

Empowering High-Quality Development of Ancient-City Cultural Tourism Through Digital-Physical Integration: Efficiency Evaluation and Optimization Paths—A Case Study of Chaozhou Ancient City

Yenan Lu

School of Economics, Guangdong Ocean University, Zhanjiang 524088, Guangdong, China

Copyright: © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Digital-physical integration driven by digital technologies has become a critical engine for the transformation and upgrading of cultural tourism in living ancient cities. As a living carrier of Chaoshan culture, Chaozhou Ancient City has built smart cultural-tourism platforms and digital infrastructure. Nevertheless, it is confronted with practical dilemmas including fragmented digital cultural resources, insufficient virtual-real experience supply, data silos, homogeneous business forms, and shortages of interdisciplinary talents. Taking Chaozhou Ancient City as the research subject, this paper sorts out its practice of digital-physical integration and analyzes existing problems. Optimization paths are proposed from five dimensions: constructing digital-cultural resource repositories, innovating virtual-real scenarios, coordinating data governance, upgrading business formats, and fostering local talents. This research aims to leverage digital technologies to empower heritage conservation, cultural communication, and industrial development, and provide practical references for the high-quality development of cultural tourism enabled by digital-physical integration among similar living historical ancient cities in China.

Keywords: Digital-physical integration; Ancient-city cultural tourism; High-quality development; Efficiency evaluation; Chaozhou Ancient City

Online publication: September 30, 2026

1. Introduction

The National Strategy for Digital Culture promotes the in-depth coupling between digital technologies and the cultural-tourism industry. Digital-physical integration offers new ideas for historical ancient cities to resolve the contradiction between heritage conservation and tourism development. Preserving intact street patterns, architectural relics, and a living inheritance system of intangible cultural heritage, Chaozhou Ancient City serves as a typical representative of living ancient cities in China. At present, the construction of smart

cultural tourism in Chaozhou Ancient City keeps advancing, yet its technological implementation suffers from prioritizing hardware over content and difficulties in converting online popularity into cultural consumption. Empirical analyses concerning digital-physical integration in living ancient cities remain insufficient in existing studies. Accordingly, this paper takes Chaozhou Ancient City as an example to review its practical status, identify development bottlenecks, and explore optimization paths of digital-physical integration adapted to the conservation requirements of living ancient cities, so as to furnish case references for the high-quality development of ancient-city cultural tourism.

2. Practical status of digital-physical integration in Chaozhou Ancient City

Centered on Paifang Street, Guangji Bridge and Guangji Tower, the core zone of Chaozhou Ancient City accommodates a large number of old residential dwellings and intangible cultural heritage workshops. It ranks among the few living historical urban areas in China with continuous residential functions. In terms of digital-physical integration, Chaozhou Ancient City has completed the construction of basic digital infrastructure^[1].

First, smart service platforms have been gradually launched. The *One-Ticket Chaozhou* smart cultural-tourism platform integrates functions such as ticket reservation, consumption verification, parking-space inquiry, and tourist-profile analysis. It realizes integrated operation, including online scenic-spot reservations and preferential tour packages, and supports visualized passenger-flow monitoring to provide data evidence for operational strategy adjustment. The *Zhichengbo* smart parking system connects thousands of parking berths within the ancient city, alleviating parking difficulties and improving travel experiences for tourists. The digital map of intangible cultural heritage life in Chaozhou digitizes locations of scattered workshops for Chao embroidery, hand-poured teapots, and wood carving. Tourists may navigate via mini-programs, removing information barriers for intangible cultural heritage experiences.

Second, infrastructure has undergone digital renovation. Wireless network basically covers core areas of the ancient city, and electronic audio guides have been put into operation at key scenic spots. The *Chaozhihui · Chaoshenghui* unified-management platform for the ancient city aggregates video surveillance, passenger-flow, and traffic data. It visualizes operational conditions of the ancient city to support cultural-relic security monitoring, passenger-flow guidance and urban governance.

Third, the digitization of cultural resources has taken initial shape. The digital map of the museum city incorporates 82 museums and thematic exhibition halls across Chaozhou. 3D scanning has been completed for selected key cultural relics. Short-video platforms facilitate online communication of Chao opera, kongfu tea, and Chaozhou cuisine, expanding the online influence of ancient-city cultural tourism.

Field investigations reveal that digital-physical integration in Chaozhou Ancient City remains at the preliminary stage. Over 60 % of stores on Paifang Street sell local specialty snacks, while interactive intangible cultural heritage experience stores account for a low proportion. Immersive AR and VR projects are scarce, and most digital products merely provide information queries. Digital cultural-resource repositories are fragmented, without a unified collection of digital assets for cultural relics and intangible cultural heritage. Online publicity heat can hardly be translated into in-depth offline cultural consumption. Tourists are dominated by sightseeing check-ins, and in-depth cultural-experience offerings are inadequate^[2].

3. Practical dilemmas of cultural tourism in Chaozhou Ancient City from the perspective of digital-physical integration

3.1. Insufficient integration of digital cultural resources and weak capacity for cultural content translation

Chaozhou Ancient City boasts abundant architectural heritage, folk customs, and intangible cultural heritage resources. However, digital resources are dispersed across different government departments, lacking a unified-standard digital-cultural-asset repository for the ancient city. Some historic buildings are only archived by simple photographs, while high-precision 3D modeling and digital reconstruction advance slowly. Launched mini-programs and digital maps mainly provide location navigation and basic textual descriptions, lacking in-depth digital narratives for the histories behind memorial archways, the architectural wisdom of Guangji Bridge, Chao-opera folk tales, and so forth. Digital products mostly serve check-in-style sightseeing, failing to convey core connotations of the ancient city, including living lifestyles, clan cultures, and overseas-Chinese remittance cultures, to tourists. Digital technologies show inadequate capacity for value translation of cultural heritage.

3.2. Scarce supply of virtual-real integrated scenarios and superficial cultural-tourism experiences

Current digitization in Chaozhou Ancient City is dominated by instrumental services such as navigation, reservation, and parking inquiry, whereas immersive and interactive virtual-real cultural-tourism products are insufficient. Characteristic experience projects, including digital reconstruction of Guangji Bridge, digital roaming along Paifang Street, and interactive virtual theaters for Chao opera, are absent. Tourists still focus on offline strolls and photography. Few AR applications, digital-human performances, and interactive interpretations are implemented on-site. Digital technologies are not deeply embedded throughout tourist itineraries. Disconnections exist between online-offline scenarios and between digital contents and physical urban spaces, restraining tourists from in-depth cultural exploration and resulting in superficial sightseeing experiences^[3].

3.3. Unbroken data silos and imperfect multi-agent coordination mechanisms

Governance over the ancient city involves multiple authorities covering culture-tourism, cultural-relic preservation, urban administration, transportation, and sub-district communities. Separate business systems are constructed by different departments with inconsistent data standards, generating data silos. Data on cultural-tourism operations, cultural-relic security monitoring, and passenger-flow transportation have not been fully interconnected and shared. At the market-agent level, linkages among government-run platforms, cultural-tourism enterprises, intangible-cultural-heritage workshops, and local micro-merchants are inadequate. Large-scale platform projects are mostly led by state-owned enterprises. Local micro-entities for intangible cultural heritage have limited channels for digital transformation. Small-and-medium-sized merchants suffer shortages of capital, technologies, and talent for digital operations, and digital dividends cannot sufficiently reach grassroots local entities^[3].

3.4. Prominent homogenization of business forms and limited industrial-upgrading effects enabled by digitization

Commercial formats on core blocks of Paifang Street suffer severe homogenization. Shops selling specialty products occupy excessive proportions, while stores offering intangible cultural heritage experiences and

cultural-creative products are insufficient. Internet-popular catering and travel-photography services squeeze living spaces for local cultural businesses. Digital platforms mainly realize ticket sales and traffic diversion, exerting limited impacts on optimizing industrial structures. Digitized development of intangible cultural heritage cultural-creative products remains limited. New-process technologies such as 3D printing and digital design are applied on a small scale, and high-quality digital cultural-creative products are in short supply. Online traffic is difficult to convert into in-depth cultural consumption, giving rise to the phenomenon of “high traffic yet weak cultural consumption.” The efficiency of digital-physical integration in driving industrial quality improvement has not been fully unlocked ^[4].

3.5. Talent shortages and inadequate digital competence of local entities

Digital-physical integration demands both operation-and-development talents proficient in digital technologies and content-creation talents well-versed in Chaoshan history and culture. There exists a remarkable shortage of interdisciplinary digital cultural-tourism talents. Local inheritors of intangible cultural heritage and street-shop merchants generally lack capabilities in digital operations and new-media content creation. External technical teams often master technologies but poorly understand the local history and culture of Chaozhou. Technical solutions may become decoupled from cultural characteristics of the ancient city, resulting in loss of cultural essence in certain digital products.

4. Optimization paths for high-quality development of cultural tourism in Chaozhou Ancient City enabled by digital-physical integration

4.1. Constructing a unified digital-cultural resource repository for the ancient city to consolidate the content foundation for digital-physical integration

First, promote digitized archiving of cultural heritage within the ancient city under unified standards. Conduct high-precision 3D scanning and digital archiving for key cultural relics such as Guangji Bridge, memorial-archway groups on Paifang Street, and ancient residential buildings. Systematically sort out intangible cultural heritage craftsmanship, including Chao embroidery, wood carving, Chao opera, and kongfu tea, documenting craft procedures and artisan stories. Establish a general digital cultural resource repository for Chaozhou Ancient City to centrally collect and manage digital assets of cultural relics and intangible cultural heritage, meeting dual demands of backup for heritage conservation and cultural-tourism utilization.

Second, explore local cultural narratives based on the resource repository. Excavate clan histories behind memorial archways, construction wisdom of Guangji Bridge, overseas Chinese remittance cultures, and folk legends. Transform historical stories into digital content suitable for mini-programs, AR, and short-video communication. Shift from “resource digitization” toward “value-oriented digital translation,” changing the status quo where digital products merely provide basic information ^[5].

4.2. Innovating virtual-real integrated cultural-tourism scenarios and building multi-level immersive cultural experiences

Based on original street textures and physical-space foundations of Chaozhou Ancient City, digital technologies shall be moderately embedded into tourist scenarios without damaging historical styles and features. Lightweight and localized virtual-real integrated experience projects shall be developed to enrich tourist content while preserving original urban features. Digital renovation shall avoid large-scale reconstruction. Low-cost

and readily implementable technical solutions are prioritized so that digital content serves physical streets, and excessive technologization shall not dilute original historical atmospheres.

First, deploy lightweight AR experience projects along streets. Set AR trigger points at landmark nodes, including Guangji Tower, representative memorial archways, and Guangji Bridge. Tourists scan QR codes with mobile phones to access digital content, viewing visualized reconstructions of historical scenes and dynamic interpretations of folk tales, and experiencing digital roaming along Paifang Street. Relying on tourists' personal mobile terminals without massive hardware renovation, this low-cost, lightweight mode converts archived historical materials into visualized digital content, extending cultural narratives of street spaces and deepening tourists' cultural experiences.

Second, build small-scale digital workshops for intangible cultural heritage. Adopt 3D digital modeling and motion-capture technologies to develop online interactive modules for representative Chaozhou intangible cultural heritage craftsmanship such as Chao embroidery and hand-poured teapot making. Tourists preview craft procedures and virtually operate online to perceive technical aesthetics, and are then guided to offline physical workshops for hands-on practices. Bidirectional linkages are built between virtual online perception and offline physical experiences. Digital workshops do not replace traditional handicrafts; instead, they serve as pre-popularization digital media to lower comprehension thresholds for intangible cultural heritage and drive tourists from cursory sightseeing toward participatory in-depth experiences.

Third, construct an interactive virtual theater for Chao opera. Digitally reconstruct classic Chao-opera repertoires and innovate presentation forms with interactive digital technologies to break spatial limits of conventional theaters. Modernize interpretations of Chao-opera plots, characters, and arias through virtual interaction and segmented performances catering to the aesthetic preferences of contemporary youth, expand young audiences for traditional operas, and boost the living inheritance of local traditional dramas.

Targeting differentiated demands of various tourist groups, including mass sight-seers and in-depth cultural enthusiasts, establishes a multi-level cultural-tourism product system covering basic smart services, lightweight AR experiences, and immersive thematic exhibitions. Basic smart services satisfy tourists' elementary travel demands for navigation and information inquiry; lightweight AR projects popularize ancient-city history and culture for mass tourists; immersive thematic exhibitions serve in-depth cultural devotees. Multi-level virtual-real experience products address superficial tourist experiences and realize organic integration of digital innovation, physical urban spaces, and local cultural essence.

4.3. Deepening data-element governance, breaking data silos, and establishing multi-agent coordination mechanisms

Premised on compliance with data-security regulations, promote cross-departmental data interconnection. Connect data interfaces of business platforms for culture-tourism, cultural-relic preservation, transportation, and urban administration, and iteratively improve the unified-management platform for the ancient city as the digital foundation for refined governance. Integrate multi-dimensional data of passenger-flow thermal monitoring, cultural-relic security surveillance, parking, and transportation for joint analysis and collaborative application. Supported by integrated data evaluation, implement staggered passenger-flow guidance, dynamic risk early warning for hidden dangers to historic-building safety, rapid information circulation and emergency disposal for unexpected incidents, and comprehensively enhance the intelligence and responsiveness of ancient-city management.

Establish multi-agent collaborative operation modes engaging governments, state-owned platform enterprises, inheritors of intangible cultural heritage, local merchants and universities to gather joint forces for ancient-city conservation and development. Governments conduct top-level planning, formulate industrial standards, implement supporting policy incentives, and undertake overall coordination. Give full play to the *One-Ticket Chaozhou* platform, open traffic and service entrances for street-side micro-merchants and intangible cultural heritage workshops, lower technical and operational thresholds for digital transformation of small-and-medium-sized business entities, and help local micro-entities share dividends of digital cultural tourism.

Strengthen university-local cooperation with local universities such as Hanshan Normal University to build collaborative mechanisms for digital-cultural-content co-creation. Tap intellectual resources from local universities and encourage teachers and students to participate in the development of ancient-city digital IP, cultural-tourism short-video creation, and R&D of digital cultural-creative products, converting university research strengths and creative talents into driving forces for ancient-city digitization. Remove departmental barriers through data interconnection, stimulate market and social vitality via multi-agent collaboration, and form a new-pattern ancient-city development featuring data empowerment and co-construction, co-governance and benefit-sharing among diverse participants.

4.4. Promoting business-format iteration via digital-physical integration to alleviate homogenization and extend cultural-tourism industrial chains

Digital-physical integration provides new momentum for transformation and upgrading of ancient-city cultural-tourism business formats, mitigates homogenization, and extends full industrial chains of ancient-city cultural tourism. Give full play to the regulatory and guiding functions of digital platforms. Leverage big-data analytics on existing commercial formats of Paifang Street to sort out store-operation types, passenger-flow distribution, and consumption preferences. Optimize commercial layouts of Paifang Street accordingly. Grant priority support, including platform-traffic inclination and activity resources, to intangible cultural heritage experience projects and local craft workshops to facilitate agglomeration of characteristic cultural businesses, restrain disorderly expansion of simple specialty retail stores, and drive transformation from superficial commodity sales toward in-depth cultural experiences.

Tap local Chaozhou cultural digital resources and develop featured Chaozhou digital cultural-creative products based on the digital-cultural resource repository. Combine 3D-printing and flexible manufacturing technologies to develop derivative digital cultural-creative products themed on local classic IP such as the Fulou Monkey. Cover multi-level consumer groups, including high-end collectible intangible cultural heritage products and affordable cultural-creative commodities for ordinary tourists. Build online customized sales channels to expand market space for cultural-creative products.

Construct the industrial closed loop of “online traffic attraction—offline experiences—online repurchases.” Rely on the digital map of intangible cultural heritage life to guide tourists toward hidden intangible cultural heritage workshops in alleyways. Efficiently convert online traffic accumulated via short videos and new-media matrices into offline on-site experiences. After immersive intangible cultural heritage experiences, tourists complete online repurchases of cultural-creative products via e-commerce platforms, realizing effective conversion from traffic to industrial benefits. Digital-physical integration connects consumption chains and translates online traffic into tangible economic gains for local cultural-tourism industries, unleashing

empowering values of digital technologies for industrial quality improvement and value increment of extended cultural-tourism industrial chains^[6].

4.5. Improving talent training systems and strengthening digital empowerment for local entities

Implement hierarchical talent cultivation. On the one hand, introduce interdisciplinary operational talents for digital cultural tourism. On the other hand, organize regular digital-skill training courses for intangible cultural heritage inheritors and ancient city merchants covering short-video creation, online store operation, and new media marketing, so as to enhance the digital capabilities of local market entities. Establish joint review mechanisms involving technical teams and cultural experts. Invite Chaoshan historical and cultural experts and intangible cultural heritage inheritors to participate in content reviews during digital project development, avoid prioritizing technologies over culture, and guarantee authenticity and local characteristics of cultural expressions in digital products. Improve policy and financial support, set up special funds for digital-physical-integrated cultural-tourism projects in the ancient city, and give priority to projects for intangible cultural heritage digitization and digital transformation of micro-merchants.

5. Conclusion

Digital-physical integration constitutes a vital driving force for high-quality cultural-tourism development of living ancient cities. Its core lies in taking physical cultures as fundamentals and applying digital technologies to realize coordinated progress of heritage conservation, cultural communication, cultural-tourism industries, and urban governance. Although Chaozhou Ancient City has built its digital infrastructure, deficiencies persist in cultural-content transformation, scenario innovation, and multi-agent collaboration. The empowering efficiency of digital-physical integration can be unlocked by constructing unified digital-cultural-resource repositories, innovating lightweight virtual-real experiences, eliminating data barriers, optimizing business formats, and strengthening local-talent cultivation. Digitization construction for ancient cities shall adhere to cultural authenticity and avoid excessive technologization. This research offers references for digital transformation of cultural tourism in similar ancient cities nationwide. Follow-up studies may further deepen empirical analyses through quantitative measurements based on questionnaire data.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Lian G, 2025, Research on High-Quality Development of Jinyang Ancient City Empowered by Cultural-Tourism Integration. *Tourism Overview*, (24): 133–135.
- [2] Tang C, Zheng Q, Shi J, et al., 2024, Digital-Physical Integration Empowers Regional Cultural-Tourism Innovation: Preface to the Special Column “Digital Economy and High-Quality Development of Regional Cultural Tourism.” *Progress in Geography*, 43(10): 1891–1893.
- [3] Jiang A, Analysis on High-Quality Development Paths of Kashgar Ancient City from the Perspective of Cultural-

Tourism Integration. *Travel Journal*, 2026, 13(2): 24–26.

- [4] Xu J, 2026, Research on High-Quality Development of Juguo Ancient-City Scenic Spot Based on Cultural-Tourism Integration, thesis, Qufu Normal University.
- [5] Chen Z, Lin C, 2024, Optimizing and Upgrading Business Formats of Historical and Cultural Blocks in Ancient Cities to Promote High-Quality Integrated Development of New-Type Culture, Tourism and Commerce. *CPPCC World*, (12): 32–33.
- [6] Xue L, 2024, Multiple Measures Taken by Xinzhou Ancient City to Promote High-Quality Cultural-Tourism Integration Development, *Xinzhou Daily*, November 11, 2024, (001).

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.