Application use labour turmeric digital twin in develop development travel sustainable tourism heritage destinations

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Abstract:

This study focuses on analyzing the application of Digital Twin technology in sustainable tourism development at heritage destinations. The purpose of the study is to assess the potential and challenges of applying this technology in heritage conservation and sustainable tourism development. Historical research methods Using a combination of secondary document analysis, field surveys at three representative heritage destinations and interviews experts in the fields of tourism and technology. Results shows that Digital Twin brings many significant benefits in simulation and prediction Report the impact of tourism activities on heritage, optimize visitor experience, support support customer flow management and heritage conservation. However, the study also found challenges regarding investment costs, technical requirements high technology and the need to train specialized human resources. The conclusion shows that the application of Digital Twin needs a roadmap. appropriate development and support policy support to maximize efficiency in sustainable tourism development.

Keywords: Tell exist go products, Digital Twin, Travel calendar durable steady, labour

1. INTRODUCTION

In the context of globalization and digital technology development, the tourism industry is undergoing dramatic changes, especially at cultural and natural heritage destinations. World heritage sites not only have great cultural and historical values but are also important tourist destinations, contributing significantly to local economic development (Timothy & Boyd, 2021). However, tourism exploitation at heritage destinations is posing major challenges in terms of balance between economic development and preserve heritage values.

According to UNESCO report (2023), more than 70% of world heritage sites the world is facing pressure from Overcrowded tourism activities, leading to risks degradation and irreversible loss. In Vietnam, heritage such as Ha Long Bay, Hoi An Ancient Town, and Trang An are also facing a similar situation with a sudden increase in the number of visitors in recent years (Ministry of Culture, Sports and Tourism, 2023).

Digital Twin technology, defined as a digital replica of a physical object, system, or process, is emerging as a potential solution to these challenges (Grieves & Vickers, 2017). Unlike traditional 3D models, Digital Twin has the ability to integrate real-time data, simulate different scenarios, and support support data-driven decision making data (Kritzinger et al., 2018).

International studies Recently, the great potential of Digital Twin in tourism destination management has been demonstrated. Research by Buhalis & Karatay (2022) in European heritage sites showed that the application of Digital Twin can reduce the negative impact of tourism by 45% compared to traditional management methods (Buhalis & Karatay, 2022). Similarly, Li et al. (2023) demonstrated the effectiveness of this technology in optimizing tour schedules and enhancing visitor experiences (Li et al., 2023).

However, in Vietnam, research and application of Digital Twin in the field of heritage tourism is

still very limited. Most current studies only focus on the aspect of edge technique technique but Not yet Go deep stool product author dynamic arrive develop development travel calendar durable sustainability and heritage conservation. This research gap creates an urgent need for a comprehensive study, assessing the applicability of Digital Twin in the specific context of Vietnam.

This study was conducted with the following objectives: (1) To analyze the potential and benefits of applying Digital Twin in sustainable tourism development at destinations heritage; (2) Assessing challenges and limitations during implementation; (3) Proposal the recommend proposal main book and war comb develop development edema fit with thing lawsuit Vietnam.

2. DIRECTION FRANCE RESEARCH RESCUE

The study used mixed research methods, combining qualitative and quantitative research to ensure comprehensiveness and accuracy reliability of the results. The research process was carried out from March to August 2025.

2.1. Secondary data collection

The study conducted a literature review of 156 scientific articles published between 2018 and 2025, focusing on the following topics: Subject: Digital Twin, sustainable tourism, heritage management and technology tourism. The facilities office data materials used Applications include Web of Science, Scopus, Google Scholar and reputable tourism journals.

2.2. Field survey

Three heritage destinations were selected as research sites: Ha Long Bay (natural heritage) (natural), Neighborhood neck Festival An (cultural heritage) and Complex Hue relics (mixed heritage). Selection criteria are based on: (1) Representativeness of other types of heritage each other; (2) Degree tourism development; (3) Ability data access and collection whether

At each destination, the study conducted structured observations for 30 days, recording information on: visitor numbers, visitor behavior, heritage conservation status, and issues. current management.

2.3. Expert Interview

The study conducted semi-structured interviews with 24 experts, including: 8 experts on technology Digital Twin, 8 heritage tourism management experts, and 8 tourism policy makers. Interviews were conducted face-to-face and online, each lasting 45-60 minutes.

2.4. Tourist survey

The questionnaire was designed with 35 questions, surveying 420 tourists at three destinations (140 tourists/destination). The convenience sampling method was applied, with the criteria: tourists from 18 years old and above have visited at least one heritage site in the past 12 months.

2.5. Data analysis

Qualitative data were analyzed using thematic content analysis with the support of NVivo 12 software. Quantitative data were processed processed by SPSS 26 software Using descriptive statistics, T-test and multivariate regression analysis.

3. CONCLUDE FRUITAND GRAPE DISCUSSION

3.1. Concept and characteristics of Digital Twin in heritage tourism

3.1.1. Definition of Digital Twin in the context of cultural heritage development

Digital Twin in heritage tourism is defined as an interactive and dynamic digital replica of a cultural or natural heritage site, integrating real-time data from IoT sensors, historical information, and precise 3D models to create a virtual environment capable of simulating, predicting, and optimizing conservation and tourism activities. Unlike traditional static 3D models, heritage Digital Twins are able to "live" and react to real-world changes through a continuous data stream.

According to Gabellone (2022), Digital Twin of heritage is not only a documentation tool but also an integrated knowledge platform that allows stakeholders from heritage managers, researchers to visitors to interact and exploit multidimensional information about heritage. This is an evolution from the traditional Heritage Building Information Modeling (HBIM) concept to an intelligent system capable of self-learning and prediction.

3.1.2. Architecture and core components

3.1.2.1. Physical Layer

This is the foundation layer that includes the actual heritage with all its physical components:

architecture, landscape, artifacts, and surrounding environment. At this layer, IoT sensors are deployed to continuously collect data on:

- Environmental conditions: temperature, humidity, air quality, UV light
- Structural condition: vibration, displacement, cracking, stability
- Tourism activities: visitor traffic, density in areas, length of stay
- Security and safety: unusual movements, fire, illegal intrusion

3.1.2.2. Connectivity Layer

This layer ensures real-time data transmission from the physical legacy to the Digital Twin system through connectivity technologies such as 5G, WiFi 6, LoRaWAN, and Edge Computing. Of particular importance is the ability to process data at the Edge to reduce latency and ensure instant response in emergency situations.

3.1.2.3. Analytics Layer

This is the "brain" of the Digital Twin, using Machine Learning and AI algorithms to:

- Analysis of conservation trends and risk prediction
- Optimize visitor flow and resource allocation
- Detect abnormalities and early warning
- Scenario simulation to support decision making

3.1.2.4. Experience Layer

This layer provides interactive interfaces for different user groups:

- Management dashboard for heritage operators
- AR/VR applications for tourists
- Research platform for scientists
- Education system for students

3.1.3. Characteristics of Digital Twin in heritage tourism

3.1.3.1. Multi-temporal

Heritage Digital Twins have the ability to "time travel", allowing users to experience heritage sites at different historical periods. For example, visitors can explore the Thang Long Imperial Citadel during the prosperous Ly-Tran period, then move to the period of decline under French colonial rule, and finally to its current state after archaeological excavation.

3.1.3.2. Multi-sensory

Unlike conventional virtual tours that only focus on visuals, the heritage Digital Twin integrates 3D spatial audio, haptic feedback, and even simulated scents to create a complete immersive experience. Visitors can hear the distant sound of temple bells at Yen Tu and feel the humidity and smell of the sea at Ha Long.

3.1.3.3. Social Interaction

Heritage Digital Twin supports group virtual tours, allowing multiple people to explore and interact in a virtual space. Families can visit the Imperial City of Hue together from different parts of the world, or research groups can discuss directly in the 3D environment of the heritage.

3.1.3.4. Personalization

The system uses personalized AI to tailor content and presentation to each visitor's interests, level of knowledge, and needs. A historian will receive detailed information about architectural techniques and eras, while children will experience interactive games and vivid stories.

3.1.4. Classification of legacy Digital Twin

3.1.4.1. Static Digital Twin

This is the most basic form, mainly focusing on accurate 3D reconstruction of the heritage at a specific time. No real-time data but allows for detailed exploration and basic interaction. Suitable for heritage sites that have not changed much, such as My Son or Thanh Dynasty Ho.

3.1.4.2. Dynamic Digital Twin

Integrates real-time data from sensors and is able to reflect current changes in the heritage. Suitable for heritage sites with changing environments such as Ha Long Bay (weather, tides) or Hoi An (flood levels).

3.1.4.3. Predictive Digital Twin

Use AI and Machine Learning to predict trends and make recommendations. Can simulate future scenarios such as the impact of climate change, the impact of development projects, or the effectiveness of conservation measures.

3.1.3.4. Optimization Digital Twin

At the highest level, it is capable of automatically optimizing operations based on real-time data and set goals. For example, automatically adjusting travel routes to avoid overcrowding, or suggesting optimal conservation measures based on current environmental conditions.

3.1.5. Differentiating value from traditional technologies

While static 3D models only provide images, 360° virtual tours allow movement but no deep interaction, and VR creates immersive experiences but lacks connection to reality, the legacy Digital Twin combines all these advantages and adds:

- Real-time connectivity to physical heritage
- Ability to learn and evolve from collected data
- Integrate multiple data sources from history, archaeology to current environment
- Support decision making based on scientific analysis
- Scalability and customization to specific needs

The heritage Digital Twin is therefore not only an experiential tool but also a complete digital ecosystem that simultaneously serves conservation, research, education, and sustainable tourism.

3.2. Benefits benefits of Digital Twin applications in heritage conservation and sustainable tourism development

3.2.1. For heritage conservation

Research rescue body determine year application use main belong to Digital Twin in tell exist go product:

Supervisor close and attend newspaper love the doctor **go product:** Digital Twin give permission according to follow link custom factors impact on heritage such as degree humidity, temperature, vibration and level erosion. In Ha Long Bay Long, the simulation shows that it is possible attend report the impact of climate change on limestone islands with 87% accurate

Tissue photo author degree belong to **cough degree travel calendar:** System system Have body tissue interview author dynamics of levels different visitors to the heritage. The results shows that when the number of visitors exceeds 2,000 people/day at the Festival An, negative impact on ancient architectural structures increased by 34%.

Appendix lake and re create go product: Digital Twin bow grant copy Star number main body, support support restoration process when heritage is damaged broken harm. This is an especially important application in the context of increasing natural disasters and climate change.

3.2. For sustainable tourism development

Result Survey shows Digital Twin offers significant benefits for sustainable tourism development:

- Optimize **customer flow management:** System system can attend reporting and distribution visitors in a reasonable way, reducing overcrowding at sensitive points. Results Simulations at three destinations show that adopting a Digital Twin can reduce waiting times by 42%. visitor waiting and reduce pressure on sensitive areas by 35%.

- **Enhanced** visitor experience: **78 % of** surveyed visitors said that using an integrated Digital Twin application helped them understand more about value heritage and have a better experience. In particular, virtual reality (VR) and augmented reality (AR) features are highly appreciated with the level

satisfied 4.2/5.

- **Support support management decision** making: **100** % of management experts interviewed **affirmed** determine Digital Twin bow grant information believe have benefits give job go out decide determined System The system helps predict 85% of possible problems and makes appropriate treatment recommendations.

3.4. Challenges and limitations in applying Digital Twin to tourism development at heritage destinations

3.4.1. Technological and technical challenges

3.4.1.1. Complexity of heritage digitization

Creating accurate Digital Twins for cultural heritage requires an extremely high level of detail, especially for architecturally complex structures such as the Hue Imperial City with more than 600 relics or the Phong Nha - Ke Bang cave system with its complex 3D structure. The 3D scanning process of a large relic can take months and generate terabytes of raw data to process. In particular, digitizing intangible elements such as ancient sounds, traditional scents, or cultural rituals remains a major challenge with current technology.

3.4.1.2. Multi-data source integration

Heritage Digital Twins need to combine data from many different sources: historical data from ancient books and documents, archaeological data from excavations, environmental data from IoT sensors, and tourism data from management systems. Synchronizing and ensuring consistency between these data sources requires complex technical protocols and standards that Vietnam does not yet have.

3.4.1.3. Performance and scalability issues

Digital Twin applications require huge computing power, especially when serving thousands of tourists accessing virtual tours simultaneously. Cloud computing infrastructure in Vietnam is not strong enough to handle these tasks smoothly. High network latency can reduce the quality of immersive experiences and cause dizziness for VR users.

3.4.2. Human resource challenges

3.4.2.1. Lack of multidisciplinary experts

Heritage Digital Twin requires a combination of many expertises: history - archaeology, information technology, 3D/VR design, and heritage management. Vietnam currently has a serious shortage of experts who can work across these fields. Most current projects have to outsource to international experts at high costs (50,000-100,000 USD for an average project).

3.4.2.2. Resistance to change from traditional management teams

Many older heritage managers have difficulty accessing and using new technology. They are concerned about the security of heritage data and believe that digital technology can "destroy the traditional values" of heritage. Retraining this team takes a long time and is costly.

3.4.2.3. Lack of tech-savvy tour guides

To maximize the effectiveness of Digital Twin, it is necessary to have a team of tour guides who not only have a deep understanding of history and culture but are also proficient in AR/VR technology to support visitors' experiences. Currently, 80% of tour guides at Vietnamese heritage sites have not been trained in digital technology.

3.4.3. Financial challenges

3.4.3.1. High initial investment cost

Building a complete Digital Twin for a heritage site can cost from 2-10 million USD, including the cost of specialized 3D scanning equipment (500,000-1 million USD), processing software (100,000-300,000 USD/year), and specialized human resources. With 9 world heritage sites, Vietnam needs to invest at least

50-100 million USD, a large number for the current state budget.

3.4.2.2. Operation and maintenance costs

Once deployed, Digital Twins need to be continuously updated to ensure accuracy. Annual operating costs can be up to 20-30% of the initial investment, including server costs, software maintenance, content updates, and staff training. Many Digital Twin projects around the world have had to stop operating due to lack of maintenance funding.

3.4.2.4. Difficulty in recovering investment capital

Unlike traditional infrastructure projects, the economic benefits from Digital Twin are difficult to quantify and are often long-term. Private investors are therefore hesitant to participate. The PPP (public-private partnership) model for legacy Digital Twin has no precedent for success in Vietnam.

3.4.4. Legal and management challenges

3.4.4.1. Lack of legal framework on digital heritage

Vietnam does not have specific laws and regulations on intellectual property rights for digital heritage, the right to use heritage images and data, as well as the responsibility to protect tourists' personal data. This creates legal risks for investors and limits the ability to commercialize Digital Twin products.

3.4.4.2. Decentralization of management authority

Heritage management involves many agencies: the Ministry of Culture, Sports and Tourism, the Ministry of Natural Resources and Environment, People's Committees at all levels, and specialized conservation centers. Overlapping authorities make Digital Twin implementation encounter many administrative obstacles. Inter-provincial Digital Twin projects such as Yen Tu - Vinh Nghiem - Con Son - Kiep Bac are even more complicated when coordination between 3 provinces is required.

3.4.4.3. Data security and privacy issues

Digital Twins contain detailed information about the structure, layout, and security systems of heritage sites, which can be exploited by malicious actors. Balancing openness (for tourism development) and security (for heritage protection) is a major challenge.

3.4.5. Cultural and social challenges

3.4.5. 1. Acceptance by local communities

Many communities living around heritage sites are concerned that Digital Twins will reduce the number of actual visitors, affecting their livelihoods from accommodation, food and beverage services, and souvenir sales. In Hoi An, some small businesses have opposed the development of virtual tours for fear of losing customers.

3.4.5. 2. Balance between tradition and modernity

There is a view that digitizing heritage can "lose the soul" of heritage, turning it into a commercial product. Ensuring that Digital Twin still respects and conveys the spiritual and cultural values of heritage is a big challenge.

3.4.5. 3. Digital divide in society

Not everyone has access to AR/VR technology due to high equipment costs and limited technological capabilities. This can create inequality in access to heritage, which goes against the goal of universalizing cultural values.

3.4.6. Competition and market challenges

3.4.6. 1. Compete with other destinations in the region

Countries like Japan, Singapore, and South Korea have invested heavily in Digital Twin tourism and have advantages in technology. Vietnam risks falling behind if it does not quickly catch up, especially

in the context of tourists increasingly preferring high-tech experiences.

3.4.6. 2. Changing tourist behavior

COVID-19 has changed travel habits, accelerating the trend of virtual travel. However, it is unclear whether this trend will be sustainable or just a temporary solution. Large investments in Digital Twins could be at risk if travelers return to prefer traditional travel.

3.5. The tissue image infection **use wall labour Digital Twin in tourism development at heritage destinations**

3.5.1. Comprehensive Digital Twin model at UNESCO Genoa, Italy

The Palazzi dei Rolli Digital Twin project (2021-2024) deployed a system of 200 IoT sensors to monitor 42 UNESCO palaces, using Machine Learning to predict risks 3-6 months in advance. Results achieved: Detected and prevented 27 potential problems, saving 2.3 million Euros in emergency repair costs. Tourist length of stay increased from 2.1 to 3.4 days, tourism revenue increased by 35%, creating 230 new jobs. Success factors: Effective PPP model and active participation of local communities.

3.5.2. Digital Heritage Ecosystem Model in China

National program (2020-2025) for 55 world heritage sites with an investment of 1.2 billion USD, applying a 6-level framework from Digital Documentation to Cognitive Digital Twin. Notable achievements: Forbidden City reached level 6 with multilingual AI tour guide, attracting 15 million virtual tours/year. Terracotta Warriors increased 45% of international visitors thanks to AI regenerating damaged warriors. Lesson: Standardized framework and large-scale investment create overall efficiency.

3.5.3. Smart Heritage Management Model in Korea

Gyeongbokgung Palace "Time Machine" (2019-2023) uses a holographic display to recreate 5 historical periods, AI Royal Guide speaks 8 languages, and the digital environment changes according to real seasons. Economic efficiency: Number of visitors increased by 67%, revenue from 28 million USD to 52 million USD. Technology exports to 12 countries brought in 45 million USD. Strengths: Integrating advanced technology with deep cultural storytelling.

3.5.4. Community-based Digital Heritage model in New Zealand

Māori Cultural Heritage Digital Twin focuses on engaging with indigenous communities with the Cultural Sensitivity Protocol - all content must be approved by Māori elders. Special technology: Sacred Space Recognition (AI restricts access to sacred areas), Traditional Craft VR (learning crafts through haptic feedback), Storytelling AI (voice of an elder telling legends). Value: Protecting traditional knowledge and transmitting culture across generations.

3.5.5. Hybrid Tourism Experience Model in Japan

Kyoto Digital-Physical Integration perfectly combines virtual and real experiences through 3 stages: Pre-visit (VR surveys and route selection), On-site (AR adds information and recreates lost structures), Post-visit (Digital Twin reviews the experience). Achievements: Satisfaction score 9.3/10, return rate 43% (double the regional average), 89% of visitors understand more about Japanese culture.

3.5.6. Lessons for Vietnam

3.5.6.1. On governance and organizational models

Inter-sectoral coordination mechanism: Based on China's experience with the National Heritage Digitalization Committee, Vietnam should establish a National Steering Committee on Heritage Digitalization under the Prime Minister, including representatives from the Ministry of Culture, Sports and Tourism, the Ministry of Planning and Investment, the Ministry of Information and Communications, and localities with heritage. This committee has the authority to coordinate budgets, policies, and unified technical standards.

Effective PPP mechanism: Learning from the Genoa model, Vietnam needs to build a specialized PPP legal framework for Digital Twin heritage with specific incentives: exempting investment tax for the

first 10 years, allowing private enterprises to commercially exploit 30% of the system capacity, and ensuring capital recovery in 8-12 years through virtual tourism revenue and value-added services.

Three-tier management model: Applying New Zealand experience with the structure of (1) Central: Policy and standard development, (2) Province/City: Implementation and operation, (3) Local community: Content participation and quality monitoring.

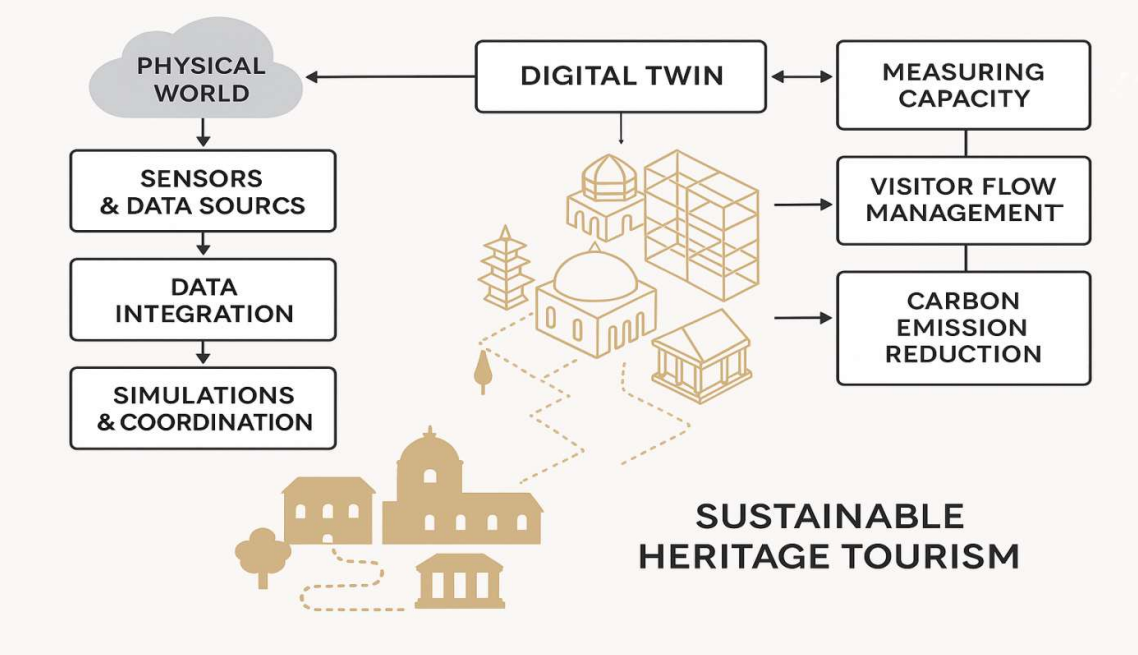

Figure 1. Model showing the relationship between Digital Win and Sustainable Tourism Development

(Source: Proposed by the author group)

Physical World: The physical world is the original entity that the Digital Twin reflects. It includes the entire heritage space, tourism infrastructure, natural ecosystems, visitor flows, residents, and tangible physical resources.

A Digital Twin only makes sense when there is a "living physical object" to mirror. Therefore, the prerequisite is to fully understand the physical, social and environmental characteristics of the destination: from ancient structures, tourist traffic, to climate fluctuations.

Sensors & Data Sources: This is the layer that collects information from the physical world. Environmental sensors, motion sensors, AI cameras that count people, energy meters, and internal management data (POS, tickets, check-in, social media) form the "sensory" system for the Digital Twin. All this data helps to observe in real time, without having to rely on delayed statistics. Thanks to that, tourism management becomes more responsive to emerging situations such as customer congestion, weather fluctuations, or sudden increases in waste.

Data Integration: Data collected from multiple sources is often distributed, heterogeneous and asynchronous. The data integration layer is responsible for standardizing, synthesizing, synchronizing and storing data in a unified "data lake". This stage requires standardization according to international standards such as ISO 23247 - which regulates the connection between physical and digital entities. Data integration helps build a sustainable data value chain, ensuring the ability to retrieve, communicate and analyze.

Simulations & Coordination: Once the data has been integrated, the Digital Twin model can simulate and predict system behavior. Through simulation algorithms (e.g., agent-based modeling or system dynamics), DT recreates how visitors move, interact with spaces, consume resources, and impact the environment. Based on the simulation results, the system provides dynamic coordination solutions: customer flow, ticket price adjustment, or triggering alerts when capacity thresholds are exceeded.

Digital Twin: The Digital Twin is the central core of the model. It is a dynamic digital version that continuously reflects the state of the physical world. DT combines geometric data (HBIM - Heritage

Building Information Modeling) with real-time data to create a vivid virtual model.

Measuring Capacity: Carrying capacity is the optimal load limit of the heritage in terms of number of visitors, energy, and environment. DT allows for a shift from static to "dynamic carrying capacity" - real-time calculations based on temperature, humidity, population density, and infrastructure conditions. When thresholds are exceeded, the system automatically alerts or adjusts the number of visitors, avoiding overload and degradation.

Visitor Flow Management: A sustainable heritage destination cannot do without smart visitor flow management. Based on real-time data, DT recognizes the movement of visitors, detects congested areas and suggests alternative routes.

When integrated with tourism apps and electronic boards, the system can coordinate people flow over time, avoiding congestion, enhancing experiences and protecting heritage.

Carbon Emission Reduction: DT helps track and optimize the carbon footprint of all tourism activities: electricity, water, waste, transportation and emissions. Through operational data analysis, DT proposes energy-saving strategies, such as adjusting lighting times, providing optimal travel guidance or prioritizing green vehicles.

Sustainable Heritage Tourism: This is the ultimate goal of the entire model. The combination of data, simulation, and feedback helps achieve three pillars of sustainability:

Economy: increase operational efficiency, equitable distribution of benefits.

Society: reduce resident-tourist conflicts, improve community quality of life.

Environment - culture: preserving buildings, reducing emissions and maintaining heritage values.

Digital Twin, therefore, is not just a technological tool, but an evidence-based management model - helping managers make decisions based on real data, not emotions.

3.5.6.2. On technology and innovation strategy

Digital Twin Framework suitable for Vietnam: Based on China's 6-level framework, develop "Vietnam Heritage Digital Twin Framework - VHDTF" with 4 levels suitable for actual conditions:

- Level 1 - Heritage Documentation: Basic digitization (100% heritage, completed 2025-2026)
- Level 2 - Interactive Experience: Virtual tours and AR (80% of heritage, completed 2026-2027)
- Level 3 - Smart Monitoring: IoT and AI analytics (50% legacy, completed 2027-2029)
- Level 4 - Integrated Management: Automated management (30% of legacy, completed 2029-2030)

"Make in Vietnam" technology: Learning from Korea in developing domestic technology, Vietnam needs to encourage companies like FPT and Viettel to develop Digital Twin solutions at 40-60% lower costs than imports. Establish a 500 billion VND Digital Heritage Innovation Fund to support R&D.

Data standardization: Building Vietnam Heritage Data Standard (VHDS) to ensure compatibility between 9 heritages, can be integrated with UNESCO's CIDOC-CRM (Conceptual Reference Model) and Dublin Core Metadata.

Through learning and selectively applying successful models around the world, Vietnam can absolutely become a leading country in the region in Digital Twin heritage, not only effectively preserving precious cultural values but also creating sustainable revenue and enhancing international status.

4. CONCLUSION AND DISCUSSION

Research has demonstrated the enormous potential of the technology. Digital Twin in sustainable tourism development at heritage destinations. Application of technology This not only contributes to effectively preserving heritage but also improves the quality of tourist experience and optimizes efficiency. destination management

Key benefits include: the ability to monitor and forecast legacy status with high accuracy, optimized guest flow management reducing wait times by 42%. wait, and support support management decisions based on scientific data. In particular, Digital Twin has demonstrated the ability to reduce 35-45% of the negative impacts of tourism activities on heritage.

However, challenges in terms of investment costs, high technical requirements and data security issues still need to be addressed comprehensively. The study proposes make recommendations policy: (1) Road construction step-by-step development process, prioritizing the valuable heritage and great tourism pressure; (2) Strengthening training of specialized human resources through international cooperation

and business-university linkages; (3) Completing the legal framework on data security data and privacy in the digital environment.

The next research direction should focus on developing Digital Twin models suitable for Vietnam's socio-economic conditions, studying the long-term impact of technology. This leads to sustainable development and the development of performance evaluation standards. application under specific conditions body of each type of heritage.

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