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Digital Transformation and Smart Tourism Development in Nepal's Heritage Cities: A Technology Adoption and Governance Perspective

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Abstract

This study examines how digital transformation and governance shape smart tourism development in Nepal's heritage cities. The research focuses on Kathmandu Valley, Pokhara, and Lumbini, where small and medium enterprises, tour guides, local officials, and tourists increasingly interact with digital services. A mixed methods design combines a survey of 350 respondents with key informant interviews and field observation. The survey adapts constructions from the Technology Acceptance Model, the Unified Theory of Acceptance and Use of Technology, and smart tourism literature. Structural equation modelling tests the direct effects of technology adoption drivers on smart tourism development and tourist experience. Mediation by smart infrastructure, smart services, and smart destination management, and moderation by governance support, collaboration, and regulation are also examined. Results show that performance expectancy is the strongest predictor of technology adoption, followed by technological readiness, facilitating conditions, social influence, and trust. Technology adoption has a strong positive effect on smart tourism development and tourist experience. Smart infrastructure and smart services partially mediate this relationship, indicating that investments in connectivity, interoperable platforms, and digital content are critical. The contribution of governance support and collaborative arrangements to the effects of adopting technology on smart tourism outcomes is important. Qualitative evidence shows that the gaps in broadband coverage, skills, and coordination persist, but stakeholders are willing to use digital tools. The paper offers policy-level advice to planners and destination managers who would like to develop inclusive digital policies in heritage tourism in Nepal and other South Asian settings.

Keywords: Digital transformation, smart tourism, technology adoption, governance, structural equation modelling, heritage cities, Nepal

1. Introduction

Digital technologies have fundamentally changed the way destinations are promoted, managed, and experienced, with mobile applications, digital platforms, and AI-driven services becoming the key elements of destination competitiveness (Buhalis and Amaranggana, 2015; Gretzel, Sigala, Xiang, and

Koo, 2015). This change was further accelerated by the COVID-19 pandemic, considering that destinations and tourism enterprises turned into digital and contactless technologies to transform the behavior of the travelers and their daily operations routines (Sigala, 2020). However, such a change has not been evenly distributed, especially in the Global South, the digital preparedness of which is limited by infrastructure disparities, funds, and insufficient institutional resources, all of which reduce the pace of smart tourism solution implementation (UNWTO, 2022). In this regard, the issue of who can access, implement, and utilize digital tools has become one of the paradigms of inclusive and sustainable tourism development (Buhalis, 2020).

Nepal is indicative of these systemic regional inequalities, as stakeholders related to tourism display irregular access to ICT infrastructure, unreliable connectivity, and a lack of digital literacy among small and medium enterprises and community-based operators (NTB, 2023; Shrestha and Sigdel, 2022). Specifically, these limitations mainly relate to heritage cities where tourism relies on the delicate cultural property, multi-scalar government structures, and visitor experience quality (Timothy and Boyd, 2015). The UNESCO World Heritage Site, which is a high-density cluster of temples, squares, and traditional neighborhoods, is Kathmandu Valley, which needs sophisticated digital interpretation instruments and visitor management platforms to make heritage more accessible and preserve its integrity (UNESCO, 2021). One of the leading global pilgrimage destinations that attracts more travelers with the expectation of digital navigation, information on the internet, and virtual interaction, Lumbini, which was the birthplace of Buddha, welcomes increasing numbers of visitors (MoCTCA, 2022). One of the largest tourist access points and smart city pilot areas, Pokhara has started to explore digital services, though the development of such services has been partial and scattered, and the key functions of smart cities have not yet become widespread (NRA, 2021). Such dynamics imply that the rate and nature at which digital transformation occurs in the heritage cities of Nepal will have a powerful effect on the competitiveness, strength, and sustainability of such cities (Buhalis, 2020).

Although there has been an increasing awareness of the digital opportunities, the underlying digital infrastructure of the Nepalese heritage cities is still not complete, as characterized by unequal access to broadband, slow internet speeds, and underutilization of smart services in the streets and heritage areas (NTC, 2023). Most tourism SMEs persist in their traditional business frameworks that require face-to-face forms of transactions, offline forms of advertisement, and manual forms of booking, which compromise their visibility on the global platforms and reduce their ability to attract and retain digitally oriented tourists (Shrestha and Sigdel, 2022; Sigala, 2020). Nepal does not have a unified smart tourism policy at the policy level, which includes the systematic association of digital innovation with heritage conservation and destination management and multi-level tourism governance, and this leads to inconsistent efforts and duplication of efforts by the agencies (MoCTCA, 2023). Augmented reality, virtual reality, and other types of immersive technologies used nowadays in some of the top heritage sites to engage with digital stories, virtual tours, and layered interpretation are not used in Nepal as they are most often due to financial, technical, and institutional constraints (Guttentag, 2010; Gretzel et al., 20). All these weaknesses in infrastructure, strategy, and practice limit the development of smart tourism ecosystems and limit the prospects of data-driven destination management that is technologically enabled.

It is against this background that the current research question is what influences the adoption of technology by the tourism stakeholders in the heritage cities of Nepal, the effect of continuous digital transformation on the preparedness of smart tourism in Kathmandu, Pokhara, and Lumbini, the influence of governance and community dynamics in enabling or hindering the digital tourism ecosystem, and how

smart tourism technologies can be used to improve the experiences of tourists and at the same time sustain heritage management. To answer these questions, the study begins by evaluating the use of digital tools by tourism stakeholders based on the constructs of the Technology Acceptance Model and the Unified Theory of Acceptance and Use of Technology, specifically, concerning the performance expectancy, effort expectancy, social influence, facilitating situations, trust, and technology readiness (Davis, 1989, Venkatesh et al., 2003, Lin, Shih, and Sher, 2007). It subsequently assesses the preparedness of the smart tourism ecosystem in heritage cities in Nepal based on indicators of infrastructure and extent of services provided, service availability, including connectivity, smart services, and destination management services (Gretzel et al., 2015; Li, Hu, Huang, and Duan, 2017). The paper also examines the role of governance support and institutional roles at national, provincial, and local governance levels with a focus on policy frameworks, coordination, and the collaboration of stakeholders that drive digital transformation pathways (Bramwell and Lane, 2011; Buhalis, 2020; UNWTO, 2022; MoCTCA, 2023). Lastly, it also has a proposal of a smart tourism development model, which is based on empirical findings and especially adapted to heritage destinations of a developing economy, including the South Asian context.

The research has important implications for academic and practice. In theory, it adds to the literature by converting constructs of TAM and UTAUT-based technology adoption to smart tourism ecosystems and perspectives, and theories of governance in the context of heritage cities in a developing nation (Gretzel et al., 2015; Gretzel and Koo, 2021; Buhalis, 2020). Empirically, it addresses the existing bias in the current studies of smart tourism research in favor of Global North destinations by offering a methodological approach to evidence in Nepal, where digital preparedness and governance potentials vary strikingly with high-income contexts (UNWTO, 2022; NTB, 2023). In the case of tourism SMEs, the insights uncover objective impediments and potential to use digital tools, enhance visibility, and quality of services, thus providing insights into the use of interventions to make tourism providers competitive in the steady digital tourism markets (Sigala, 2020; Amoako, Dzogbenuku, and Kofi, 2022). Among heritage managers, the paper explains how digital interpretation, online content, and smart service may be strategically implemented to enhance accessibility, culturally sensitive visitor interaction, and conservation goals in heritage sites like Kathmandu Valley and Lumbini (Timothy and Boyd, 2015; UNESCO, 2021; MoCTCA, 2022). To the policymakers, the study points to the areas of strengthening digital infrastructure, encouraging public-private collaboration, and developing an integrated approach to smart tourism, which would bring the national tourism policy in Nepal in line with localized digital initiatives and sustainable development objectives more widely (MoCTCA, 2023; Bramwell, Higham, Lane, and Miller, 2017; UNWTO, 2023).

2. Literature Review

Digital transformation has changed the tourism sector by integrating the use of information and communication technologies in managing the destinations, service delivery, and interaction with the visitors (Gretzel et al., 2015). Mobile technologies, digital platforms, and smart services have become valuable solutions used by tourism businesses to meet the demands of digitally savvy travelers and keep up with competition in the global markets (Buhalis and Amaranggana, 2015). This trend was accelerated by the COVID-19 pandemic, which urged tourism businesses to embrace digital solutions to provide contactless experience, virtual communication, and online transactions as a health and safety protocol and business continuity strategy (Sigala, 2020). Real-time navigation, itinerary planning, and user-made reviews are now supported with the help of mobile applications, which impact destination image and

tourist decision-making (Xiang et al., 2017). Location-based services provided through digital maps and geolocation support nearby attractions, alerts, and route guidance that enhance ease of access and convenience to visitors (Gretzel and Koo, 2021). E-ticketing systems have minimized physical queues, simplified access control, and enhanced the public health measures and especially during and after the pandemic era (UNWTO, 2022). It is the case that Immersive technologies, such as augmented reality and virtual reality, offer new means of interpreting heritage in terms of digital storytelling and virtual tours, which can enhance the learning experience and experience at cultural locations (Guttentag, 2010). Although the world has accelerated to digitally integrated tourism systems, most developing nations continue to have uneven adoption due to poor infrastructure, inability to meet financial responsibilities, skills shortage, and inability to govern (Buhalis, 2020).

The smart tourism concept is based on smart city thinking and emphasizes the application of ICT, real-time data, and interconnected services to bring more efficient and experiential tourism environments (Boes et al., 2016). Smart tourism infrastructure would generally consist of high-speed internet, Wi Fi networks, digital kiosks, Internet of Things, and camera systems that create and transmit information between destinations (Gretzel et al., 2015). It is based on those smart services, including mobile applications, online booking systems, e-payments, QR coded information, digital signage, and AR or VR applications, that can facilitate more interactive and accessible tourism experiences (Li et al., 2017). The smart destination management system combines them on centralized platforms and dashboards that enable authorities to observe flows of visitors, control congestion, distribute resources, and react to arising concerns in near real-time (Wang et al., 2016). These systems are further improved by big data analytics and artificial intelligence to aid in forecasting demand, customized suggestions, and spatial and temporal planning of tourism activities more accurately (Xiang et al., 2015). To ensure a smart tourism ecosystem, cooperation between the public agencies, source companies, information technology providers, as well as local communities is essential, as the sharing of information, joint investment, and orchestrated management are needed to achieve some degree of meaningful integration (Gretzel and Koo, 2021). Nevertheless, smart tourism maturity is very unevenly distributed in the regions as destinations in the Global South are frequently limited by the lack of infrastructural facilities, institutional capacity, and policy support (UNWTO, 2022).

In this wider background, Nepal has a lot of potential in smart heritage tourism due to its high cultural and religious resources. Kathmandu Valley is among the UNESCO World Heritage sites because of its historic temples, palaces, and monastic complexes, which are characterized by unique architectural and spiritual traditions (UNESCO, 2021). The Lumbini, the birthplace of Lord Buddha, is a key pilgrimage site and a significant location in the global networks of Buddhist tourism (MoCTCA, 2022). Regardless of this presence, digital technologies are underrepresented in heritage tourism practices. Many locations do not have the basic digital infrastructure like valid Wi Fi, QR-coded information signs, interactive digital signboards, AR or VR-based experiences of both on-site and remote visitors (NTB, 2023). Kathmandu, Lumbini, and other heritage destinations tourism small and medium enterprises often rely on the traditional marketing channel and manual booking processes that limit their online presence and exposure to the global market and restrict the ability to focus on the tech-savvy traveler (Shrestha and Sigdel, 2022). Digital interpretation technologies that are commonly used in other destinations included in the UNESCO lists are seldom implemented in Nepal, which is also significantly caused by insufficient funding, lack of technical skill, and ambiguous institutional accountability to digital innovation (Timothy and Boyd, 2015). These limitations undermine visitor engagement, limit access to cultural information by different

categories of tourists and constrain the potential of developing integrated smart tourism systems that can serve both conservation and development objectives (Buhalis, 2020).

The digital technology acceptance models should be sound to understand how the tourism stakeholders embrace digital tools in such environments. Davis (1989) Technology Acceptance Model is among the widely utilized models of explaining user intentions to use new technologies. There are two key constructions of TAM. Performance expectancy or perceived usefulness describes how users think that a system would enhance their work performance or service delivery (Davis, 1989). Effort expectancy, also known as the perceived ease of use, is the extent to which a system is perceived to lack complexity and is simple to use (Venkatesh and Davis, 2000). TAM has been used in tourism research to examine the adoption of mobile applications, e-ticketing, online booking platforms, and other smart tourism tools that facilitate search, reservation, payment, and navigation functions (Morosan and DeFranco, 2016). Perceived usefulness and ease of use are of particular significance in the developing country context, as users may have only limited previous experience with advanced ICT systems, and may be limited by digital and technical literacy and support (Kamal et al., 2020).

The Unified Theory of Acceptance and Use of Technology extend TAM by including a broader set of determinants of technology adoption and use (Venkatesh et al., 2003). UTAUT retains performance and effort expectancy but adds social influence and facilitating conditions as core constructions. Social influence refers to the degree to which individuals perceive that important others, such as managers, colleagues, or peers, expect them to use specific technology (Venkatesh et al., 2003). Facilitating conditions cover the organizational and technical infrastructure needed to support technology use, including training, hardware and software availability, and helpdesk services (Venkatesh et al., 2012). Subsequent work has incorporated trust as a critical factor in environments involving online payments, data sharing, and digital platforms, since perceptions of security and reliability affect users' willingness to engage with ICT systems (Gefen et al., 2003). Technology readiness, defined as the overall tendency of individuals or organizations to embrace new technologies, has also been combined with UTAUT in several tourism studies to capture openness to innovation and perceived control over digital tools (Lin et al., 2007). UTAUT-based models are widely applied to explain the adoption of mobile apps, online booking systems, digital maps, and smart tourism services in both consumer and business contexts (Li et al., 2018). They are particularly relevant for tourism SMEs operating under conditions of heterogeneous digital capacity and varying organizational support (Alalwan, 2018).

The introduction, management, and maintenance of these technologies in tourism destinations are influenced by governance and community participation. Smart tourism projects need consistent governmental policies, strategic ICT investments, and sector coordinated activities, which are all based on good governance systems (Buhalis, 2020). The design and delivery of digital interventions at heritage sites are affected by local government approaches, particularly where there are competing demands by interventions to visitor accessibility, cultural sensitivity and conservation (Timothy, 2011). P2P arrangements provide the means of marshaling financial capabilities, technological capabilities, and expediting the deployment of intelligent infrastructure and services like broadband networks, digital ticketing, and information platforms (Zeng et al., 2015). Community involvement will assist in ensuring that digital projects can meet the cultural values on the ground, inclusive participation in digital activities, and not isolate the groups that have limited access to digital gadgets and literacy (Bramwell and Lane, 2011). Simultaneously, data privacy, cybersecurity, electronic transactions, and heritage protection regulations determine the demarcation under which ICT-based tourism solutions are applied and affect the

level of trust among stakeholders in the systems (UNWTO, 2022). The poor governance capacity, institutional fragmentation, and lack of interagency coordination in most of the developing countries hinder the development of smart tourism and introduce gaps in its implementation (Boes et al., 2016). Nepal is not an exception and has to deal with such issues as the lack of investment in digital infrastructure, the incomplete inclusion of ICT priorities in tourism and heritage policies, and the poor cooperation between the government agencies, tourism associations, and technology providers (MoCTCA, 2023).

The given conditions demonstrate an evident research gap. Available literature on smart tourism is mainly focused on the examples of developed nations, where infrastructure, governance, and institutional settings vary greatly when compared to Nepal (UNWTO, 2022). The empirical studies that have implemented TAM or UTAUT to comprehend the adoption of technology among the stakeholders in the tourism industry in the heritage tourism sites within Nepal are scarce and usually concentrate on specific elements of digital marketing or social media promotion as opposed to comprehensive smart tourism-based systems (Shrestha and Sigdel, 2022; Gautam, 2021; NTB, 2023). Very little literature directly takes the variables of governance that are directly related to policy support, institutional capacity, and community participation into digital tourism development models, although these three elements have a powerful impact on technology adoption and sustainability in heritage contexts (Timothy and Boyd, 2015). No existing framework of Nepal integrates TAM and UTAUT constructs with smart tourism ecosystem elements and governance variables in the environment of heritage cities like Kathmandu Valley, Lumbini and associated cultural sites (Buhalis, 2020). The current research paper seals this gap by designing and implementing a combined model that analyzes the technology adoption, digital readiness, governance support, and development of smart tourism in the heritage cities of Nepal.

Available sources regarding the topic of digital transformation, smart tourism, heritage management, and governance indicate that the development of smart tourism requires both technology acceptance at the level of stakeholders and conditions that occur within the system (Gretzel et al., 2015; Buhalis, 2020; UNWTO, 2022). TAM and UTAUT describe the role of usefulness, ease of use, social influence, support condition, trust, and readiness in affecting the adoption of digital tools, and smart tourism research identifies the significance of infrastructure, services, and data-driven destination management (Davis, 1989; Venkatesh et al., 2003; Li et al., 2017; Morosan and DeFranco, 2016). The research on heritage and governance also emphasizes the support of policies, institutional capacity, and involvement of communities in sensitive sites like Kathmandu Valley and Lumbini (Timothy and Boyd, 2015; UNESCO, 2021; and MoCTCA, 2022). Nevertheless, such strands have hardly been put together in an empirical construct of Nepal, and this is the reason why a contextually specific conceptual framework of heritage cities should be formulated.

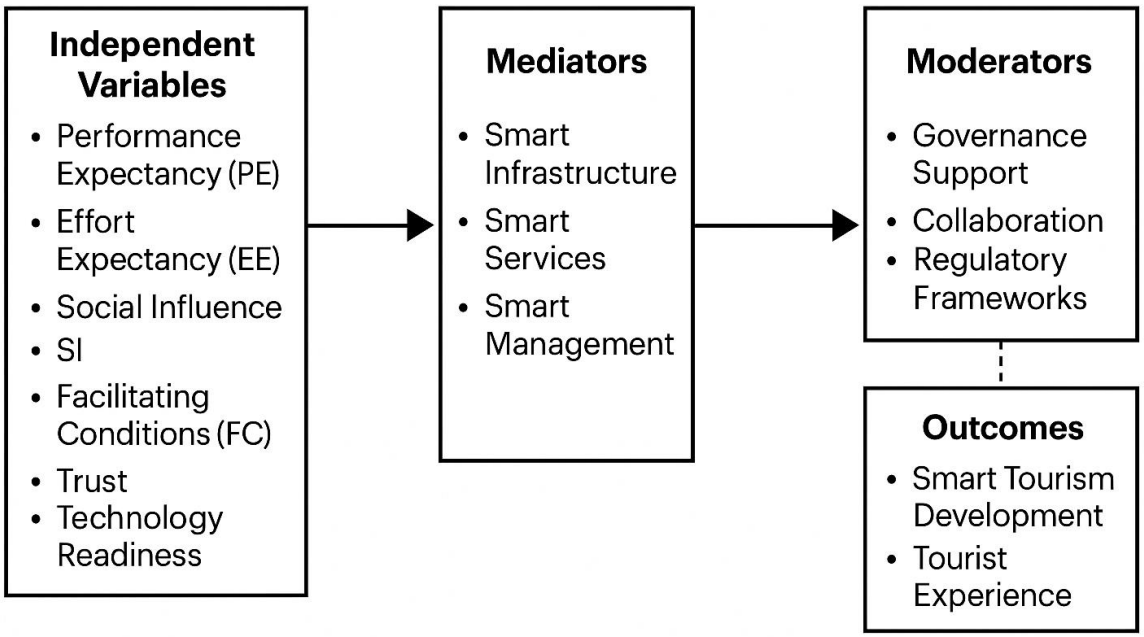

Figure 1: Integrated conceptual framework linking technology adoption, smart tourism ecosystem components, and governance factors in Nepal's heritage cities

The proposed conceptual framework links technology adoption factors, smart tourism ecosystem components, and governance-related moderators to explain variations in smart tourism development and tourist experience outcomes in Kathmandu, Pokhara, and Lumbini. It posits that performance expectancy, effort expectancy, social influence, facilitating conditions, trust, and technology readiness influence stakeholder use of digital tools, which in turn strengthen smart infrastructure, smart services, and smart destination management under supportive governance, collaboration, and regulatory conditions (Gretzel et al., 2015; Buhalis, 2020; MoCTCA, 2023). Higher levels of digital integration are expected to improve tourist satisfaction, accessibility, and heritage interpretation while supporting more sustainable destination management in Nepal's heritage cities (Xiang et al., 2017; Gretzel & Koo, 2021; UNESCO, 2021). This framework guides the selection of variables, hypotheses, and indicators used in the empirical analysis.

3. Methodology

3.1 Research Design

The mixed methods research design is the research design used in this study, as it involves the combination of the quantitative and qualitative research designs to provide a comprehensive view of the digital transformation and the evolution of smart tourism in the heritage cities of Nepal. A structured survey will constitute the quantitative part and will examine technology adoption, smart tourism preparedness, governance issues, and tourism outcomes as some of the most crucial stakeholder groups. The qualitative part will be interviews with key informants, which will bring a better understanding of the findings of the survey and help to justify the challenges of institutions, governance, and infrastructure. The research presupposes a cross-sectional design, according to which all data are gathered at a single point in time in order to establish the current rates of digital adoption and the willingness of the sampled destinations to adopt it.

3.2 Study Area

The study focuses on three major heritage tourism destinations in Nepal.

1. Kathmandu Valley, a UNESCO World Heritage Site that includes Kathmandu, Bhaktapur, and Lalitpur, known for its dense concentration of cultural monuments, historic squares, and living heritage clusters.
2. Pokhara Metropolitan City, a major tourism hub and one of Nepal's designated smart city pilot areas, where digital services and infrastructure upgrading have begun.
3. Lumbini, an international Buddhist pilgrimage center and UNESCO World Heritage Site that receives high numbers of domestic and international visitors and requires improved digital interpretation and visitor management.

These three sites represent varied cultural, institutional, and technological contexts, and together provide an appropriate basis for assessing smart tourism development in heritage settings.

3.3 Target Population

The target population includes stakeholders who directly provide or manage tourism and heritage services, as well as tourists who use these services. The main groups are:

1. Tourism small and medium enterprises, including hotels, homestays, travel agencies, restaurants, and handicraft shops.
2. Licensed tour guides and trekking guides operating in the study areas.
3. Local government officials working in tourism, culture, heritage conservation, and information technology units.
4. Domestic and international tourists visit Kathmandu Valley, Pokhara, and Lumbini during the survey period.

These groups are selected because they either drive digital transformation through their decisions and investments or experience the effects of digital services in practice.

3.4 Sample Size

The sample size of the quantitative survey will be determined using Cochran (1977) formula on the sample size and representative sampling of Krejcie and Morgan (1970) in social research. Adequate numbers of 300-400 respondents can be stated to be sufficient to achieve reasonable levels of statistical power and credible parameter estimates in Structural Equation Modelling. Based on such standards, the sample size of the study shall be at least 350 filled questionnaires in the three areas of study. The qualitative component will consist of 10-15 major interviews with the major informants, policymakers, heritage managers, representatives of tourism associations, and ICT specialists involved directly in the work of tourism and digital projects.

3.5 Data Collection Tools

Three main tools are used for primary data collection.

1. Structured questionnaire. The questionnaire uses a five-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree), to measure constructs related to technology adoption, smart tourism readiness, governance factors, and tourism outcomes. Items are adapted from established scales and adjusted to fit the heritage tourism context of Nepal.
2. Key informant interviews. Semi-structured interview guides focus on governance support, digital infrastructure, policy priorities, AR and VR potential, coordination among stakeholders, and barriers to smart tourism implementation. These interviews provide contextual explanations for the quantitative patterns.

3. Field observation checklist. A standardized checklist is used to document visible digital infrastructure and services at the study sites, including Wi Fi availability, digital signage, QR systems, AR or VR tools, e-ticketing facilities, and other ICT-based visitor services.

3.6 Measures

The study applies validated measurement scales derived from the Technology Acceptance Model, the Unified Theory of Acceptance and Use of Technology, and smart tourism and governance literature.

1. TAM and UTAUT constructs. Performance expectancy, effort expectancy, social influence, facilitating conditions, trust, and technology readiness are measured using items adapted from Davis (1989) and Venkatesh et al. (2003), with wording adjusted to the tourism SME and heritage management context.
2. Smart tourism readiness index. Indicators of smart infrastructure, smart services, and smart destination management are adapted from Gretzel et al. (2015) and Li et al. (2017). These indicators capture connectivity, digital service availability, and ICT-based management functions at the destination level.
3. Governance effectiveness scale. Governance support, stakeholder collaboration, and regulatory frameworks are measured using items adapted from Buhalis (2020), Timothy and Boyd (2015), and UNWTO (2022). The scale focuses on policy clarity, budget support, partnership quality, and perceived adequacy of legal provisions for digital tourism.
4. Tourism outcomes. Smart tourism development and tourist experience are measured through indicators of digital accessibility, perceived service efficiency, satisfaction with digital services, and perceived improvement in heritage interpretation due to digital tools.

3.7 Data Analysis

Both quantitative and qualitative analysis techniques are used.

In the case of the quantitative data, the descriptive statistics will provide the characteristics of the respondents, their baseline digital use, and the degree of agreement with the main constructs. Cronbach alpha of the scale is used to determine reliability, and composite reliability is used to determine internal consistency of each scale. Confirmatory Factor Analysis assesses convergent and discriminant validity and determines how the model of measurement fits the data. The hypothesized relationships between the technology adoption factors, smart tourism ecosystem components, variables of governance, and outcome constructs, mediation, and moderation are then tested using Structural Equation Modelling, applying the partial least squares method in SmartPLS.

In the case of qualitative data, thematic analysis is used to transcribe and code the interviews through coding. The codes are categorized into themes of governance support, infrastructure constraints, institutional coordination, stakeholder perceptions of digital tools and prospects of smart tourism. The triangulation of survey and interview results is based on field observations, particularly on the reality and quality of digital infrastructure. The combination of quantitative and qualitative findings can be used to cross-validate the obtained results and gain a deeper insight into digital transformation and development of smart tourism in the heritage cities of Nepal.

4. Results and Discussion

4.1 Respondent characteristics

A total of 350 respondents from Kathmandu Valley, Pokhara, and Lumbini filled the survey. Their characteristics are summarized in Table 1. The sample consists of 56.6 percent males and 43.4 percent females surveyed, which demonstrates the equal activity of both sexes in heritage tourism and the delivery of digital services. Most of the respondents fall within the 31 to 45 age bracket, who are economically

active, followed by the younger adults between 18 and 30 years. This hierarchy shows that the heart of digital adoption lies with mid-career players who can make decisions in businesses and local politics. The owners of tourism SMEs constitute the highest number of 40 percent, then tour guides, tourists, and local officials. This combination sums up the supply and the demand side perception of digital transformation. Nearly fifty percent of the respondents are bachelor's degree graduates, and over a third of the respondents are master's or higher degree graduates. This rather high level of education opens good perspectives for digital skills upgrading and provides the application of TAM and UTAUT constructs that presuppose a minimum of basic knowledge of ICT. The sample, in general, offers an adequate point to study the adoption of technology and smart tourism preparedness of the heritage destinations.

Table 1: Respondent characteristics in Kathmandu Valley, Pokhara, and Lumbini (n = 350)

Variable	Category	Frequency	Percentage (%)
Gender	Male	198	56.6
	Female	152	43.4
Age Group	18–30	104	29.7
	31–45	163	46.6
	46+	83	23.7
Occupation	Tourism SME owners	140	40.0
	Tour guides	95	27.1
	Local officials	45	12.9
	Tourists	70	20.0
Education	Secondary	52	14.9
	Bachelor's	172	49.1
	Master's and above	126	36.0

Figure 2 presents a combined respondent profile by gender, age group, occupation, and education level. This visual summary complements Table 1 and highlights the mix of tourism stakeholders and visitors across the three study sites.

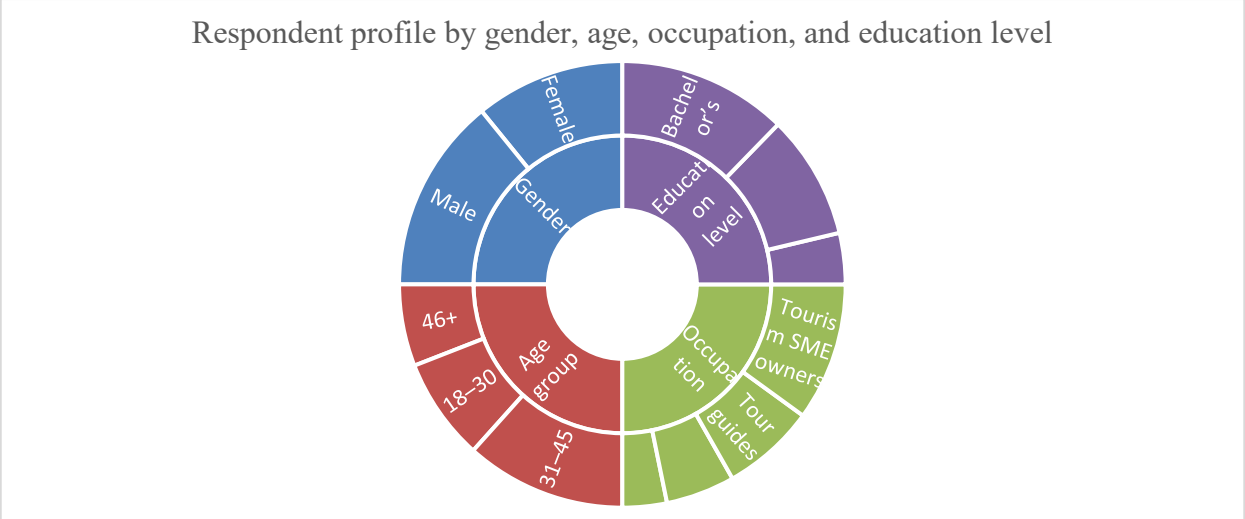

Figure 2: summarizes the distribution of respondents by gender, age group, occupation, and education level in a single visual profile

4.2 Descriptive statistics of key constructions

Table 2 presents the mean scores and standard deviations for the main constructions. Performance expectancy shows the highest mean score at 3.98, followed closely by tourist experience at 3.94. Respondents therefore agree that digital tools can improve efficiency, visibility, and service quality, and that these tools enhance visitor satisfaction. Technology readiness and effort expectancy also display relatively high means above 3.8, indicating that stakeholders feel generally prepared and willing to use digital platforms and do not view them as overly complex.

By contrast, smart infrastructure, smart services, and smart destination management show slightly lower mean values that cluster between 3.45 and 3.59. These scores indicate average progress, but also indicate at the destination level, an incomplete integration with digital. The respondents see obvious advantages in digital tools and are willing to use it, but the lack of connectivity, service coverage, and integrated management systems remains. This trend is like a literature on emerging destinations, which usually documents a favorable response to technology despite ongoing infrastructural and institutional limitations. It validates the fact that the primary bottleneck is not the willingness of the stakeholders but the maturity of smart tourism ecosystems in the heritage cities of Nepal.

Table 2: Descriptive statistics of technology adoption, smart tourism, governance, and outcome constructs

Construct	Items	Mean	SD
Performance Expectancy (PE)	4	3.98	0.72
Effort Expectancy (EE)	4	3.84	0.75
Social Influence (SI)	3	3.76	0.81
Facilitating Conditions (FC)	4	3.62	0.78
Trust	4	3.71	0.73
Technology Readiness	4	3.88	0.69
Smart Infrastructure	5	3.59	0.82
Smart Services	5	3.45	0.79
Smart Destination Management	4	3.52	0.74
Smart Tourism Development	5	3.63	0.72
Tourist Experience	5	3.94	0.70

4.3 Reliability and validity of measurement scales

Table 3 reports Cronbach's alpha, composite reliability, and average variance extracted for each construct. All alpha values are larger than 0.80, and all values of composite reliability are between 0.88 and 0.93. These findings demonstrate a high level of internal consistency and imply that the items contained in each scale are gauging the same concept. All constructions have a value of greater than 0.60, or an acceptable level in convergent validity.

Table 3: Reliability and validity of measurement scales for key constructs

Construct	Cronbach's α	CR	AVE	Status
PE	0.87	0.90	0.68	Acceptable
EE	0.86	0.89	0.67	Acceptable

SI	0.82	0.88	0.65	Acceptable
FC	0.84	0.88	0.63	Acceptable
Trust	0.85	0.89	0.66	Acceptable
Tech Readiness	0.88	0.91	0.70	Acceptable
Smart Infrastructure	0.89	0.92	0.69	Acceptable
Smart Services	0.87	0.90	0.65	Acceptable
Smart Destination Management	0.88	0.91	0.68	Acceptable
Smart Tourism Development	0.90	0.93	0.71	Acceptable
Tourist Experience	0.89	0.92	0.70	Acceptable

The robustness of the measurement model strengthens confidence in the subsequent structural analysis. It shows that the adapted TAM, UTAUT, smart tourism, governance, and outcome indicators function well in the Nepalese heritage tourism context. This is important because many scales were originally developed in different sectors and regions. Their strong performance here suggests that global technology adoption and smart tourism constructs can be meaningfully applied in South Asian heritage destinations when carefully contextualized.

4.4 Structural model results and technology adoption drivers

The structural equation model tests the direct effects of TAM and UTAUT-related constructs on technology adoption. Table 4 shows that all six factors have significant positive effects, with p values below 0.001. Performance expectancy exerts the strongest influence with a standardized coefficient of 0.28. This indicates that stakeholders adopt digital tools primarily when they believe these tools will improve business performance, visibility, and service quality. This finding mirrors global tourism studies that highlight perceived usefulness as the central driver of ICT adoption.

Technology readiness has the second strongest effect at 0.24. Respondents who feel confident and prepared to use digital technologies are much more likely to adopt them. This contributes to the current research that emphasizes the significance of psychological and skills-based preparation of tourism SMEs. The coefficient of effort expectancy is 0.22, and it highlights the fact that the perceived ease of use is important in the context where there is an uneven level of digital literacy. Also, of substantial and important impact are facilitating conditions, social influence, and trust. Adoption is augmented through supportive infrastructure and training, peer and customer expectations, and trust in the security of the data. These findings put together affirm the applicability of the combined TAM and UTAUT model in explaining digital behaviour among tourism stakeholders in Nepal.

Table 4: Structural model path coefficients for technology adoption drivers

Hypothesis	Path	β	t-value	p-value	Supported?
H1	PE → Tech Adoption	0.28	5.21	<0.001	Yes
H2	EE → Tech Adoption	0.22	4.63	<0.001	Yes
H3	SI → Tech Adoption	0.17	3.89	<0.001	Yes
H4	FC → Tech Adoption	0.19	4.12	<0.001	Yes
H5	Trust → Tech Adoption	0.16	3.55	<0.001	Yes
H6	Tech Readiness → Tech Adoption	0.24	4.98	<0.001	Yes

4.5 Mediation through smart tourism ecosystem components

Smart infrastructure, smart services, and smart destination management are tested as mediators between technology adoption and smart tourism development. All three mediators have large indirect effects as indicated by Table 5, with a coefficient of 0.19-0.23. Both mediators have a partial mediation, and this implies that the adoption of technology directly affects the development of smart tourism and indirectly affects these elements of the ecosystem.

There are huge mediation effects of smart infrastructure and smart services. When the stakeholders embrace the use of digital tools, chances of them investing in improved connectivity, Wi Fi internet coverage, digital kiosks, online booking systems, and mobile-based services are higher. Such investments, in their turn, empower the development of smart tourism. Smart destination management shows the best mediation with the coefficient of 0.23. This implies that the highest profits are achieved when adoption is translated into integrated management systems, e.g., digital dashboards, real-time monitoring instruments, and centralized databases. The result aligns with global evidence that smart tourism outcomes depend not only on isolated tools but on how well destinations integrate data and digital functions into coordinated management. For Nepal's heritage cities, this means that policies and projects must move beyond standalone apps or websites and prioritize interoperable systems that link multiple actors and sites.

Table 5: Mediation effects of smart infrastructure, services, and destination management on smart tourism development

Mediator	β (Indirect Effect)	p-value	Mediation Type
Smart Infrastructure	0.19	<0.01	Partial
Smart Services	0.21	<0.01	Partial
Smart Destination Management	0.23	<0.01	Partial

4.6 Moderation effects of governance, collaboration, and regulation

Governance support, stakeholder collaboration, and regulatory frameworks are tested as moderators. Table 6 shows that all three interaction terms are significant. Governance support has the strongest moderate effect with a coefficient of 0.18. In contexts where government policies, budgets, and digital strategies are strong, the positive relationship between technology adoption and smart tourism development becomes much steeper. This finding supports recent work that views digital transformation as an institutional process as much as a technical one.

Collaboration among government bodies, SMEs, communities, and ICT providers also enhances the translation of adoption into smart tourism outcomes. Its interaction coefficient of 0.15 indicates that coordinated action can unlock synergies, reduce duplication, and ensure that technologies respond to local needs. Regulatory structures have a significant but lower moderating influence at 0.12. Explicit regulations regarding any transactions involving a digital world, data safety, and preservation of heritage would build a facilitating environment where the stakeholders feel secure to invest in and use digital tools. In the case of Nepal, these findings emphasize the fact that smart tourism cannot be developed only via the efforts of individual enterprises. To make optimal use of the technology adoption, there is a need to have strong public leadership, multi-stakeholder partnerships, and updated digital regulations.

Table 6: Moderation effects of governance support, collaboration, and regulatory frameworks on smart tourism development

Moderator	Interaction Term	β	p-value	Conclusion
Governance Support	Tech Adoption × Governance	0.18	<0.01	Significant moderator
Collaboration	Smart Tourism × Collaboration	0.15	<0.05	Significant
Regulatory Frameworks	Tech Adoption × Regulations	0.12	<0.05	Significant

4.7 Qualitative insights and implications for Nepal's heritage cities

The qualitative findings complement the statistical results and provide concrete illustrations from Kathmandu Valley, Pokhara, and Lumbini. Digital transformation is a widely recognized aspect of becoming competitive and even addressing the demands of new tourists among the interviewees. The high ratings of performance expectancy and technology readiness are also reflected in the many reports by SME owners and guides that are interested in digital marketing, online booking, and customer engagement tools. Simultaneously, they also state that ICT competencies, time, and financial resources are severely limited, which is rather understandable as the reasons why smart infrastructure and smart services are not as ready as attitudinal ones.

Government-led training programs, subsidies, and integrated tourism information portals are recurrently mentioned by the respondents. They desire one-stop resources that would blend useful travel data, heritage stories, and real-time news. Such requests reflect quantitative data on the significance of enabling circumstances and smart destination management. Stakeholders consider AR and VR to be potential, but they are expensive, technically illiterate, and worry about cultural correctness and sensitivity. They emphasize the importance of professional participation and social consultation in the process of creating immersive digital content.

These concerns are supported by field observations. Lots of important heritage sites do not have a stable Wi Fi connection, QR-coded interpretation, or mobile apps integration. The process of ticketing is still manual in various places, and the information of various agencies is not connected to a single system. These findings are consistent with the moderate means of smart infrastructure and smart services and with the governance-associated limitations carried out through the moderation analysis.

Combined, the results indicate that Nepal has heritage cities that are in an initial and optimistic phase of smart tourism evolution. The stakeholders are aware of the importance of digital tools and are willing to utilize them. The factors related to technology adoption are high and greatly associated with the results, yet infrastructural gaps, disjointed governance, and lack of collaboration with one another slow the pace of development. The results imply evident priorities. The government must allocate resources to simple ICT infrastructure on heritage sites, invest in SME-driven digital education and development of interoperable information, booking, and visitor management platforms. Meanwhile, any regulatory changes and cultural protection must ensure that digital innovation does not harm heritage values and promotes long-term sustainability. This manner will transform digital transformation into integrated smart tourism systems that promote destination competitiveness as well as tourist experience in Kathmandu Valley, Pokhara, and Lumbini.

5. Conclusion

This study examined how technology adoption, smart tourism ecosystem components, and governance factors jointly shape smart tourism development and tourist experience outcomes in Nepal's heritage

cities. Using an integrated TAM and UTAUT-based framework, combined with smart tourism and governance perspectives, the research showed that performance expectancy, effort expectancy, social influence, facilitating conditions, trust, and technology readiness all significantly drive digital technology adoption among tourism stakeholders in Kathmandu Valley, Pokhara, and Lumbini. The results confirm that stakeholders recognize clear benefits from digital tools and show strong attitudinal readiness to adopt them but also face contextual barriers that limit full realization of smart tourism potential.

Smart infrastructure, smart services, and smart destination management were found to partially mediate the relationship between technology adoption and smart tourism development, highlighting that digital uptake generates the greatest benefits when it leads to investments in connectivity, digital service provision, and integrated management systems. Governance support, stakeholder collaboration, and regulatory frameworks significantly moderate these relationships. Strong policies, active partnerships, and clear rules have amplified the positive effects of technology adoption, while weak governance and fragmented coordination have reduced impact. Qualitative findings reinforced these patterns, revealing persistent gaps in Wi Fi coverage, digital interpretation, AR and VR deployment, and integrated information platforms, alongside stakeholder calls for government-led training, financial support, and coordinated digital strategies.

The findings have clear implications for Nepal's tourism sector. For public authorities, priority actions include investing in core ICT infrastructure at heritage sites, mainstreaming digital objectives into tourism and heritage policies, and building interoperable platforms for ticketing, information, and visitor management. Public–private partnerships and multi-stakeholder coordination mechanisms are essential to mobilize resources, share expertise, and ensure that digital innovations reflect local cultural values and conservation needs. For tourism SMEs and guides, targeted training in digital marketing, online booking, data security, and technology-enabled customer engagement can help close the readiness to practice gap and improve competitiveness in increasingly digital markets. For heritage managers, carefully designed AR and VR applications, QR-based storytelling, and multilingual digital content can enhance visitor experience and support more informed and respectful engagement with cultural sites.

The study also offers conceptual contributions by operationalizing an integrated framework that combines TAM and UTAUT constructs with smart tourism ecosystem components and governance dimensions in a developing country heritage context. This responds to the current imbalance in smart tourism research that focuses largely on high-income destinations. At the same time, several limitations suggest directions for future work. A cross-sectional design captures only a single point in time and cannot track how digital adoption and governance reforms evolve. The sample focuses on three major destinations and may not fully represent smaller or emerging sites. Future studies could use longitudinal designs, including additional regions, examine specific technologies such as AR and VR in greater depth, and incorporate environmental and social impact indicators. Despite these limitations, the evidence shows that Nepal's heritage cities hold substantial potential for smart tourism transformation, provided that digital adoption is matched with strategic investments, strong governance, and sustained capacity building.

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