

Functional Positioning, Scenario Demands and Digital Transformation Paths: A Comparative Study of Four Types of Characteristic Commercial Districts in Haikou

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Abstract: Digitalization is reshaping urban commercial spaces. Existing research and practices, however, often take for granted that uniform technology deployment delivers comparable outcomes, while paying inadequate attention to scenario variations across districts with different functional orientations. This paper selects four representative characteristic commercial districts in Haikou—Qilou Old Street, Mission Hills Resort, cdf Haikou Riyue Square, and the South Gate Night Market of Hainan University—as cases for a multi-case comparative study. Drawing on 800 consumer questionnaires, semi-structured interviews with 24 merchants, 30 days of on-site observation, and publicly available literature, it analyzes functional positioning, scenario demands, merchant capabilities and collaboration mechanisms. The findings indicate that mobile payment adoption ranges from 92% to 99% across the four districts, but platform awareness and sustained usage have not risen in tandem, creating a *technology-application gap*. Historical-cultural districts, culture-tourism integrated districts, commercial complexes and nighttime convenience districts center their core demands on cultural revitalization, cross-format synergy, shopping decision efficiency and instant turnover respectively. Inadequate digital literacy among merchants and insufficient collaborative support act as shared constraints, yet they operate through markedly different mechanisms. Accordingly, this paper proposes a layered "common foundation – classified application" pathway, offering a scenario-based analytical framework for the digital transformation of diversified commercial spaces in tourist cities.

Keywords: Digital economy; Characteristic commercial district; Digital transformation; Scenario governance

Introduction

The digital economy has transformed how consumers access information, navigate physical spaces, complete transactions and evaluate services. It has also extended merchant operations from one-off sales to content dissemination, membership management and data feedback. Characteristic commercial districts serve multiple functions including consumption, cultural display, tourism services and community life. Their digital performance cannot be measured merely by the number of devices or platform features; instead, it should be judged by whether digital tools penetrate the full

consumption process, whether they are sustainably adopted by merchants, and whether collaboration emerges among multiple stakeholders.

Smart tourism research has gradually come to view tourist destinations as digital ecosystems co-constituted by visitors, enterprises, platforms and administrative organizations, emphasizing the role of information services, personalized experiences and organizational networks in value creation[1-5]. Domestic scholarship discusses the transformation of commercial districts from perspectives such as spatial vitality, scenario reconstruction, digital business ecosystems, nighttime economy governance, format mixing and

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online-offline integration[6-11]. These studies have laid a multidimensional foundation covering technology, space, business formats and governance, but most focus on a single type of district or individual technology. Few have systematically compared digital demands and organizational constraints across different functional districts within the same urban context.

Two interrelated gaps remain in the literature. Theoretically, some studies implicitly assume that greater technology input leads to better transformation outcomes, which struggles to explain why awareness and usage rates of official platforms remain low after their launch, and why widespread mobile payment has not translated into continuous service chains. Empirically, horizontal research on diversified commercial spaces in tropical coastal tourist cities is scarce. Haikou is home to historical-cultural blocks, integrated resorts, duty-free commercial complexes and high-density night markets, making it a suitable sample for controlling external conditions such as urban policies, economic environment and tourism brand while identifying district-level heterogeneity.

This paper addresses three research questions: How do consumer digital demands diverge across districts with different functions? Through what mechanisms do merchant capabilities and collaborative constraints shape digital application? How can a city-level shared digital foundation connect with district-specific applications? Its theoretical contribution lies in constructing an analytical framework of "functional positioning – scenario demands – merchant capabilities – collaboration mechanisms", reframing digital transformation from a technical deployment issue to a matching problem between scenarios and organizational conditions. Its practical contribution is the proposed "common foundation – classified application" pathway, which provides a tiered implementation reference for similar tourist cities.

Literature Review and Analytical Framework

Three levels of digital technology impact

Digital technology exerts influence on commercial districts at three levels: transaction, operation and governance. The transaction level covers mobile payment, online search, e-ticketing and digital navigation, which primarily reduce information acquisition and settlement costs. The operation level includes membership management, product recommendation, passenger flow feedback and demand identification, requiring sustained data quality, staff competence and service responsiveness. The governance level involves data interfaces, rights-responsibility arrangements and benefit sharing among public agencies, operators, merchants, platforms and consumers. Research on smart destination ecosystems further notes that competitiveness stems not from individual technologies but from interconnected actors and resources[12].

Differences across the three levels imply that payment QR codes and district-level digital platforms should not be treated as markers of equal maturity. Payment tools have simple tasks and direct returns, and can be adopted by individual merchants. By contrast, cultural navigation, cross-format benefits, membership operation and queue management require continuous content updates, data continuity and organizational coordination. This paper defines the gap between high penetration of basic technologies and low awareness/usage of advanced services as the *technology-application gap*.

Digitalization models for different district types

The core resources of historical-cultural districts are architecture, collective memory and local culture. Cultural tourism research underscores the importance of visitor participation and everyday cultural resources[13]. For such districts, digital tools should focus on translating resources into credible, understandable and participatory experiences, rather than replacing cultural content with superficial interactions. Integrated resorts encompass accommodation, leisure, sports, catering and retail, and their main challenge is the lack of continuity across multiple systems and benefit schemes. Commercial complexes emphasize product search, spatial navigation and repurchase, but consumers are not passive recipients of technology; their willingness to use services is simultaneously shaped by relevance, privacy and perceived control[14]. Night markets feature high transaction frequency, low per-customer spending and concentrated peak hours, and thus require lightweight tools such as stable network connectivity, ordering systems, queue management and on-site order maintenance.

Studies across different district types show that personalization and cross-format connectivity create value only when embedded in concrete travel journeys[5,15]. Existing literature still lacks systematic comparison of multiple district types within the same city, making it difficult to determine whether unified construction or targeted policies are preferable. This paper defines "characteristic commercial districts" as urban commercial spaces combining commercial consumption with cultural display, tourism services, recreation or community life, covering four categories: historical-cultural, culture-tourism integrated, commercial complex, and nighttime convenience-oriented. Although Mission Hills is not a traditional street block, its concentrated commercial and cultural-tourism services form a continuous consumption scene, and is therefore included in the comparison.

Analytical framework

The term *scenario governance* used in this paper takes specific frictions in the consumer journey—arrival, touring, transaction, waiting, feedback and departure—as governance units, and combines technical tools, content provision, merchant capabilities and collaboration rules to address them. Compared with traditional governance centered on facility checklists or administrative boundaries, it pays greater

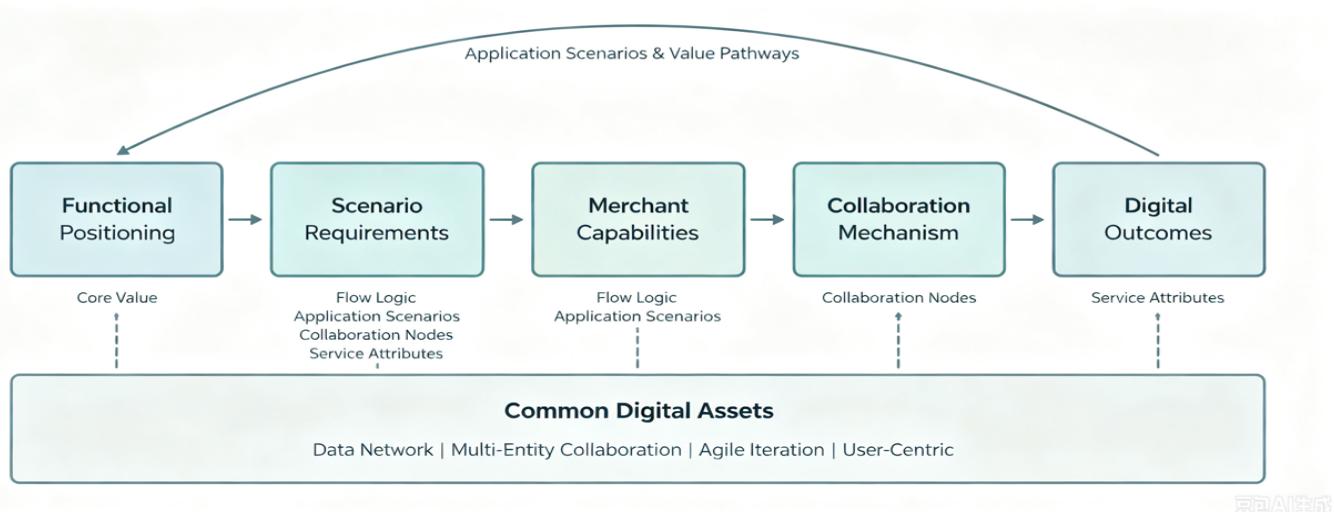


Figure 1 | 'Function Positioning – Scenario Needs – Merchant Capabilities – Collaboration Mechanism' Analysis Framework

Note: The diagram illustrates the logical relationship between core constructs and the shared digital foundation.

attention to whether service processes can be completed in full.

Accordingly, a four-dimensional framework is constructed. Functional positioning defines the core value and consumption journey of a district. Scenario demands identify specific frictions within that journey. Merchant capabilities determine whether tools can be adopted and translated into daily operations. Collaboration mechanisms determine whether services, data, benefits and responsibilities can cross organizational boundaries. A shared digital foundation provides network, interface, privacy, security and training support for all four dimensions, and application outcomes in turn drive iterative adjustments through usage feedback (Figure 1).

Research Design

Spatial location and case selection

The four cases first exhibit clear locational differentiation. Qilou Old Street, South Gate Night Market and Riyue Square are located in the northern urban area, embedded respectively in old-town alleys, a waterfront island district and a central business zone. Mission Hills lies in the southern cultural-tourism zone, forming a relatively independent facility cluster of accommodation, recreation, culture and supporting commerce. Figure 2 provides a city-scale spatial overview before moving to case selection and micro-morphological analysis.

This study adopts a multi-case comparative method, which is suitable for identifying mechanisms through similarities and differences across cases in complex contexts[16]. Case selection follows three criteria: first, clearly distinct functional orientations covering the four main types of characteristic commercial spaces in Haikou; second, co-

location in Haikou, which allows relative control over macro policies, economic level, climate and tourism brand; third, existing digitalization practices, enabling comparison of actual usage rather than planned visions.

Qilou Old Street represents the historical-cultural type, with its value foundation in arcade architecture, local history, catering and tourism. Mission Hills Resort represents the culture-tourism integrated type, linking accommodation, sports, recreation, entertainment and retail. cdf Haikou Riyue Square represents the duty-free and urban commercial complex type. The South Gate Night Market of Hainan University represents the nighttime convenience type, characterized by small merchants, high-frequency low-value transactions and concentrated short-duration passenger flows.

Spatial morphology and functional differences

Building on the city-scale location, Figures 3–6 further illustrate the micro spatial morphology of the four cases. All four figures are derived from public maps, on-site observation and case materials; color blocks, nodes and flow lines are used to identify dominant functional relationships, and do not represent land tenure, property rights, fixed stalls or traffic organization.

The four spatial morphologies correspond to different functions and target groups. The open streets of Qilou Old Street simultaneously host cultural experience, dining and recreation, and daily community use. Mission Hills organizes cross-project journeys for vacationers, family leisure participants and event attendees across dispersed facilities. Riyue Square serves both local and tourist shoppers within a single complex. The South Gate Night Market relies on linear stall belts to serve university students, nearby residents and short-duration visitors. These judgments are used to explain

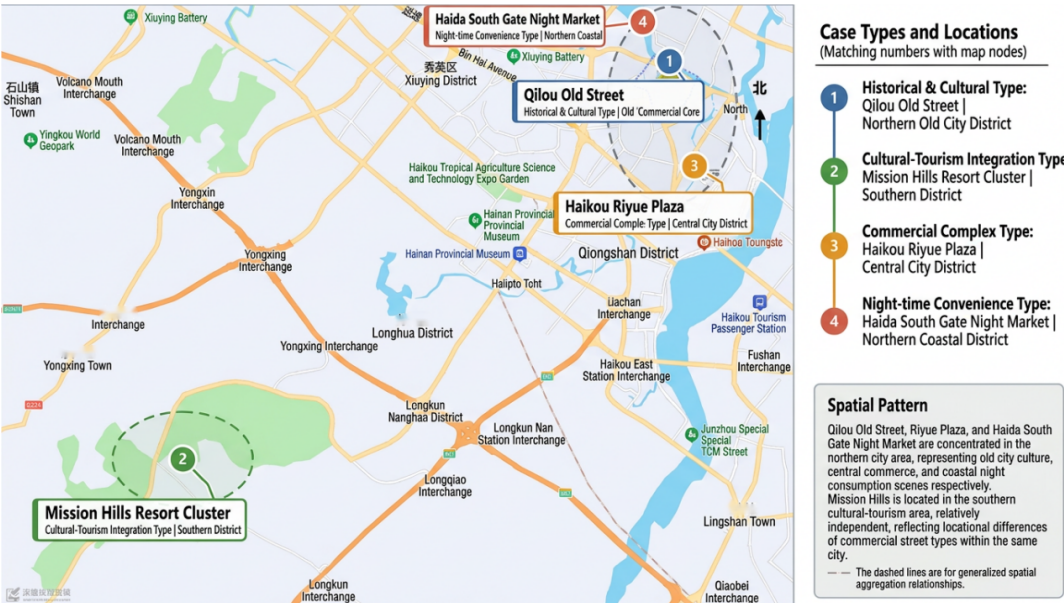


Figure 2 | Location Distribution of Four Types of Characteristic Commercial Streets in Haikou

Note: Numbers correspond to case types; dashed outlines only indicate spatial clustering. Markers represent representative locations and are not survey coordinates or travel route references.



Figure 3 | Diagram of Functional Zones in the Old Arcade Street

Note: Colored corridors, nodes and arrows are analytical illustrations only and do not represent official operation boundaries, traffic controls or property rights scopes.

differences in consumption processes, and do not constitute statistical estimates of visitor segment proportions.

Thus, spatial morphology is not merely background description but the explanatory starting point for subsequent comparison: open streets emphasize cross-actor content continuity, facility clusters emphasize cross-project journey connectivity, complexes emphasize search and membership synergy, and linear night markets emphasize peak-hour turnover.

Data collection

Consumer questionnaires and on-site observation were conducted simultaneously. Questionnaires were distributed via random on-site intercept, with 200 responses from each district, totaling 800. The questionnaire focused on digital tool usage, service demands, usage concerns and overall evaluation, while recording the visited district and basic visit characteristics; items were adjusted following a pilot study. Only aggregated results directly related to the comparative framework are reported in the main text; the full

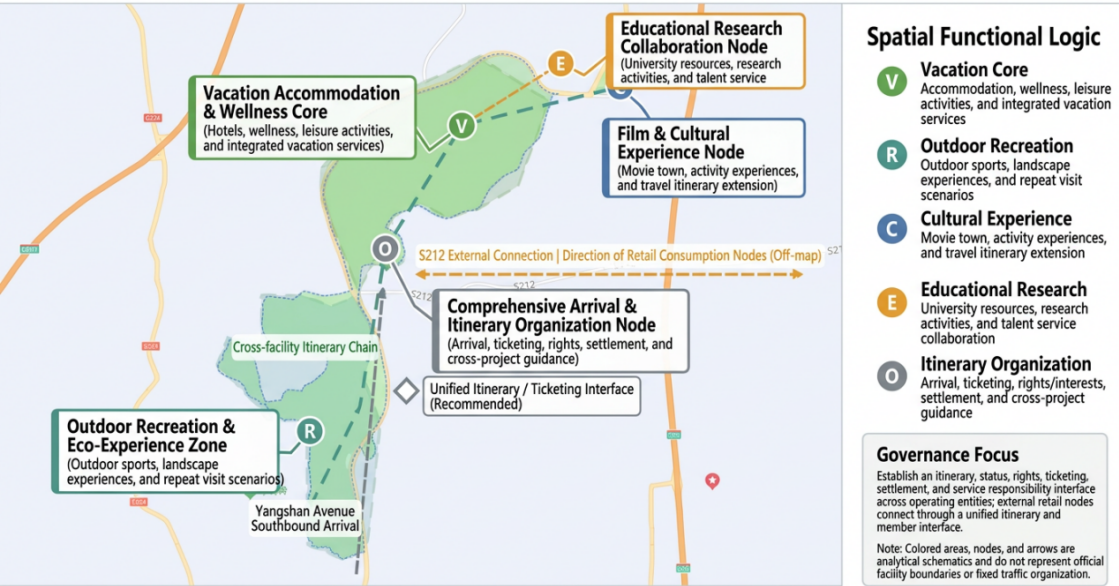


Figure 4 | Schematic of the spatial functional zones of Mission Hills Resort facilities

Note: Colored areas, nodes and arrows are analytical illustrations only and do not represent official facility boundaries or fixed traffic arrangements.

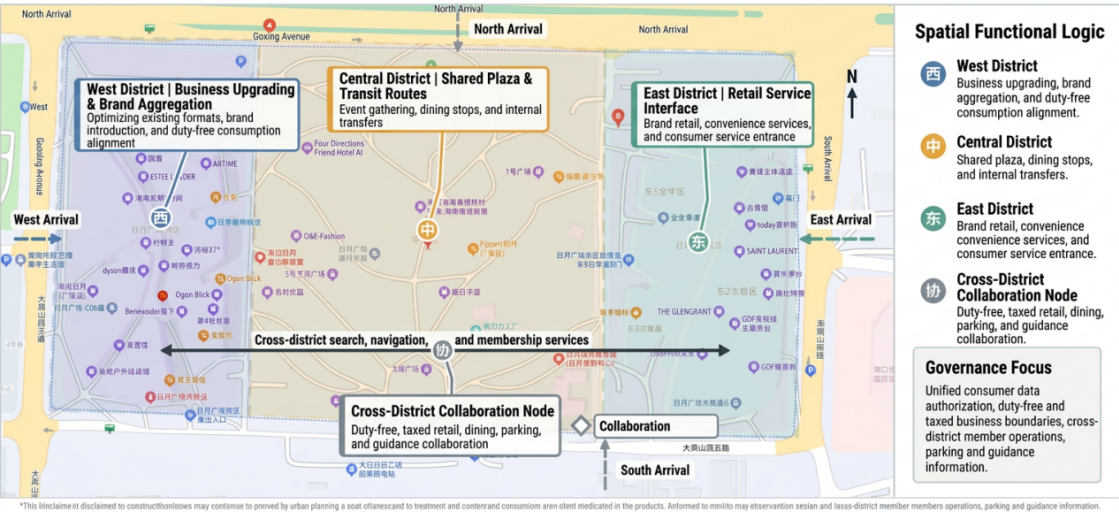


Figure 5 | Space Function Zoning Diagram of Riyue Square in Haikou

Note: Zoning, arrival directions and circulation lines are analytical illustrations only and do not represent official operation boundaries, ownership scopes or fixed traffic arrangements.

questionnaire is provided in Appendix A, and sample implementation details in Appendix C.

Semi-structured merchant interviews covered six businesses per district, totaling 24, selected to balance business format and operating scale. Interviews centered on passenger flow and consumption processes, digital tool usage, application barriers, management support and willingness to share services. The full interview guide is provided in Appendix B. Only district-level thematic summaries and frequency counts are retained from existing materials; complete verbatim transcripts, individual coding and consistent

interview duration records are unavailable. Therefore, interview data are used only for triangulation and pattern corroboration.

On-site observation was conducted in staggered time periods across the four districts, totaling 30 natural days covering both weekdays and weekends. Records included passenger flow patterns, digital facility usage, queuing and circulation, service entrances and on-site order. Specific observation dates and sample allocation for each district are listed in Appendix C. Policy documents, industry materials and published papers are used only to supplement background

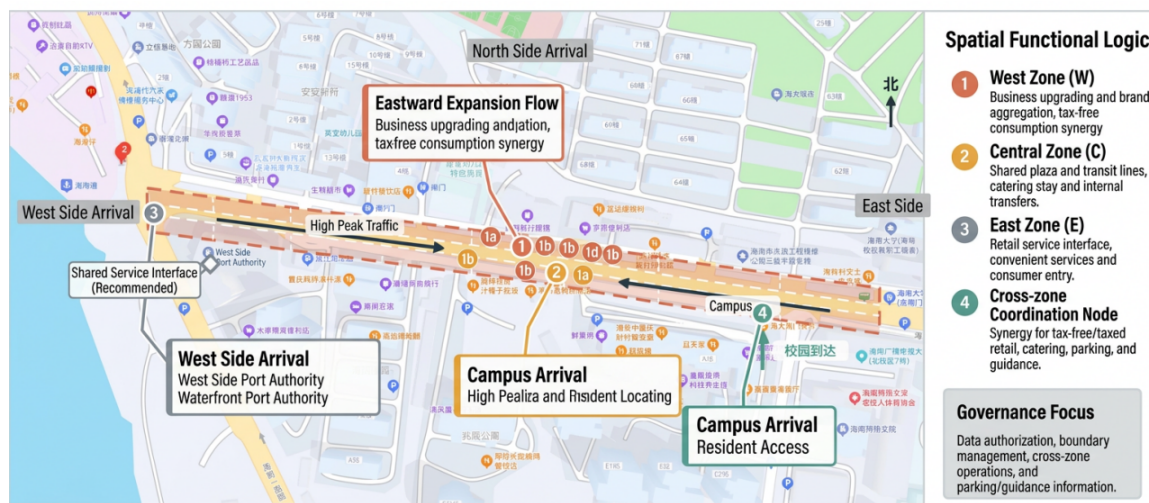


Figure 6 | Space Function Layout of the Night Market at the South Gate of Haida

Note: Colored areas, dashed units and arrows are analytical illustrations only and do not represent legal boundaries, fixed stalls or traffic organization.

and are not combined with primary data for statistical inference.

Analytical methods and evidentiary boundaries

Questionnaire data are used only to calculate descriptive proportions within each district; no significance tests, confidence interval estimates or population extrapolation are performed. Qualitative analysis follows the logic of thematic analysis[17]: interview summaries and observation records are first descriptively coded, then similar contents are grouped into themes such as passenger flow, products, digital capabilities and collaborative support, and finally mapped onto the four-dimensional framework for cross-case comparison.

Triangulation operates in three directions: consumer questionnaires identify demands and concerns, merchant summaries identify operational constraints, and on-site observation identifies usage conditions and peak-hour pressures. Patterns appearing in at least two data sources are regarded as relatively robust evidence.

Comparative Results

Functional positioning and visitor group differences

Spatial morphology and on-site records jointly show that the four districts serve different consumption journeys. Qilou Old Street revolves around cultural understanding, street touring and dining stops. Mission Hills centers on journey organization across multiple facilities. Riyue Square focuses on product decision-making, spatial navigation and repurchase. The South Gate Night Market is organized

around short-duration arrival, ordering, queuing and rapid turnover.

Basic payment and advanced service usage

All four samples show high mobile payment rates: 95% for Qilou Old Street, 92% for Mission Hills, 99% for Riyue Square, and 98% for the South Gate Night Market, with an overall range of 92%–99%. Awareness and usage of advanced services are comparatively uneven. For Qilou Old Street, 30% of respondents both knew about and used the official platform. For Riyue Square, 35% were aware of the official app or mini-program. No stable district-level platform usage has yet formed for the night market. At Mission Hills, the combined rate of awareness and satisfaction with AR interactions and electronic all-in-one tickets reaches 75%, but this item is not fully isomorphic with those of other districts and cannot be directly ranked.

Scenario demand differences

Eighty-five percent of respondents in Qilou Old Street wanted AR architectural restoration or scan-access audio guides, and 72% wanted personalized routes or shop recommendations. At Mission Hills, 78% wanted location-based recommendations, and 68% wanted cross-format consumption linkage. At Riyue Square, 70% were open to product or promotion recommendations, and 60% hoped to improve the efficiency of circulation and promotion access. At the night market, 85% wanted scan-to-order or prepayment, 90% wanted free Wi-Fi, and 70% wanted a lightweight mini-program with navigation and promotions. The four sets of demands concentrate respectively on cultural understanding, journey organization, shopping decision-making and instant turnover.

Table 1 | Consumer digital behavior and core demands across four characteristic commercial districts

District	Functional type	Mobile payment	Awareness/usage of advanced services	Most frequent demand	Other demands or concerns
Qilou Old Street	Historical-cultural	95%	Official platform: 30%	AR restoration / audio guide: 85%	Personalized routes: 72%; privacy concerns: 55%
Mission Hills Resort	Culture-tourism integrated	92%	AR interaction / e-ticket: 75%	Location-based intelligent recommendation: 78%	Cross-format linkage: 68%; Wi-Fi issues: 48%
cdf Haikou Riyue Square	Commercial complex	99%	Official app/mini-program: 35%	Product or promotion recommendation: 70%	Circulation and promotion efficiency: 60%; privacy / information interference: 65%
South Gate Night Market	Nighttime convenience-oriented	98%	No stable platform usage	Scan-to-order / prepayment: 85%	Free Wi-Fi: 90%; lightweight mini-program: 70%

Note: n=200 per district, total sample N=800. Advanced service items are not fully identical across districts; proportions are for descriptive comparison only.

Merchant capabilities and collaborative constraints

Across the six interviewed merchants per district, all fell under the theme of "lacking suitable digital tools or capacity for expanded usage". All six merchants in Qilou Old Street cited imbalance between weekday and weekend passenger flows, four mentioned product homogenization, and all six noted insufficient cultural content or unified support. At Mission Hills, five pointed out difficulty converting passenger flows across different formats, and all six cited insufficient cross-format platform support. At Riyue Square, four noted difficulty converting offline passenger flows into retained customers, all six lacked behavioral data tools, and five considered linkage between duty-free and taxed businesses inadequate. At the night market, all six faced both peak congestion and off-peak lulls, five mentioned category duplication, and all six relied on little beyond payment QR codes and needed unified management support.

Passenger flow temporal characteristics

During the observation period, Qilou Old Street recorded approximately 8,500 daily visits on weekdays and 18,000 on weekends; Mission Hills approximately 12,000 and 28,000; Riyue Square approximately 55,000 and 75,000; and the night market approximately 8,000 and 15,000 nighttime visits respectively. These figures represent only the specific observation week and should not be extrapolated to annual levels. On-site records reveal four operational patterns: weekly tidal fluctuation in historical districts, weekend cross-event clustering in resorts, high-base passenger flows in commercial complexes, and short-duration peaks in night markets.

Discussion

Formation mechanism of the "Technology-application gap"

Mobile payment has clear tasks, mature consumer habits and direct merchant returns, and can be adopted by individual operators. By contrast, navigation, recommendations,

memberships, cross-format benefits and queue management require content updates, data continuity, staff responsiveness and responsibility coordination. Therefore, high payment rates and low platform usage are not contradictory; the gap reflects differing organizational requirements between single-point transaction tools and continuous service systems. This finding aligns with smart tourism scholarship emphasizing that visitors, enterprises and organizations co-create value[1,2], and further clarifies that technological availability does not equal governance effectiveness.

Differences in demand across the four district types derive from their core consumption processes. Qilou Old Street must first translate architecture and local culture into understandable, participatory experiences. Frictions at Mission Hills occur between different activities; geographical proximity does not automatically create continuous benefits and journeys. Riyue Square must simultaneously handle recommendation efficiency and consumer control. The night market must first address connectivity, queuing, circulation and low-cost maintenance. For these reasons, a one-size-fits-all smart district template cannot simultaneously cover all four scenarios.

Shared constraints and typified mechanisms

"Insufficient merchant digital capabilities" carries different meanings across districts: for historical districts, it focuses on cultural content production and product connection; for resorts, on shared itineraries and benefit recognition; for commercial complexes, on customer data comprehension and compliant operation; for night markets, on reliable use of simple tools. Collaborative constraints are likewise not a single variable. Qilou Old Street involves diverse property rights and content responsibilities. Mission Hills involves cross-format settlement and service accountability. Riyue Square involves boundaries between duty-free and taxed businesses. Night markets depend on management to uniformly supply low-cost tools.

Thus, the four-dimensional framework forms a mechanistic chain: functional positioning determines which journey matters most, scenario demands identify frictions within that journey, merchant capabilities limit available solutions, and collaboration mechanisms determine whether

single-store services can connect into a district-wide experience. The theoretical increment of this paper lies not in adding new technology categories, but in explaining why the same technology generates different value under different functional and organizational conditions.

Comparison with peer tourist cities

Research on Sanya regards the internet and big data as pillars of smart tourism city construction and discusses the connection between all-for-one tourism and urban development[18], corresponding to the city-level common foundation. Research on Zhongshan Road in Xiamen constructs tiered cultural visiting routes based on the coupling of cultural resource value and walking environment, emphasizing resource continuity and district-scale experience[19], corresponding to classified application. These two studies cannot directly validate Haikou's findings, but together indicate that tourist cities can share network, interface and public service rules, while individual districts still need to configure applications according to cultural resources, walking conditions and operational structures.

This comparison suggests that the "common foundation – classified application" approach has conditional transferability. It applies to cities with multiple types of tourism commercial spaces, but cannot replace specific investigations into local property rights, operating entities, platform ownership and visitor structures.

Implementation risks and research limitations

Classified application may increase design, procurement and maintenance costs. Incomplete interfaces may create new data silos. If the common foundation is long controlled by a single platform, it may lead to technology lock-in and raise exit costs for small and medium merchants. Personalized services may also degenerate into excessive data collection and information interference. Therefore, the common layer should be limited to stable network connectivity, minimum data standards, open interfaces, privacy and security, accessibility and basic training. Specific modules should be piloted on a small scale starting from scenarios with the most concentrated pain points for merchants and consumers, with provisions for data portability, convenient exit and accountability auditing.

This study has four limitations. First, the questionnaire lacks complete individual data, response rates, demographic structure and a unified scale, precluding significance testing. Second, interviews lack verbatim transcripts and consistent duration records, which cannot support direct quotation or subgroup analysis. Third, each district was observed for only one period, which may be affected by weather, holidays and events. Fourth, Sanya and Xiamen are used only for conceptual comparison and do not constitute a rigorous multi-city empirical design. Future research should collect isomorphic questionnaires across different seasons, preserve interview transcripts with informed consent, and use pre-post implementation or phased pilot designs to examine queuing expe-

rience, route completion, merchant burden, repeated usage and exit behavior.

Conclusions and Practical Implications

The comparison of four characteristic commercial districts in Haikou shows that the popularization of basic mobile payment is not equivalent to the completion of digital transformation. Digital demands diverge with functional positioning. Merchant capabilities and collaborative support are shared constraints, but they affect application through mechanisms of cultural translation, cross-format connection, customer information retention and on-site turnover respectively.

At the city level, a "minimal yet open" shared digital foundation should be built, including stable network connectivity, data and interface standards, privacy and security, accessibility services and inclusive training, to avoid redundant construction and closed platforms. At the district level, configurations should be classified: Qilou Old Street should focus on verified cultural content, themed routes and connected participatory activities; Mission Hills should prioritize booking, status, benefits, settlement and service accountability; Riyue Square should improve product search, navigation, stock alerts and authorized membership operation efficiency; the South Gate Night Market should prioritize lightweight tools such as network access, ordering, queuing, stall navigation and fault response.

Implementation should start from scenarios with the most concentrated pain points for merchants and consumers, pilot first, review usage outcomes, and then gradually expand modules. Evaluation indicators should also vary by scenario, and should not focus solely on registration numbers and feature counts. Overall, the digitalization of characteristic commercial districts is not about stacking devices, but about the joint reconstruction of technology, scenarios, capabilities and collaboration rules.

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Appendix A | Consumer Questionnaire

Questionnaire on Digital Experience and Consumption Demand of Haikou's Characteristic Commercial Districts

Questionnaire Instructions: Dear visitor/consumer, hello! To understand the digital service level and consumption demands of Haikou's characteristic commercial districts, this anonymous survey is conducted. All data are used only for academic research and policy reference, and no personal information will be disclosed. Please fill in according to your actual experience.

A.1 Basic Information

1. Your gender: ☐ A. Male ☐ B. Female
2. Your age group: ☐ A. 18 and under ☐ B. 19–25 ☐ C. 26–35 ☐ D. 36–45 ☐ E. 46–55 ☐ F. 56 and above
3. Your identity: ☐ A. Local resident (living in Haikou for over 6 months) ☐ B. Non-local tourist (travel/business) ☐ C. Student ☐ D. Other
4. The district you are visiting this time: ☐ A. Qilou Old Street ☐ B. Mission Hills Resort ☐ C. Riyue Square ☐ D. South Gate Night Market
5. Frequency of your visits to this district: ☐ A. First visit ☐ B. 1–2 times per month ☐ C. 1–2 times per week ☐ D. Almost daily

A.2 Consumption Behavior and Payment Habits

1. Main payment methods you use when consuming in this district (multiple choices allowed): ☐ A. WeChat Pay ☐ B. Alipay ☐ C. Digital RMB ☐ D. Cash ☐ E. Bank card ☐ F. Other
2. Are you willing to use integrated "digital payment + intelligent recommendation" services (e.g., personalized promotions pushed after payment): ☐ A. Very willing ☐ B. Willing ☐ C. Neutral ☐ D. Unwilling ☐ E. Very unwilling
3. Approximate single consumption amount in this district: ☐ A. 50 yuan and under ☐ B. 51–200 yuan ☐ C. 201–500 yuan ☐ D. 501–1000 yuan ☐ E. 1001 yuan and above
4. Types of consumption in this district (multiple choices allowed): ☐ A. Catering ☐ B. Retail shopping (including duty-free goods) ☐ C. Cultural-tourism experience (e.g., tickets, cultural and creative products) ☐ D. Leisure and entertainment (e.g., cinema, hot spring) ☐ E. Accommodation ☐ F. Other\|\|\|\|

A.3 Awareness and Usage of Digital Services

1. Are you aware that this district has an official app/mini-program: ☐ A. Aware and have used ☐ B. Aware but have not used ☐ C. Not aware
2. If you have used the official platform, main functions you use (multiple choices allowed; skip to Q3 if not used): ☐ A.

Find shops/stalls ☐ B. View promotional activities ☐ C. Claim parking coupons/discount coupons ☐ D. Navigation and guidance ☐ E. Online reservation/ordering ☐ F. Other

3. Have you encountered any problems related to digital services in this district (multiple choices allowed): ☐ A. Poor network signal (Wi-Fi/5G) ☐ B. Complicated operation of official platform ☐ C. Payment failure ☐ D. Cannot find required digital functions ☐ E. No related problems ☐ F. Other

A.4 Digital Demands and Expectations

1. Smart services you hope the district will add or improve (multiple choices allowed): ☐ A. AR navigation for finding shops/stalls ☐ B. Scan-to-order + prepayment (reduce queuing) ☐ C. Personalized promotion push ☐ D. Real-time passenger flow heat map (check congestion) ☐ E. Cross-store points redemption and settlement ☐ F. Digital guidance (e.g., scan to listen to explanations, AR historical restoration) ☐ G. Food safety traceability query ☐ H. Other
2. For historical-cultural districts (e.g., Qilou Old Street), do you expect digital historical and cultural experiences (e.g., AR architectural restoration, digital intangible cultural heritage interactions): ☐ A. Very expectant ☐ B. Expectant ☐ C. Neutral ☐ D. Not expectant ☐ E. Very not expectant (respondents from non-historical-cultural districts may select "Neutral")
3. For commercial complexes/resorts (e.g., Riyue Square, Mission Hills), do you need a one-stop smart service platform (integrating ticketing, reservation, navigation, payment): ☐ A. Very needed ☐ B. Needed ☐ C. Neutral ☐ D. Not needed ☐ E. Very not needed (respondents from non-commercial complex/resort districts may select "Neutral")
4. For night market districts (e.g., South Gate Night Market), most urgently needed digital services (multiple choices allowed): ☐ A. Full coverage of free Wi-Fi ☐ B. Intelligent queuing and calling ☐ C. Stall navigation ☐ D. Online coupon collection ☐ E. Other

A.5 Concerns and Improvement Suggestions

1. Main concerns when using district digital services (multiple choices allowed): ☐ A. Personal information/privacy leakage ☐ B. Service interruption due to system failure ☐ C. Complicated operation process ☐ D. Too frequent recommendation information (harassment) ☐ E. No related concerns ☐ F. Other
2. Overall satisfaction with the digital construction of this district: ☐ A. Very satisfied ☐ B. Satisfied ☐ C. Average ☐ D. Dissatisfied ☐ E. Very dissatisfied
3. Aspects that most need improvement in the district's digital construction (multiple choices allowed): ☐ A. Basic network coverage (Wi-Fi/5G) ☐ B. Improvement of offi-

Table C1 | Data collection and sample implementation information for each case

Case	Consumer questionnaires	Merchant interviews	On-site observation dates	Main observation contents
Qilou Old Street	200	6	Feb 15–21, 2025	Visitor arrival, cultural guidance, street circulation, digital service entrances
Mission Hills resort facility cluster	200	6	Feb 22–28, 2025	Cross-facility journeys, reservation and benefit connection, weekend event clustering
cdf Haikou Riyue Square	200	6	Mar 1–9, 2025	Product search, spatial navigation, membership services and commercial circulation
South Gate Night Market	200	6	Mar 10–16, 2025	Peak passenger flow, ordering and queuing, circulation order and campus arrival
Total	800	24	30 natural days	Covering weekdays and weekends

cial platform functions □ C. Diversity of smart services □ D. Operational convenience □ E. Privacy and security guarantee □ F. Other

- Other suggestions on the digital construction of the district:

Appendix B | Semi-structured Interview Guide for Merchants

Interviewees are merchants or operators of different business formats and scales in the four case districts. Interviews aim to understand consumption processes, digital tool usage, operational constraints and collaboration demands, and do not collect personal sensitive information unrelated to the research.

B.1 General Interview Questions

- What are the main customer types, visiting time periods and typical consumption processes of your store?
- What operational problems do changes in passenger flow between weekdays, weekends or peak hours bring?
- What digital tools does your store currently use? Do these tools mainly solve payment, promotion, ordering, membership or other problems?
- What are the main cost, skill or maintenance barriers when using platforms, mini-programs, membership systems or data tools?
- What problems do customers most often encounter in finding stores, obtaining information, queuing, paying, after-sales service or revisiting?
- Is there homogenization in existing products or services? Can digital tools help display differentiated content?
- What kinds of support in network, training, data, guidance, order maintenance or fault response do you hope the district management will provide?

- Are you willing to participate in cross-store points, joint activities, shared guidance or other shared services? What are the prerequisites and concerns for participation?

B.2 Type-specific Supplementary Questions

- Qilou Old Street:** Who provides and updates cultural content? How can cultural guidance be connected with merchant products and services?
- Mission Hills resort facility cluster:** What connection difficulties exist in reservation, benefits, settlement and service responsibilities between different projects?
- Haikou Riyue Square:** How can duty-free and taxed businesses, product search, membership operation and data authorization be coordinated?
- South Gate Night Market:** What lightweight tools are most needed for ordering, queuing, circulation, delivery and emergency response during peak hours?

Appendix C | Data Collection and Sample Implementation Information

C.1 Implementation Arrangement for Each Case

See Table C1

C.2 Data Preservation and Analytical Boundaries

The appendix table only records implementation information verifiable from existing materials. Complete individual data, response rates and demographic structure are not retained for consumer data; complete verbatim transcripts, individual coding and consistent interview duration records are not retained for merchant interviews. Therefore, the main text only uses district-level aggregation, descriptive proportions and cross-data triangulation, and does not conduct population extrapolation or causal inference.