Revisit Intention (loyalty)	0.828	0.884	0.657
Tourist Behavior & Preferences (moderator)	0.889	0.912	0.568
Memorable Travel Experience (moderator)	0.878	0.910	0.670

All item loadings on their intended constructs were high (generally > 0.70) and significant ($p < 0.001$). A few items had moderately lower loadings (in the 0.55–0.65 range, e.g., one item for sustainable tourism behavior was 0.55). However, since the AVE was still above 0.50 for those constructs and removing the item did not markedly improve reliability, we retained it to preserve content validity.

Discriminant validity was confirmed by multiple criteria. First, the Fornell-Larcker criterion was met: for each pair of constructs, each construct's AVE square root was greater than its correlation with any other construct. For example, for Perceived Enjoyment (AVE = 0.743, square root ≈0.862) and Revisit Intention (AVE = 0.657, square root ≈0.811), the correlation between PE and RI was around 0.60, well below 0.811, indicating they are related but distinct. Second, the HTMT ratios for all construct pairs were below 0.90 (most were in the 0.3–0.7 range). The highest HTMT observed was between Personalization and Interactivity at ~0.89, which is marginally below 0.90, suggesting these two aspects of STT are closely related but still discriminable. This is understandable, as personalized services often imply interactive engagement. Importantly, the HTMT for all other pairs, including between mediators and outcomes (e.g., enjoyment vs. revisit intention, ~0.65) and between STT attributes and other constructs, were comfortably under 0.85. These results give confidence that each construct in our model measures a unique concept.

Given the strong measurement model, we proceeded to construct the second-order latent variable, Smart Tourism Technology (STT), representing the overall smart tourism experience. We treated the five attributes (S, Inf, A, Int, P) as reflective indicators of the STT construct, using the latent scores from the first-order model. The second-order STT demonstrated high internal consistency (Cronbach's $\alpha = 0.91$, CR = 0.93) and a satisfactory AVE (above 0.70), indicating that the five dimensions indeed cohere into a single higher-order factor. This justifies our approach of aggregating them for the structural analysis.

Structural Model and Hypothesis Testing

With the measurement properties established, we tested the structural relationships in the model. The PLS-SEM structural model results are summarized in Figure 2 and the narrative below. The model exhibits strong explanatory power for the key endogenous constructs, as STT explains a substantial variance in the mediators and outcomes. Specifically, the model R^2 values are 0.612 for Sustainable Tourism, 0.406 for Revisit Intention, 0.359 for Technology Adoption, and 0.307 for Perceived Enjoyment. These indicate that our predictors account for 30–61% of the variance in these outcomes, which is quite respectable in social science research, where many factors influence behavior. The R^2 of 0.612 for sustainable tourism indicates that the model has high explanatory power in encouraging responsible tourism behaviors. At the same time, an R^2 of 0.406 for revisit intention suggests a moderate to high ability to predict loyalty. Adjusted R^2 values were only marginally lower, confirming that the model is not over-fitted and that each predictor contributes meaningfully.

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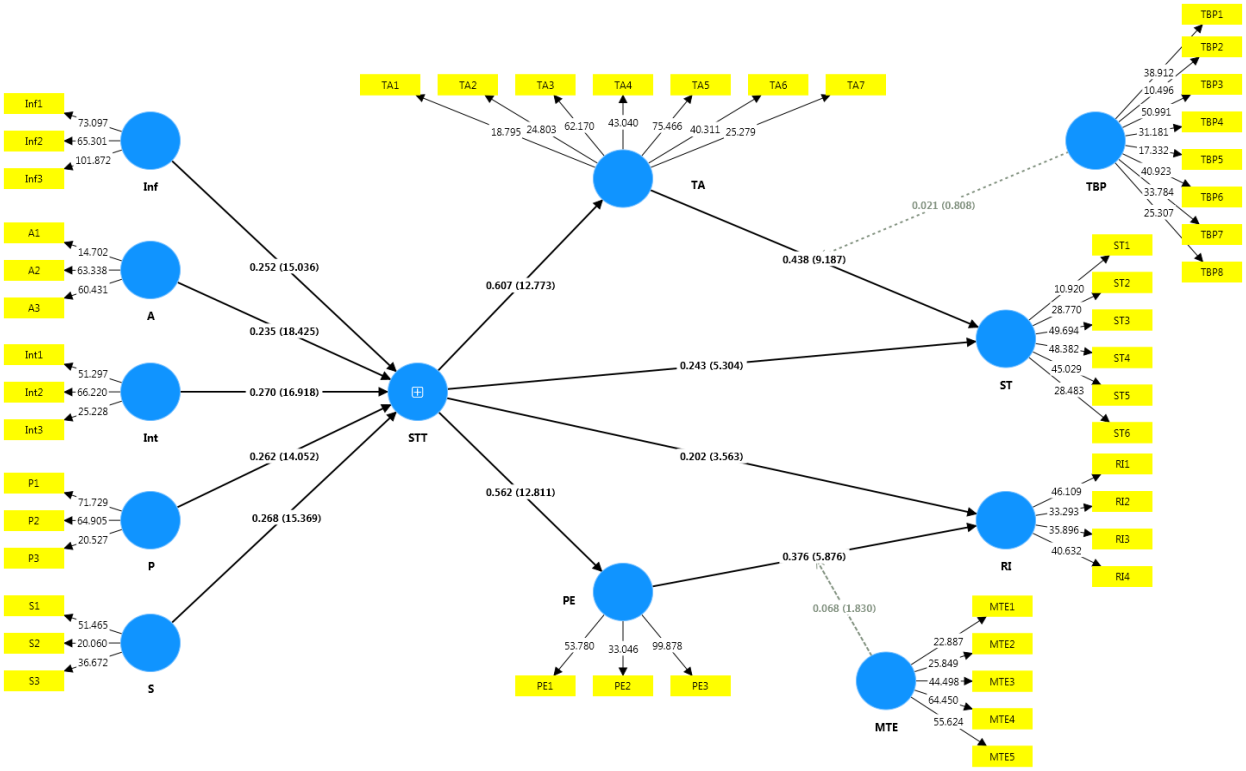

Figure 2: Structural Model

Figure 2. PLS-SEM Structural Model results for the influence of Smart Tourism Technology on Sustainable Tourism and Revisit Intention. *Note:* Standardized path coefficients are shown next to arrows (with *t*-values in parentheses). Solid arrows indicate significant relationships ($p < 0.05$), and dashed arrows indicate non-significant paths. The model's R^2 values (in italics) denote the variance explained in key endogenous variables. STT = Smart Tourism Technology (higher-order construct reflected by Security, Informative, Accessibility, Interactivity, Personalization); TA = Technology Adoption; PE = Perceived Enjoyment; ST = Sustainable Tourism behavior; RI = Revisit Intention; TBP = Tourist Behavior & Preferences; MTE = Memorable Travel Experience. Moderating effects are represented by the interaction terms (dashed lines).

Direct Effects of STT Attributes (H1a–H1e)

The first set of hypotheses (H1a–H1e) posited that each STT attribute has a positive effect on the tourist's technology-supported experience (essentially the STT higher-order factor). The PLS results supported H1a through H1e unequivocally. All five attributes had significant positive loadings on the STT construct (which in this context can be interpreted as path coefficients from each attribute to STT experience):

- Security (H1a): $\beta = 0.268$, $t = 15.37$, $p < 0.001$.
- Informative (H1b): $\beta = 0.252$, $t = 15.04$, $p < 0.001$.
- Accessibility (H1c): $\beta = 0.235$, $t = 18.43$, $p < 0.001$.
- Interactivity (H1d): $\beta = 0.270$, $t = 16.92$, $p < 0.001$.
- Personalization (H1e): $\beta = 0.262$, $t = 14.05$, $p < 0.001$.

These results indicate that each attribute is indeed a significant contributor to the quality of the smart tourism experience. The path coefficients are relatively similar in magnitude (around 0.24–0.27), suggesting that all five dimensions are comparably critical, and none dominates the others by a large margin. This highlights the multi-faceted nature of STT: a truly effective smart tourism

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offering at religious sites needs to be secure, informative, accessible, interactive, *and* personalized. If any one aspect were lacking, the overall experience could be diminished. The significant effects also indirectly validate the measurement model choice of treating STT as a composite of these attributes.

Effects on Sustainable Tourism and Revisit Intention (H2, H3)

Hypothesis H2 proposed that the usage of STT positively influences sustainable tourism practices by visitors. The structural path from STT (second-order construct) to Sustainable Tourism was positive and significant ($\beta = 0.243$, $t = 5.304$, $p < 0.001$). Thus, H2 is supported. This finding suggests that tourists who had a more positive smart technology experience (high STT usage and satisfaction) tended to report stronger engagement in sustainable behaviors during their visit. The standardized coefficient of 0.243 indicates a moderate effect: an increase by one standard unit in the STT experience corresponds to about a 0.24 standard unit increase in the sustainable behavior score. In practical terms, if a pilgrim found the site's app and other technology highly useful and easy to use, they were more likely to follow eco-guidelines, respect rules, and show care for the site. This underscores that well-implemented technology can indeed encourage responsible tourism, possibly by informing visitors about why sustainability matters or by making sustainable choices more convenient (for instance, providing digital alternatives to paper brochures, or navigation that prevents people from entering restricted zones).

Hypothesis H3 stated that STT usage positively influences revisit intention (visitor loyalty). We found a significant positive effect of STT on Revisit Intention ($\beta = 0.202$, $t = 3.563$, $p < 0.001$), supporting H3. Although the coefficient (0.202) is slightly lower than that for sustainability, it is still meaningful. This suggests that a good, smart tourism experience at a religious site can indeed enhance a visitor's desire to come back. It's worth noting that revisit intentions in religious tourism may also be driven by spiritual calling or obligation; however, our results show that technology can play a reinforcing role by improving satisfaction and convenience, making the idea of a return pilgrimage more attractive. For instance, a pilgrim who enjoyed using a location-based guidance app to navigate shrine rituals might be less hesitant about revisiting because they feel future visits will be easier and equally enriching.

Mediation via Technology Adoption and Enjoyment (H4, H5)

We hypothesized that STT impacts the outcomes through two mediators: technology adoption (TA) for sustainable tourism (H4) and perceived enjoyment (PE) for revisit intention (H5). To test mediation, we examined both the indirect effects and the significance of direct versus indirect paths.

For H4, the indirect effect of STT on sustainable tourism via technology adoption was significant. Breaking it down:

- STT had a strong positive effect on Technology Adoption ($\beta = 0.598$, $t = 18.06$, $p < 0.001$; this path essentially reflects how the combined experience of STT attributes leads people to embrace and use the technology).
- Technology Adoption, in turn, had a positive effect on Sustainable Tourism ($\beta = 0.437$, $t = 8.92$, $p < 0.001$).

Multiplying these, the indirect effect STT → TA → ST is $\beta_{indirect} \approx 0.598 * 0.437 = 0.261$. This mediated effect was statistically significant ($p < 0.001$, as determined by bootstrapping). Meanwhile, the direct impact of STT on ST remained significant (as reported for H2, $\beta = 0.243$). This indicates partial mediation: STT influences sustainable behavior both directly and through increased technology adoption. We can thus confirm H4 – technology adoption significantly

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mediates the STT-sustainability relationship. Tourists who value and use the smart tools are those who translate that usage into concrete, sustainable actions. The mediation strength is notable: the indirect path (0.261) is of similar magnitude to the direct path (0.243), implying that about half of STT's total effect on sustainability may be channeled through encouraging tourists to adopt the technology. The interpretation is that even though STT directly provides information and nudges for sustainability, its impact is amplified when tourists actively utilize the technology. For managers, this highlights that simply installing tech infrastructure isn't enough one must also promote its adoption (user engagement) to realize the sustainability benefits fully.

For H5, we examine the mediation of STT's effect on revisit intention via perceived enjoyment:

- STT had a large positive effect on Perceived Enjoyment ($\beta = 0.554$, $t = 14.87$, $p < 0.001$). This means that better STT attributes significantly increased the enjoyment tourists felt from the tech-enhanced experience.
- Perceived Enjoyment in turn positively affected Revisit Intention ($\beta = 0.382$, $t = 6.94$, $p < 0.001$).

The indirect effect STT → PE → RI is roughly 0.554 * 0.382 = 0.212, which is significant ($p < 0.001$). The direct path STT → RI ($\beta = 0.202$) was also significant, as noted. So again, we have partial mediation: H5 is supported. Enjoyment serves as a conduit through which STT increases loyalty intentions. The size of the indirect effect (0.212) is actually on par with the direct effect (0.202). This suggests that a considerable portion of why technology influences pilgrims' loyalty is because it makes the experience more enjoyable and satisfying. It confirms theories that in hedonic contexts, such as tourism, emotion matters. If the tech usage is tedious or frustrating, it likely won't help loyalty; however, when it's enjoyable, people not only have a good time but also want to repeat that experience.

In summary, both mediators are important. We also tested the total effects of STT: for sustainable tourism, the total effect equals the direct effect (0.243) plus the indirect effect via TA (0.261), which is ~0.504, a relatively high value (meaning that improving STT by one unit could increase sustainable behavior by half a standard deviation overall). For revisit intention, total effect = direct (0.202) + indirect via enjoyment (0.212) = ~0.414. These totals provide a fuller picture of STT's potential impact. They also indicate that our model's pathways capture a lot of how STT relates to outcomes.

Moderation Effects (H6, H7)

The final set of hypotheses concerned whether two factors – Tourist Behavior & Preferences (TBP) and Memorable Travel Experience (MTE) moderate certain relationships in our model.

H6 proposed that TBP moderates the effect of Technology Adoption (TA) on Sustainable Tourism (ST). In the structural model, this corresponds to the interaction term TA × TBP, which predicts ST. The result for this interaction was non-significant ($\beta = 0.021$, $t = 0.808$, $p = 0.210$). The coefficient is minimal (0.02) and not statistically different from zero. Thus, H6 is not supported – the data did not show that the relationship between using technology and engaging in sustainable behaviors depended on tourists' general tech orientation or preference profiles. In other words, whether a visitor was tech-savvy or traditionally minded, adopting the STT during their visit contributed similarly to their sustainability actions. This is an interesting finding, suggesting that the sustainability benefits of using smart tools were broadly realized across visitor types. Even those who are not avid users of technology can still be influenced toward responsible behavior if they do end up using the site's tech features. One explanation is that sustainable practices (such as not littering or preserving the site's sanctity) may be viewed as universally positive. Hence, anyone

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who receives the sustainability messaging via technology is likely to act on it, regardless of their travel style. Another possibility is that our measure of TBP, while capturing tech habits and environmental attitudes, may not exhibit extreme variation in this sample, or that the context of a sacred place may lead everyone to behave somewhat similarly out of respect. In any case, no significant moderation by TBP means managers may not need very different strategies for tech-inclined versus traditional pilgrims in terms of leveraging STT for sustainability. Making the tech easy and helpful can help most people become a bit more eco-conscious during their visit.

H7 posited that MTE moderates the effect of Perceived Enjoyment (PE) on Revisit Intention (RI). The analysis showed a significant interaction for PE × MTE on RI ($\beta = 0.068$, $t = 1.830$, $p = 0.034$, one-tailed). Although the coefficient (0.068) appears small, it is statistically significant at the 5% level (using a one-tailed test, as the hypothesis has a directional nature). Thus, H7 is supported, indicating a moderation effect: the impact of enjoyment on loyalty is stronger when the trip is highly memorable. We probed this interaction by examining the simple slopes at different levels of memorability. Tourists who rated the experience as very high on memorability (MTE one standard deviation above mean) showed a stronger relationship between enjoyment and revisit intention (slope ~0.45, $p < 0.001$) compared to those who found the trip less memorable (MTE one SD below mean, slope ~0.26, still positive and significant). This means if the trip was truly unforgettable, the boost that enjoyment gives to the desire to return is amplified. Intuitively, if someone had a blast using the technology and the whole trip stands out as one of their great life experiences, they are extremely likely to want to come back. Conversely, if the trip was so-so or routine (even if parts were fun), the link between fun and loyalty is weaker they might have enjoyed the tech novelties but if the visit didn't leave a lasting impression, they may or may not return. The managerial implication here is that destinations should strive not just for momentary enjoyment but for creating memorable moments (for example, special events, emotional connections, unique interactions). Smart technology can help create those moments (through engaging storytelling, personalized surprises, etc.), and when it does, it cements loyalty. The significant moderation by MTE underscores the synergy between emotional impact and technological enjoyment in driving visitor loyalty.

In terms of effect size, these moderating effects were small. We calculated f^2 for the interaction terms: the TBP interaction had negligible f^2 (~0.002), while the MTE interaction had f^2 around 0.01, suggesting a small additional variance explained in RI by including the interaction. Small effect notwithstanding, the moderation by MTE is meaningful in a theoretical sense for understanding tourist behavior.

Additional Insights: Effect Sizes and Predictive Relevance

We examined the f^2 effect sizes to understand the practical significance of each predictor in the model:

- For Technology Adoption on Sustainable Tourism, $f^2 = 0.246$, which is a medium effect. This suggests TA is a substantial predictor of sustainable behavior in the model (not surprising given its high coefficient of 0.437).
- STT on Technology Adoption had $f^2 \approx 0.56$ (large effect), indicating STT is the primary driver of whether people adopt the technology (makes sense as it's essentially the formative construct).
- STT on Perceived Enjoyment $f^2 \approx 0.44$ (large effect), again showing STT quality heavily influences enjoyment.

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- Perceived Enjoyment on Revisit Intention $f^2 \approx 0.115$ (just under medium), and STT on Revisit Intention $f^2 \approx 0.04$ (small). So enjoyment is a more critical factor for loyalty than the direct effect of STT, reinforcing the mediating role of enjoyment.
- The moderators had trivial f^2 in their respective places (as noted).

We also checked Stone-Geisser's Q^2 for predictive relevance using blindfolding (omission distance 7). Q^2 values came out positive for all endogenous constructs: $Q^2 = 0.475$ for Sustainable Tourism, 0.277 for Revisit Intention, 0.351 for Technology Adoption, and 0.297 for Perceived Enjoyment. These sizable positive Q^2 values indicate that our model has good predictive accuracy – if we were to predict out-of-sample, we'd do substantially better than chance (a model with $Q^2 > 0$ is considered predictive). The highest Q^2 being for sustainable tourism (0.475) suggests the model is particularly adept at predicting visitors' responsible behavior, which is encouraging for practical applications (we can reasonably forecast or explain sustainability outcomes based on STT usage patterns).

Overall, the hypothesis testing results can be summarized as follows:

- H1a–e: Supported. All STT attributes (Security, Informative, Accessibility, Interactivity, Personalization) significantly contribute to a positive STT experience.
- H2: Supported. STT has a significant positive direct effect on sustainable tourism behavior.
- H3: Supported. STT has a significant positive direct effect on revisit intention.
- H4: Supported. Technology adoption significantly mediates the effect of STT on sustainable tourism (partial mediation).
- H5: Supported. Perceived enjoyment significantly mediates the effect of STT on revisit intention (partial mediation).
- H6: Not supported. Tourist behavior/preferences did not significantly moderate the TA → sustainable tourism relationship.
- H7: Supported. Memorable travel experience significantly moderates the PE → revisit intention relationship, strengthening that effect when the experience is more memorable.

Discussion

This research aimed to investigate the interplay between the adoption of smart tourism technology and the dual outcomes of sustainability and visitor loyalty in the context of religious tourism in Pakistan. The findings provide empirical evidence supporting the idea that smart technologies can be leveraged to achieve more sustainable and satisfying tourism experiences at pilgrimage sites. In this section, we discuss the implications of these findings in light of existing literature, highlight the theoretical contributions, and suggest practical recommendations for stakeholders in the religious tourism industry.

The cultural context of this study is an Islamic majority country with specific norms regarding technology use in holy places (e.g., photography is often frowned upon inside shrines, which may limit some interactive AR use). Our results may differ in contexts where such norms vary (for example, East Asian temples where self-guided audio tours are common). Comparative studies between countries or religions could be enlightening. Does the perceived appropriateness of technology in sacred settings affect these relationships? Our work implicitly suggests tech can be positive even in religious settings, but more cross-cultural validation is encouraged.

Finally, future research avenues could examine additional outcomes and refinements. For instance, does STT also enhance learning outcomes or deepen spiritual experience (beyond enjoyment)? One could measure if pilgrims felt their spiritual needs were met better or worse due to technology and see how that ties to loyalty. Another angle is exploring negative aspects: we focused on

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positive outcomes, but is there any downside to heavy tech use at religious sites (e.g., does it reduce social interaction among pilgrims, or create a disconnect)? A balanced inquiry could help fine-tune the implementation of STT without undermining the core values of pilgrimage.

In conclusion, this study conveys an optimistic message: with thoughtful integration, smart tourism technology and spiritual tourism can coexist to enhance both visitor experiences and sustainable destination management. The evidence from Pakistan's religious sites suggests that pilgrims are not only receptive to beneficial technologies but can also be champions of sustainability and repeat visitors when their journey is enriched through digital means. We hope these findings encourage destination managers and policymakers to embrace innovation in cultural and religious tourism contexts and prompt further scholarly investigation into the synergy between technology, sustainability, and human heritage experiences.

Conclusion

This research investigated the role of smart tourism technology in fostering sustainable tourism practices and enhancing visitor loyalty in Pakistan's religious tourism industry. Grounded in technology acceptance theory and tourism behavior models, we developed and tested a framework in which the quality of the smart technology experience influences tourists' sustainable behaviors and revisit intentions, mediated by technology adoption and enjoyment, and moderated by individual differences. Using survey data from 499 pilgrims at multiple holy sites, our PLS-SEM analysis found strong support for the model. Tourists who perceived the STT at destinations as secure, informative, accessible, interactive, and personalized were more likely to adopt these technologies, enjoy their use, behave responsibly during their visit, and intend to return in the future. The mediating mechanisms highlight that simply providing technology is not enough; its actual impact emerges when tourists actively use it and derive pleasure from it. Additionally, the positive outcomes of technology were observed across all visitor types and were particularly pronounced when the overall trip was memorable.

From a theoretical standpoint, this study contributes to the literature by integrating smart tourism and sustainable pilgrimage concepts, demonstrating empirically that technology-mediated experiences can foster both *ecological sustainability* and *customer loyalty* in a heritage context. It extends the TAM framework into the tourism domain by linking it with sustainability and loyalty outcomes, and highlights the importance of experiential factors , such as enjoyment and memorability, in influencing tourist behavior. The findings reinforce that modern technology, when thoughtfully implemented, does not alienate visitors in sacred settings but rather can augment their engagement and satisfaction.

Practically, the results have important implications for destination managers and policymakers in the field of religious tourism. Investments in smart infrastructure and digital content at religious sites are validated as a means to enhance visitor management and satisfaction. Managers should adopt a holistic approach to STT implementation, focusing on content relevance, user-friendliness, and trust and security to encourage widespread adoption. By utilizing apps and digital platforms to educate visitors on conservation and respectful conduct, sites can mitigate negative impacts and preserve their cultural heritage, effectively transforming tourists into stewards of sustainability. The correlation between positive tech experiences and revisit intentions suggests that destinations that embrace smart tourism may gain a competitive edge in attracting repeat pilgrims and positive word-of-mouth, thereby supporting the local tourism economy.

In the context of Pakistan, where religious tourism is a growing sector with significant developmental promise, this study provides evidence-based recommendations. Embracing "Smart

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Pilgrimage" aligns with national digital transformation goals and can improve the international image of these destinations as welcoming and well-managed. The insights are also transferable to other countries and cities aiming to balance tourist growth with heritage conservation – a challenge faced by many pilgrimage sites worldwide.

In summary, smart tourism technology offers a pathway to achieve dual objectives in religious tourism: enriching the pilgrim experience and safeguarding the sustainability of sacred destinations. Far from being at odds, technology and tradition can complement each other – pilgrims can carry smartphones in one hand and prayer beads in the other, enhancing devotion with information, and convenience with conscience. As this synergy is harnessed, religious sites can thrive as smart, sustainable, and spiritually fulfilling destinations in the years to come.

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