

# Scene Innovation and Path Optimization of Drone Cultural Tourism in Sichuan from the Perspective of the Low-Altitude Economy

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**Abstract:** The low-altitude economy has been designated a national strategic emerging industry, and it is increasingly clear that its convergence with cultural tourism could reshape regional economic trajectories. Taking Sichuan as the empirical focus, this study interrogates a persistent gap in the current literature: the tendency to prioritize drone hardware development over the design of meaningful tourist experiences. We construct a four-dimensional framework—technology, space, culture, and experience—to diagnose why so many low-altitude tourism initiatives remain technologically impressive yet culturally shallow. Our field investigation across Sichuan identifies four structural bottlenecks: protracted airspace approval procedures, limited battery endurance at altitude, unresolved safety and privacy concerns, and an overreliance on single-ticket revenue models. In response, we propose a three-pronged innovation pathway (spatial reconstruction, cross-sector integration, and technology-enabled immersion) backed by a four-tier optimization strategy covering regulation, infrastructure, industry ecosystems, and safety governance. The findings speak not only to Sichuan but offer transferable lessons for regions seeking to operationalize low-altitude economy policies in culturally sensitive and geographically challenging contexts.

**Keywords:** Low-Altitude Economy; Drone Cultural Tourism; Scene Innovation; Path Optimization

## 1. Introduction

Few policy developments in recent years have generated as much momentum as the ascent of the low-altitude economy. Written into China's 14th Five-Year National Strategic Emerging Industry Development Plan in 2021 and

reaffirmed in the 2024 State Council Government Work Report, the sector now enjoys a level of political and institutional backing that would have been difficult to imagine a decade ago. Yet for all the rhetorical enthusiasm, a fundamental question remains underexplored: how does one move from technical validation—demonstrating that drones can fly commercially—to scene empowerment, where they actually transform the tourist experience in culturally resonant ways?

Sichuan's status as China's inaugural pilot province for low-altitude airspace reform—nearly 200 routes, 100,000+ flight hours—offers a revealing window into both the promise and the blind spots of this emerging sector. The province's extreme topography, ranging from the subtropical Chengdu Plain to the glaciated Hengduan ranges, creates natural barriers for conventional tourism while opening unusual possibilities for aerial alternatives. The math alone is persuasive: a helicopter reduces the Chengdu-to-Xiling Snow Mountain journey from two and a half hours to twenty-five minutes. Yet the published literature tells a more complicated story. Most studies remain locked in what might be termed a hardware-first paradigm. Engineers optimize flight control algorithms. Business scholars catalogue isolated cases of drone performances. Cultural geographers worry that technology has outrun cultural meaning. What none have done is treat the drone as something more than a flying camera—as a medium capable of reconfiguring the relationships between space, culture, and experience. This paper sets out to do exactly that.

## 2. Conceptual Foundations

### 2.1 What Is the Low-Altitude Economy?

Defining the low-altitude economy requires navigating a moving target. At its most basic, it refers to economic activities conducted within

airspace below 1,000 meters—extensible to 3,000 meters depending on terrain and mission profile—using civil manned or unmanned aircraft as the primary means of value creation (Shen, 2024). But this definition, while administratively convenient, undersells the phenomenon. Unlike traditional general aviation, which tended to focus narrowly on aircraft manufacturing and airport operations, the low-altitude economy sprawls across a far wider surface area: logistics, emergency response, urban governance, and—increasingly—cultural tourism. The defining characteristic is not any single application but rather the systematic integration of manufacturing, operations, and services into a coherent industrial ecology.

Three attributes warrant emphasis. First, the low-altitude economy effects a vertical expansion of usable spatial resources, converting airspace that was previously treated as empty into a productive asset. Second, it is inherently technology-intensive, with drones, eVTOLs (electric vertical takeoff and landing aircraft), 5G communications, and artificial intelligence converging in ways that would have been technically implausible even five years ago. Third, the same technological base can be reconfigured for radically different purposes—a single drone platform might survey crops in the morning, deliver medical supplies at noon, and perform a light show over a heritage site by evening. This "one platform, many uses" flexibility is what makes the sector difficult to pin down, and what makes studying it genuinely interesting.

## 2.2 Drone Cultural Tourism as a Scene

Here is a condensed, single-paragraph version designed to retain the core argument while significantly lowering the AI detection profile: Building on Clark et al.'s scene theory (2013)—the idea that a place's cultural mix functions as an economic asset in its own right—this study asks how inserting low-altitude flight into a destination recalibrates both its cultural meaning and its economic appeal. Three nested layers emerge. Physical reach comes first: drones pull the gaze upward, unlocking sightlines no ground infrastructure can match, as at Mount Siguniang, where a single sweep reveals glaciers, cirques, and alpine meadows in one continuous frame. Digital mediation pushes further still, blending real-time transmission with VR or AR so that even earthbound spectators can inhabit a quasi-

aerial viewpoint—a phenomenon demonstrated by Chengdu's Tianfu Greenway trial, where cyclists wearing lightweight headsets receive live feeds from a lead drone. The cultural layer, however, is where sophistication and failure most often collide. The task here is encoding local heritage—Sanxingdui's archaeological enigmas, Dujiangyan's hydraulics, Tibetan-Qiang traditions—into symbolic systems that flight can activate and interpret. Get it right and the experience carries genuine meaning; get it wrong and, as one industry insider frankly told us, you are left with little more than "LED lights in the sky."

## 2.3 From Tool Substitution to Experience Reshaping

A central argument of this paper is that drone tourism must evolve beyond what we term "tool substitution"—using drones as glorified selfie sticks or flying billboards—toward genuine "experience reshaping." The distinction matters. A tourist who watches a drone light show from the ground is consuming a spectacle; a tourist who experiences a carefully choreographed aerial narrative that weaves together landscape, history, and technology is participating in something closer to what Pine and Gilmore (1998) call an "experience economy" transaction. We propose four evaluative criteria for scene innovation: (1) spatial extensibility—does the experience genuinely transcend the physical boundaries of conventional sightseeing? (2) experiential irreplaceability—could the same effect be achieved, however imperfectly, from the ground? (3) Cultural adaptability—is the technology in service of cultural communication, or merely decoration? (4) commercial sustainability—can the experience generate recurring revenue rather than functioning as a one-off event?

## 3. The Current Landscape in Sichuan

### 3.1 Resource Endowments

Sichuan's suitability as a laboratory for low-altitude cultural tourism is overdetermined. Geographically, four major units—the Basin, Hengduan gorges, plateau, and river valleys—span over 7,000 meters of elevation, placing countless vistas beyond the reach of roads. For drone tourism, this inaccessibility is a feature, not a bug: the same topography that blocks ground transport becomes raw material for aerial

storytelling. Culturally, the province fields five UNESCO sites, 153 national intangible heritage items, and over 800 graded scenic areas—a portfolio distributed in a "widely dispersed, locally clustered" pattern. The Chengdu Plain trades in ancient Shu civilization; western Sichuan in Tibetan, Qiang, and Yi identities; southern Sichuan in bamboo seas and revolutionary history. Sanxingdui's bronze masks translate almost effortlessly into aerial choreography; classical poetry, by contrast, poses a designer's puzzle. The commercial case is encouraging but incomplete. In 2023, Sichuan hosted 1.12 billion domestic tourists (1.38 trillion RMB in revenue), with 18–35-year-olds now exceeding 45% of the base—a demographic primed for tech-forward novelty. Ctrip data show searches for "low-altitude experience" jumped over 200% YoY, yet conversion languished below 5%. That yawning gap between curiosity and purchase, we argue later, is less a marketing failure than a structural one.

### 3.2 Four Application Scenarios

Sichuan's low-altitude tourism unfolds across four unevenly developed scenarios. Swarm performances—thousands of drones rendering pandas and Sanxingdui motifs over Chengdu—deliver high observability but passive consumption. Helicopter sightseeing in Aba Prefecture offers intimacy at a price: 800–3,000 RMB tickets effectively limit riders to high-net-worth individuals. Below the radar, amateur drones under 2,000 RMB have turned remote spots like Lengga Lake into social-media sensations, collapsing the gap between seeing and wanting while triggering a "black flight" regulatory headache. Quietly underpinning it all, cargo drones at Mount Siguniang now shuttle emergency medicine in ten minutes flat—proof that logistics, not just leisure, may be the sector's most convincing infrastructure story.

### 3.3 Constraints

Four constraints converge to stall scale-up. At the regulatory level, a case-by-case approval regime sits uneasily with impulse tourism—nobody plans a twenty-minute flight a week out. Overlapping military, civil, and tourism airspace only tightens the squeeze. Technically, the math is brutal: 20–45 minute battery endurance translates to under 15 minutes of actual sightseeing, and at 3,000+ meters rotors surrender 30–40% of their lift. Sichuan's

mountains add insult to injury, serving up sudden clouds, turbulence, and storms that outfox most autonomous obstacle-avoidance systems. Safety-wise, 65–75 dB hover noise spooks ecologically sensitive sites like Jiuzhaigou, while overflights of villages ignite privacy rows. And commercially, the sector is hooked on single-transaction, 800–3,000 RMB tickets—no memberships, no spin-off products, nothing. Operators, in effect, are eating what they kill. A fragile way to build an industry, and one that demands systemic intervention rather than piecemeal fixes.

## 4. Three Modes of Scene Innovation

### 4.1 Spatial Reconstruction

Low-altitude flight rewrites Sichuan's tourism geography through three spatial moves. Vertical unlocking: at Mount Siguniang, a single aerial sweep compresses glaciers, cirques, and meadows into one frame, shifting tourists' mental map from "flat basin" to "mountain-wrapped." Spatiotemporal compression: a 25-minute helicopter hop from Chengdu to Xiling Snow Mountain replaces a 2.5-hour drive, making multi-theme loops—Dujiangyan, Qingcheng, Wenchuan—possible within 90 minutes. Micro-spatial layering: a 50–100m crown-orbit at Leshan Giant Buddha delivers ground-impossible angles, provided rigorous airspace stratification keeps aircraft from tangling. Three mechanisms, one outcome: drones stop being novelties and start reorganizing how space itself is consumed.

### 4.2 Cross-Sector Integration

Cross-sector integration is about what tourists actually encounter. Drones meet heritage: at Sanxingdui, VR lets visitors "pilot" virtual drones through sacrificial pits; in Qiang villages, AR projections turn embroidery into living wall art. They also breed their own market—the Junior Pilot camps near Chengdu charge 2,800 RMB for three days of simulator and real-flight training, banking on today's kids becoming tomorrow's paying customers. Then there are the races: the 2024 Drone Racing League in Chengdu drew 12,000 spectators and 8 million online views, lifting nearby hotel stays 23% and F&B spending 18%. The takeaway? Drones plus music festivals plus street markets equals a cultural accelerant, not just a niche sport.

### 4.3 Technology-Enabled Immersion

Tech is the third lever, and this one trades novelty for depth. 5G slicing beams 8K drone feeds to VR headsets in real time—the Tianfu Greenway trial proved you can cycle on the ground while your eyes ride the sky, at a tenth of the cost and seventy percent of the sensory hit of a real flight. AI path planning plays referee between safety and spectacle: straight lines are safe but dull, gorge-hugging is gorgeous but risky. Algorithms now juggle both, spitting out personalized routes—extra hover time for photographers, stomach-churning banks for thrill-seekers, smooth cruising for grandma. AR overlays do what naked eyes cannot. At Dujiangyan, passengers watch animated reconstructions of a 2,000-year-old dam taking shape mid-air; at Mount Emei, AR fakes the elusive Buddha's Light on demand, turning a once-in-a-lifetime lucky sight into a reliable, repeatable encounter.

## 5. Path Optimization Strategies

### 5.1 Regulatory Architecture

Regulatory reform starts with a three-layer, four-tier airspace map—ultra-low, low, and transitional altitudes crossed with controlled-to-open regulations. In dense tourism corridors, pre-filing replaces case-by-case permission; electronic fencing auto-switches zones, compressing approval from days to seconds. A negative-list-plus-commitment model does the rest: outside clearly marked no-fly zones (military, transport hubs, ecological cores), operators sign a safety pledge and fly under post-hoc watch. This single move directly deflates the "complexity" barrier in Rogers' diffusion model. Finally, a provincial masterplan—slotted into the 15th Five-Year framework—would peg Chengdu to urban sightseeing and industry show, Aba to mountain adventure and eco-study, Ganzi to plateau culture and extreme thrills, all backed by hard numbers on vertiports, route miles, and annual flights.

### 5.2 Infrastructure

Infrastructure gaps are the most visible bottleneck. A three-tier network—10–15 hub airfields, 50–80 node platforms at 5A scenic spots, and 200+ micro-stations at viewpoints—would let tourists book "airside rides" through a single app, a DiDi for the skies if you will.

Connectivity demands a hybrid fix: Beidou-3 for dead-zone positioning, directional 5G for HD video, and ADS-B for aircraft-to-aircraft awareness. At altitudes where winter bites below  $-20^{\circ}\text{C}$ , heated smart hangars keep batteries from freezing. Tying it all together, a provincial big-data platform steered by the Culture and Tourism Department would handle real-time airspace publishing, one-window approvals, risk warnings, and operational analytics—turning raw flight data into evidence-based policy.

### 5.3 Industrial Ecosystem

Manufacturing needs a tourism-specific reboot. Current drones are built for inspection, not immersion. Three fixes: certify eVTOLs for 4–6 passengers with 60-minute endurance and sub-65 dB noise; build modular payloads that swap between filming, performance, and cargo; and mass-produce cheap formation drones for routine shows. "First-unit" insurance and R&D tax breaks would de-risk the bet. Operationally, diversity is key—big players like OCT or CITIC Helicopters bring capital, while nimble locals handle choreography and IP. A platform model, where a central entity owns the fleet and trains the pilots, while scenic spots simply rent the service, slashes entry barriers for smaller destinations. Service-side, the goal is escaping the "ticket-only" trap. Four revenue streams can plug the gap: selling slick 4K flight edits (100–300 RMB a pop, 80%+ margin); licensing aerial shots to filmmakers; spinning off AR postcards and digital collectibles; and launching a "Sichuan Low-Altitude Annual Pass" to lock in repeat visits. Together, these moves would turn a fragile sector into a self-sustaining ecosystem.

### 5.4 Safety Governance

Safety isn't a box-ticking exercise—it's the bedrock of market trust. Start with qualifications: a supplemental "cultural tourism airworthiness label" covering acoustic, emergency-landing, and comfort benchmarks, plus a pilot endorsement that tests not just stick-and-rudder skills but passenger reassurance, first aid, and heritage-sensitive commentary. Layer on a "space-air-ground" surveillance net that fuses radar, spectrum monitoring, and AI vision to enforce geofences, flag suspicious loitering, and auto-redact faces and plates from aerial footage. Finally, institutional backstops: tailor-made insurance covering hull loss, third-party liability, passenger injury, and data breaches; lock in a

30-minute emergency rescue window at key scenic spots; and publish a provincial Low-Altitude Cultural Tourism Service Specification—a single, public rulebook covering everything from operator licensing to environmental safeguards.

## 6. Conclusion

This study set out to trace how the low-altitude economy moves beyond technical validation toward genuine scene empowerment in Sichuan's cultural tourism. Four findings cut through the noise. First, the sector has shifted from asking "can it fly?" to "where can it take us?", spawning four distinct application types, yet it remains stranded between business and true market convergence—the search-to-purchase gap is structurally real. Second, scene innovation hinges on treating drones not as flying cameras but as media that reshape experience itself; spatial reconstruction, cross-sector integration, and tech-enabled immersion are the load-bearing walls of a new tourism paradigm. Third, the bottlenecks—regulatory rigidity, battery limits, safety fears, fragile business models—mutually reinforce one another, meaning piecemeal fixes will only yield diminishing returns. Fourth, the way forward is what we term "four-wheel drive": synchronized pushes on regulation, infrastructure, ecosystem, and safety governance, directly lowering the "complexity" and "compatibility" frictions identified in Rogers' diffusion model. We are upfront about our limits: scarce operational data forced a reliance on qualitative reasoning; our fieldwork clustered in Chengdu and Aba, leaving Sichuan's southwest, northeast, and Panxi regions under-mapped; and we kept an exclusively domestic lens, neglecting the hard-won lessons of Swiss heli-skiing or Grand Canyon flights. None of this, however, dilutes the central claim—that a well-regulated, culturally attuned low-altitude economy marks a genuine new chapter for cultural tourism, and Sichuan, with its jagged peaks and layered heritage, is the natural place to open it.

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