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Jateng Explore (JX): Sustainable Tourism Digital Ecosystem Modelling based on Integrated Data and Payment Innovation

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Abstract

Tourism plays a vital role in Central Java's economy, yet its potential is constrained by fragmented data, uneven digital access, and limited MSME financial inclusion. This study introduces Jateng Explore (JX), a regional-scale digital public infrastructure model for sustainable tourism governance that integrates tourism services, MSMEs, and government coordination within a modular platform.. Developed through a design-based research approach, JX features smart modules including Destination Intelligence, Thematic Tourism Module, Halal & Inclusive Tourism Engine, Smart Booking, and a Digital MSME Marketplace. The platform incorporates AI-driven profiling, ESG gamification, and GIS-based analytics to enable personalized, equitable, and sustainable tourism experiences. The study's originality lies in embedding data interoperability, sustainability-by-design, and financial inclusion within a public-sector-led smart tourism ecosystem, moving beyond fragmented or firm-centric platforms. It also aligns with national platforms like Satu Data Indonesia, positioning JX as a scalable model for smart tourism governance.

Keywords: *Data Integration, Digital, Machine Learning, and Sustainability Tourism*

JEL Classification*: C55, L83, O33, and R11*

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Introduction

The economic growth is conceived as the increase in a nation's capacity to produce goods and services, molded by both internal dynamics and external circumstances. (Bostan et al., 2022; Kotz, Levermann & Wenz, 2022; Wang, 2022; Edwards, 2021; Rahman & Alam, 2021; Surya et al., 2021; Widarni & Bawono, 2021; Spash, 2020). Beyond being a technical measure of output, it is often used as a key indicator of public welfare (Lee, Koch & Alkan-Olsson, 2022; Chugunov, 2021; Collington,

2021; Kurnia et al., 2021; Mazenda & Cheteni, 2021; Walker, Druckman & Jakson, 2021). At the macro level, economic growth relates to the increase in Gross Domestic Product (GDP), while economic growth at the regional level is captured in Gross Regional Domestic Product (GRDP). The GRDP thus provides a reliable gauge of a sector's contribution to regional development, such as the contribution of the tourism sector (Nemes & Tomay, 2025; Astike, 2024; Tanjung et al., 2024; Zhang, 2024; Amoah, 2023; Dwyer, 2022).

The tourism sector in Central Java Province has a considerable involvement to support regional development. The tourism sector's leverage extends through related industries such as manufacturing, accommodation, and food services, while not readily apparent in the GRDP. As of 2024, the tourism sector at a glance has a significant involvement for 14,39% of GRDP and situates it as one of the strategic levers of economic progress. The aggregation is computed by stagnant value assumptions based on the reference value of the Regional Tourism Satellite Balance Sheet (Nesparda) 2022-2023.

Table 1. Tourism Sector Contribution to Central Java GRDP (2022-2024)

No	Business Field	Contribution to GRDP (%), 2024	Tourism Contribution to Business (%), 2022	Tourism Contribution to GRDP (%)
1	Agriculture, Forestry and Fisheries.	13.03	12.45	1.62
2	Mining and Excavation.	2.16	1.99	0.04
3	Processing Industry.	33.84	32.96	11.15
4	Electricity and Gas Supply.	0.09	0.12	0.0001
5	Water Supply, Waste Management, Waste and Recycling	0.06	0.07	0.00004
6	Construction.	11.39	10.35	1.18
7	Transportation and Warehousing.	4.1	4.01	0.16
8	Provision of Accommodation and Meals.	3.56	3.63	0.13
9	Financial and Insurance Services.	1.63	2.64	0.04
10	Government Administration, Defence and Compulsory Social Security.	2.42	2.37	0.06
Total		72.28	70.59	14.39

There are several systemic barriers that prevent tourism from achieving its utmost value (Dias, Viana & Pereira, 2024; Nguyen T, Nguyen N & Thanh, 2024; Rizaldi, Rumanti & Andrawina, 2024). Among the most pressing are fragmented spatial data between destinations, limited interoperability of service systems across districts, and a lack of digital financial integration, particularly among local MSMEs and traditional markets. These challenges undermine the efficacy and accessibility of the tourism sector.

Over the past five years, Central Java's economic performance has experienced a gradual recovery from the pandemic-induced downturn, from a contraction of -2.65% in 2020 to a positive growth rate of 4.95% in 2024 (BPS, 2025). During this period, the number of tourists also increased, with an increase in total visits of 15.67% from 2019 to 2024. However, this growth was uneven; while domestic

tourism grew strongly, the number of international visitors fell by 16.61%, indicating a slow recovery for overseas markets (BPS, 2025). In the same period, the average length of stay, especially in non-star hotels, remained short, signifying a shortage of immersive and engaging tourism experiences.

The other concerning pattern is the unbalanced distribution of tourism. Urban centers remain dominant, while rural areas, many of which have high tourism potential, remain under-visited. Despite an increase in the number of tourism events across the 35 districts and cities, this has not resulted in a proportional increase in the number of visitors. In many areas, the occupancy rate of hotels remains low, signalling a mismatch between tourism promotion efforts and the actual market response.

According to those issues, the research has two problems to be studied, which are (a) What is the overarching condition of the tourism sector in Central Java Province at present? and (b) How is the design of the digital prototype to maximize the tourism sector and its contribution to Central Java's GRDP? This research will design a digital prototype of a more sustainable and inclusive tourism model for Central Java. Reinforcing the sector's digital foundation is expected to improve not only operational efficiency, but also support evidence-based policy making and access to finance for small businesses. Going beyond mere technical tools, the designed digital solution aspires to become a framework for regional collaboration, helping tourism become a truly transformative force in economic development.

This research fills that gap by designing a provincial-scale digital prototype for a more sustainable and inclusive tourism model in Central Java, integrating real-time data, digital services, and financial access mechanisms within a unified ecosystem. Reinforcing the sector’s digital foundation through this prototype is expected to improve not only operational efficiency but also support evidence-based policymaking and access to finance for small businesses. Going beyond mere technical tools, the proposed digital solution represents a novel framework for regional collaboration, positioning tourism as a transformative driver of economic development and providing an original, replicable model for smart tourism governance in developing regions.

Literature Review

The integration of digital technology into the tourism sector has become essential in promoting inclusive, efficient, and sustainable regional development (Zeqiri, Youssef & Zahar, 2025; Archi et al., 2023; Sustacha, Banos-Pino & Valle, 2023). A wide body of literature underscores the role of digital ecosystems in overcoming traditional barriers to tourism growth, namely fragmented information, lack of service interoperability, and exclusion of the micro-enterprises from formal market structures (Petrova et al., 2025; Mou, Hossain & Siddiqui, 2022; Buhalis & Amaranggana, 2015). These challenges are particularly pronounced in emerging economies such as Indonesia, where tourism is both a key contributor to GRDP and a sector vulnerable to infrastructural and governance disparities

Smart Tourism and Data Integration

The concept of Smart Tourism, defined as the application of smart technology to enrich the tourism experience and operational efficiency, has become a notable

model in the digital transformation of the tourism sector (Hien & Trang, 2024; Sigalat-Signes et al, 2020; Gretzel et al, 2015). At its core, smart tourism relies heavily on real-time data collection, cloud-based services, and predictive analytics to support dynamic decision-making among tourists, service providers, and policymakers. This aligns with the architectural design of the Jateng Explore (JX) platform, which employs microservices architecture and Open API integration to unify disparate tourism services under a single, intelligent system.

According to Espinoza-Figueroa (2025), data integration not only facilitates coordination between tourism stakeholders but also enables regions to move beyond reactive policy toward predictive and evidence-based management. This is especially relevant for Central Java Province, where tourism development has been historically fragmented across the 35 regencies and municipalities, each with autonomous service platforms and limited regional synchronization.

Inclusive Tourism and Personalized Profiling

A crucial dimension of sustainable tourism design is inclusivity, not just in terms of accessibility for people with disabilities, but also in relation to religious, cultural, and behavioural diversity (Qiao, Cao & Zhang, 2023; Sisto et al, 2021; Jamal & Camargo, 2013). This concept is in line with one of the directions and policies of Central Java Province regional development for 2025-2029, namely the development of sustainable tourism and the sharia economy as the backbone of economic growth (Bappeda of Central Java Province, 2025). Alharbi et al (2025) emphasise that the integration of user religion preferences into platform algorithms (e.g., halal food, prayer facilities, non-alcoholic packages) enhances service relevance, user trust, and long-term engagement.

The use of machine learning algorithms for profiling, such as classification based on the religion field provided by users, offers an ethical pathway to simultaneously cater to both Muslim and non-Muslim tourists. While Muslim users may receive recommendations for halal-certified experiences and amenities, non-Muslim tourists can be offered other culturally appropriate options. Such profiling must be conducted with adherence to ethical data use principles, ensuring user consent, data privacy, and transparency, as advised by Pardo and Siemens (2014).

This dual-stream profiling ensures that tourism is not only inclusive but also equitable, allowing MSMEs and service providers from diverse cultural backgrounds to participate on a level playing field without excluding any demographic group. It also ensures a targeted and efficient distribution of promotional efforts and service recommendations, in line with the concept of personalised digital tourism (Pencarelli, 2020).

Digital Financial Inclusion for MSMEs

Digital financial infrastructure is a cornerstone of economic empowerment for local tourism actors, particularly MSMEs. In the Indonesian context, many traditional vendors and informal businesses remain unbanked or underbanked, limiting their ability to engage in digital commerce or benefit from tourism flows (Tanchangya et al, 2025). The deployment of Quick Response code (QR)-based payments, Near Field Communication or known as NFC systems, and integrated e-marketplaces such

as those envisioned within the JX Digital Marketplace module directly addresses this gap.

Setyawati, Sudarmiatin, and Wardana (2023) assert that digital financial inclusion enhances not only market access for MSMEs but also supports financial literacy, resilience, and entrepreneurial innovation. Moreover, when embedded into a tourism platform that includes ESG (Environmental, Social and Governance) incentive systems as JX proposes through its ESG Reward Points and Gamification features digital payments become tools for behaviour modification. Tourists are incentivized to support eco-friendly transport, buy local, and engage in waste reduction, linking financial inclusion with sustainable consumption.

System Interoperability and Regional Governance

The challenge of system fragmentation among tourism authorities, especially in decentralized government structures, has been well documented in tourism studies in Indonesia (Miller, 2013). Each district or municipality often develops its own isolated tourism portal or strategy, as seen in the case of Dolan Banyumas, with minimal integration with neighboring destinations or the broader provincial ecosystem. According to Stegemann and Martin (2019), a lack of digital interoperability leads to inefficiencies, duplicated efforts, and lost opportunities for regional synergy.

JX's integrated approach addresses this systemic issue by proposing a provincial-level tourism data infrastructure that bridges local platforms via open standards and APIs. This is consistent with the findings of Rosario and Dias (2024), who advocate for tourism governance frameworks that are collaborative, data-centric, and technologically harmonized. Furthermore, with the rollout of a shared analytics dashboard and layer of interoperable services, the provincial government can keep an eye on performance, allocate resources more fairly, and work together to develop tourism clusters that span multiple administrative areas.

Methodology

This research adopts the Design-Based Research framework (Parmaxi & Zaphiris, 2015), blending applied inquiry and iterative system development to formulate and validate a digital ecosystem for inclusive, sustainable, and data-driven tourism governance in Central Java Province. The methodology synthesizes interdisciplinary perspectives from regional development economics, tourism systems theory, and information architecture, ensuring contextual relevance and technical robustness. The study is structured into three integrated phases: diagnostic, design, and validation to ensure both empirical grounding and functional applicability of the proposed solution: the JX platform.

Diagnostic Phase

The diagnostic phase focuses on understanding the structural, economic, and institutional barriers that limit the transformative potential of tourism in Central Java's Province regional development trajectory. This phase comprises two core components:

Quantitative Economic Analysis

A comprehensive review of secondary datasets was undertaken, drawing from authoritative national and provincial sources such as BPS, NESPARDA, and Central Java's GRDP indicators from 2020 to 2024. The analysis focused on quantifying the contribution of the tourism sector to regional value chains, employment generation, and MSME participation. Specific attention was paid to sub-sectoral trends, including accommodation, culinary services, creative industries, and transportation, to identify underleveraged economic potentials and structural bottlenecks affecting value distribution across urban and rural districts.

Institutional and Service Landscape Mapping

This component draws from policy documents, tourism master plans, development roadmaps, and academic literature to assess digital readiness, infrastructure equity, and policy alignment across Central Java's tourism ecosystem. It identifies service fragmentation, system interoperability gaps, and regulatory barriers impacting MSMEs, local governments, and community tourism actors. Supplementary analysis of tourism board reports and digital dashboards supports institutional profiling and informs user-centric system design.

The objective was to map digital literacy levels, infrastructural gaps, service fragmentation, and user experience pain points, forming the basis for user-centred system architecture.

Design Phase

Guided by diagnostic findings, the design phase focused on the development of a modular and adaptive digital prototype, JX, which embodies principles of human-centred design and microservices system architecture. This architectural approach ensures component-level scalability, system resilience, and seamless integration across services. The platform leverages open API frameworks to enable real-time interoperability with external ecosystems, including transport networks, digital payment systems, and event databases.

Core features include AI-driven user profiling engines that personalize recommendations based on religious, cultural, and accessibility needs, as well as GIS-powered mobility analytics for dynamic crowd modelling and destination planning. The prototype consolidates key functional modules: Destination Intelligence & Visitor Analytics, Halal & Inclusive Tourism Engine, Smart Booking & Packaging, Digital Marketplace for MSMEs, ESG Gamification & Reward Engine, and the Integrated Festival Calendar. Together, these modules support a unified, context-aware tourism experience while aligning with Central Java's sustainability, inclusion, and regional development objectives.

Validation Phase

The validation phase focused on assessing the technical reliability, user interface coherence, and governance relevance of the JX platform. Usability evaluation was conducted internally using heuristic principles and comparative interface benchmarks to assess navigation flow, transaction clarity, and feature responsiveness. System simulation environments were employed to test core algorithmic components,

including dynamic packaging logic, ESG-based scoring mechanisms, and integrated transport routing across varying seasonal travel scenarios. These simulations provided metrics on system latency, predictive robustness, and service orchestration.

Additionally, structured validation was undertaken through scenario-based platform walkthroughs and collaborative assessment workshops with regional tourism authorities, aimed at verifying policy interoperability, integration potential with e-government systems, and alignment with Central Java's Tourism Master Plan (RIPPDA). This phase ensured that the platform meets both technical performance standards and institutional readiness for broader deployment.

Ethical and Inclusivity Consideration

This research adheres to ethical standards in data governance and digital system design as outlined by Indonesia's Data Protection Law. All data used were anonymized, publicly available, or synthetically modelled to avoid collecting personally identifiable information. Inclusivity was embedded in the platform's architecture through features that address religious diversity, accessibility, and digital equity. The system provides culturally sensitive recommendations via AI-based profiling that personalizes content for each category: Muslim, non-Muslim, and international users without bias.

Accessibility tools were designed to support users with disabilities, including voice/haptic navigation and mobility aid bookings. To bridge the rural digital divide, JX offers low-bandwidth interfaces, multilingual support, and onboarding content for MSMEs in underserved areas. Gender and age inclusivity were also considered through ergonomic user experience (UX), font scaling, and accessible navigation. Overall, JX was designed as an open, modular public infrastructure that prioritizes fairness, privacy, and accessibility across Central Java's tourism ecosystem.

Results and Discussion

The development of the JX digital tourism platform has resulted in a robust and modular ecosystem designed and engineered to drive inclusive, sustainable, and data-driven tourism development across Central Java Province. This section details the platform's key modules, their respective functions, social benefits, implementation roadmap, and user journey from registration to experience interaction.

Modular Architecture and Functional Components

JX is built upon a microservices architecture, enabling scalability, flexibility, and continuous integration of new features. Each module operates independently while remaining interoperable via APIs and cloud-based infrastructure.

Built to engage tourism stakeholders, including provincial and district governments, businesses, local communities, and tourism planners. This module gives real-time insights into tourism dynamics, helping you make evidence-based decisions for short-term operations and long-term strategic planning. At its core, this module aggregates and processes multi-source data captured across the digital tourism ecosystem. Key input streams include: Integrated IoT sensors installed at high-traffic destinations to measure footfall, environmental load, and temporal usage patterns; Mobile app telemetry and QR code scans, which trace visitor navigation

paths, dwell time, and content interactions within and across destinations; payment log data from QRIS/NFC systems, offering anonymized transaction-level insights into tourist spending behavior, vendor engagement, and service popularity; then crowdsourced surveys and participatory feedback mechanisms, allowing qualitative insights into user satisfaction, pain points, and suggestions.

This multiple approach ensures the level of detail, accuracy, and representativeness of the data collected, thus yielding a vivid picture with both quantitative and qualitative indicators. Using real-time data pipelines and historical pattern recognition, the module enables predictive tourism planning, such as peak season and holiday forecasting, assisting governments in scaling infrastructure, staff deployment, and emergency readiness; visitor segmentation and profiling, identifying clusters of user types based on age, origin, travel purpose, spending level, and digital engagement; then dynamic crowd redistribution tools, which suggest alternate attractions or time slots to tourists during congestion spikes, improving overall visitor experience and environmental resilience.

The predictive capabilities of the module are especially critical in managing carrying capacity, supporting climate adaptation strategies, and ensuring cultural site preservation in sensitive areas. Insights derived from the analytics layer directly inform equitable policy formulation, particularly in the following areas: Targeted destination development: By identifying underserved yet high-potential regions (e.g., low-traffic coastal villages or indigenous highland settlements), the government can channel investment and promotional resources more equitably. MSME performance mapping: Data on small vendor activity, transaction trends, and customer demographics help match support programs, such as capacity building, microfinance, or digital onboarding, to the most relevant recipients. Cross-district tourism collaboration: Mobility data reveals inter-regional travel patterns, encouraging multi-jurisdictional bundling of experiences and revenue-sharing models.

This contributes to a more balanced regional tourism economy, reducing dependency on overvisited destinations and stimulating grassroots economic growth. To ensure interoperability, scalability, and transparency, the development of this module adheres to international open-data standards and is natively integrated with Local Geographic Information Systems (GIS), aligning visitor analytics with spatial planning, zoning policies, and environmental sensitivity mapping. Google Mobility Data and third-party datasets, which enrich the platform’s predictive intelligence with broader contextual variables such as weather, public health alerts, and regional movement trends.

Open API usage and modular architecture ensure that external developers, academicians, and policy analysts can access anonymized datasets for secondary studies, policy simulations, and innovation use cases, thereby strengthening a data-democratized tourism ecosystem. In alignment with Indonesia’s sociocultural diversity and the principles of inclusive digital transformation, the Halal and Inclusive Tourism Engine within the JX platform is developed to address the heterogeneous needs of domestic and international tourists through intelligent, culturally-sensitive personalization. This module utilizes AI-based profiling mechanisms to curate tourism content, services, and recommendations according to users' stated attributes, such as religious affiliation, cultural background, language preferences, and accessibility requirements.

Central to this module is the adoption of an opt-in, self-declared user profiling system. Upon account creation or itinerary planning, users are invited to disclose preferences related to religion, dietary habits, language, and mobility support needs. The system does not mandate such disclosures, thereby preserving user autonomy and privacy, but uses declared data to activate specific content pathways powered by adaptive algorithms. This ensures ethical data handling aligned with digital rights and religious freedom frameworks, avoiding any form of exclusion, surveillance, or stereotyping.

For Muslim users who opt to declare their religious identity, the engine activates a halal-focused experience path. This includes: Halal-certified culinary options, verified through integration with BPJPH (Halal Product Assurance Organizing Agency) databases. Prayer-friendly accommodations that provide amenities such as qibla direction, prayer mats, and proximity to mosques. Islamic heritage destinations, such as *pesantren*-based ecotourism sites or historic mosques, with educational narratives available in multiple languages. In addition, real-time prayer time alerts, Ramadan-friendly itineraries, and Islamic event calendars are embedded into the user journey, ensuring spiritual alignment without intruding on broader system functions.

The engine concurrently ensures that non-Muslim users, or those who choose not to disclose religious identity, are guided toward equally rich and culturally immersive options. These include: Intercultural experience packages that highlight pluralistic narratives in Central Java, such as Chinese-Indonesian heritage walks or Dutch colonial trails. Culinary discovery routes featuring local delicacies beyond halal criteria, thereby supporting a broader set of MSMEs and food entrepreneurs. Non-religious wellness and spiritual tourism options, such as yoga retreats, nature-based meditation circuits, and Balinese-Hindu inspired spa services. This dual-path model, powered by AI-driven service bifurcation, ensures that inclusivity is achieved through equitable content access rather than homogenized offerings, mitigating the risk of cultural bias or religious exclusivity in the digital interface.

The module is equipped with multilingual content translation capabilities to address the linguistic diversity of both domestic and international visitors, supporting Indonesian, English, Arabic, Mandarin, and Japanese in the current roadmap. AI-powered Natural Language Processing (NLP) ensures semantic accuracy and cultural relevance in translations, especially in sensitive areas such as food, religion, and rituals. In addition, the system includes culturally adapted user interface and experience (UI/UX) elements, such as iconography, images, and color schemes, tailored based on user profiles and regional origins, enhancing intuitive usability and emotional resonance.

The Halal and Inclusive Tourism Engine is embedded within JX's broader Digital Inclusion Strategy, ensuring that users with disabilities are not marginalized from the digital tourism experience. Current and planned features include: Voice and haptic navigation for visually impaired users, Screen reader compatibility and ARIA-labelled UI components for web accessibility, Smart Assistance Booking, enabling pre-arrival requests for wheelchairs, personal guides, or ASL (American Sign Language)/ISL (Indonesian Sign Language) interpreters at tourism sites, and then cognitive simplicity design principles that streamline navigation for neurodivergent users and senior tourists.

These features are developed in consultation with disabled persons' organizations (DPOs), ensuring global compliance and local relevance. From a market development perspective, this module plays a transformative role in unlocking niche tourism segments such as halal lifestyle tourism, accessible travel, and cultural heritage immersion. It also expands the market for tourism MSMEs by connecting certified and non-certified providers to the appropriate consumer groups via intelligent package routing and demand-driven service curation. This creates a multi-tiered market interface that respects user identity while democratizing economic participation across provider types.

To accommodate the diverse interests of travelers and to promote a more balanced distribution of tourism benefits across Central Java, JX adopts a modular design approach through curated thematic tourism clusters. These modules are not merely content categories; they function as immersive entry points into Central Java's multifaceted tourism landscape, each powered by dynamic data, cultural intelligence, and spatial mapping.

JX Heritage module highlights Central Java's rich cultural legacy, connecting users with historical landmarks, royal palaces, temples (such as Borobudur and Gedung Songo), colonial heritage trails, and living traditions such as batik-making, wayang performances, and gamelan music. It includes story-driven itineraries, guided AR experiences, and festival calendars to help users engage deeply with local cultural narratives. JX Adventure is designed for nature and thrill seekers. This module showcases eco-adventure activities such as mountain hiking (e.g., Mount Merbabu, Mount Slamet), caving, river rafting, and forest trekking. Users can access real-time trail conditions, elevation maps, safety alerts, and sustainable tourism ratings for outdoor operators, encouraging environmentally responsible exploration.

JX Coastal focuses on marine and coastal destinations; this module curates beach getaways, island hopping routes (e.g., Karimunjawa), traditional fishing villages, and coastal conservation zones. It integrates tide charts, snorkeling and diving site directories, and coastal accommodation filters (including eco-lodges and homestays) for a seamless maritime tourism experience.

JX Culinary is a gateway to Central Java's gastronomic richness. JX Culinary presents curated food trails, street food hotspots, regional specialties (e.g., Lumpia, Garang Asem, and Grombyang Rice), halal certifications, and MSME food vendor listings. It allows users to explore culinary offerings by taste profile, dietary needs, or festival relevance, while also linking directly to ordering, booking, or workshop registration features for experiential engagement. JX Wellness module promotes holistic travel experiences with a focus on wellbeing, spiritual retreats, and eco-therapy. It includes listings for yoga retreats, herbal spas, rural wellness resorts, and spiritual tourism destinations such as pesantren tours or meditation sites. It also supports wellness-conscious travelers through accessibility filters and personalized itinerary suggestions.

Together, these thematic modules allow travelers to navigate and tailor their journeys in an intuitive, interest-driven manner. At the same time, they serve as strategic tools for regional development by drawing attention to lesser-known destinations, supporting micro and community-based tourism actors, and distributing visitor flows more evenly across the province. By combining cultural nuance, technological flexibility, and experience personalization, the modular system ensures that JX remains both user-friendly and developmentally impactful.

The Smart Booking and Dynamic Packaging System in the JX platform is designed to simplify and personalize the end-to-end travel planning experience through the integration of artificial intelligence, real-time data analytics, and multi-source aggregation. This module consolidates essential travel components: transportation, accommodation, activities, and event access into a unified digital interface, enabling users to seamlessly design and modify their itineraries based on intelligent recommendations and contextual factors.

At the core of this system is a centralized booking engine that aggregates services across different providers into a single point of interaction. Through this mechanism, users can browse, compare, and book multi-modal transport (e.g., airport rail links, Trans Jateng, Hop-on-Hop-off buses), local lodging, curated tourism experiences, and event tickets without switching platforms. The system is designed with a progressive disclosure interface, revealing booking options dynamically based on selected interests and budget constraints, thus reducing cognitive load and decision fatigue for the user.

Leveraging machine learning and predictive analytics, the system provides real-time dynamic packaging—a capability that configures optimal travel bundles by factoring in variables such as User Profile Data: Preferences drawn from declared interests, travel history, budget range, and demographic segments. Weather Forecasts: Integration with meteorological APIs enables the system to propose itinerary adjustments, such as indoor alternatives during rain forecasts or beach outings on sunny days. Crowd Density Analytics: Using historical and real-time mobility data, the system suggests off-peak destinations or events, thereby enhancing user comfort while reducing tourism pressure on high-density sites. ESG Preferences: Users can set their ESG priorities, such as eco-friendly transport, local business support, or low-emission activities, which the algorithm uses to rank and recommend package components accordingly. This adaptive packaging logic enables a personalised, responsible, and context-aware travel experience, while simultaneously promoting decentralised tourism development by distributing demand toward lesser-visited locations.

Another salient feature of the module is its price sensitivity engine, which uses predictive modelling to forecast fluctuations in accommodation and ticket prices based on seasonal trends, local events, and booking windows. The system automatically alerts users when prices are expected to rise or fall and can propose budget-optimised reconfigurations that maintain the experience quality while aligning with financial preferences. Furthermore, users can activate a "Smart Budget Lock," a constraint-based planning mode that auto-generates the best possible package within a predefined spending cap, factoring in transport cost, lodging quality, and experience diversity.

The module employs a continuous learning loop based on user interactions, feedback, and completion rates. Over time, it builds an intelligent behavioral profile for returning users, enabling more accurate future recommendations. This learning mechanism also informs system-wide improvements, such as identifying underutilized assets or emerging trends in user demand, which are fed into the strategic dashboards used by regional tourism planners.

To enhance platform scalability and interoperability, the system roadmap includes planned API integrations with major global booking platforms such as Agoda, and Traveloka. These integrations will facilitate inbound tourism by allowing

international users to access and synchronize their bookings with the JX ecosystem, while also enabling local MSMEs to be visible on global search and booking engines through back-end data harmonization. This interoperability ensures that JX can operate both as a destination platform and a transactional node within the broader digital travel ecosystem, creating value for stakeholders across the tourism value chain

This module helps MSMEs in tourism, like food vendors, artisans, local guides, traditional homestay managers, and village co-ops, get direct access to markets through a digital trading environment that's integrated, safe, easy to use, and performance-oriented.

At the foundation of the marketplace is the implementation of cashless payment technologies, most notably the QRIS and NFC systems. These tools enable MSMEs to accept a variety of payment methods from both domestic and international tourists, including e-wallets, digital banking apps, and contactless cards. This leap in payment infrastructure addresses a critical gap in rural financial inclusion while also enhancing transaction security and user trust. In addition, the use of digital receipts and automated inventory records ensures financial transparency, which can support access to credit, insurance, and other financial services in the future.

To ensure credibility, the module includes a structured vendor registration and verification workflow. This process is designed with inclusivity in mind, supporting users with low digital literacy through a simplified mobile onboarding experience. Local verification is facilitated through partnerships with BUMDes and regional economic development offices, enabling community-level vetting and support.

Upon registration, each MSME is equipped with a digital profile page that showcases their products, services, price lists, availability, customer ratings, and sustainability certifications (e.g., halal-certified, eco-friendly, fair trade, etc.). This ensures that users can make informed decisions while empowering MSMEs to build digital reputations that translate into brand equity.

The module integrates a real-time analytics dashboard for vendors, offering insights into sales performance, popular products, seasonal trends, and customer feedback. These analytics enable data-driven decision-making among MSMEs, encouraging product refinement and service quality improvement. Furthermore, JX is working with regional banks, financial cooperatives, and fintech platforms to provide training modules and microfinance access tailored to the needs of participating MSMEs. Training programs cover topics such as digital marketing, inventory management, financial literacy, and ESG compliance, and are delivered through a mixed approach combining in-app tutorials, offline workshops, and community mentoring. This integrated approach transforms the marketplace from a mere sales channel into a comprehensive capacity-building platform, fostering long-term resilience and innovation among local businesses.

The JX Digital Marketplace is more than a transactional feature; it is a strategic enabler of inclusive economic development. By connecting digitally underserved entrepreneurs with the growing market of digitally native travelers, it catalyzes bottom-up tourism growth in rural and peri-urban areas. The visibility provided by the marketplace also supports cultural preservation, as many featured vendors offer traditional crafts, heritage-based culinary products, and locally rooted experiences that are otherwise excluded from conventional tour packages.

Additionally, the marketplace serves as a feeder system into the broader JX ecosystem. Products and vendors listed on the marketplace are integrated into dynamic tourism packages, ESG reward campaigns, and event-linked promotions, enhancing cross-modular synergy and increasing exposure for small businesses.

The ESG Gamification & Reward Engine embedded within the JX platform is an innovative behavioral design module aimed at promoting environmental sustainability, social inclusivity, and governance participation through experiential incentives and digitally mediated behavior change. Drawing from principles of nudge theory (Cai, 2020; Kosters & Van der Heijden, 2015) and gamification mechanics (Pasca et al, 2021), the module is designed to subtly influence tourist choices toward more sustainable, community-conscious, and culturally respectful practices without limiting freedom of choice.

At its core, the module operationalizes a real-time reward system that allocates ESG Points to users who engage in predefined positive behaviors during their travel journeys. These behaviors include, but are not limited to: utilizing green or public transportation options (e.g., Trans Jateng, airport rail link, bike-sharing), engaging in low-waste practices, such as refilling water bottles or participating in the Smart Waste Deposit Program, supporting verified MSMEs on the JX Digital Marketplace, participating in cultural heritage tours, local festivals, or eco-volunteering programs, completing sustainability-related educational quests, such as AR-based site learning or digital storytelling. These activities are tracked either through in-app confirmations, IoT sensor inputs, or partner merchant integrations, allowing for precise validation of ESG-aligned actions.

The platform employs a multi-layered gamification strategy, integrating: Points: Earned for each qualifying action, Badges: Thematic icons that reflect behavioral milestones (e.g., “Plastic-Free Pioneer”, “Heritage Hero”), Leaderboards: Rankings among peers to foster friendly competition and community participation, Levels: Progress tiers that unlock access to additional features, such as advanced travel planning tools or exclusive community forums. Each of these elements contributes to sustained user engagement by tapping into intrinsic motivators such as curiosity, achievement, social recognition, and belonging.

ESG Points accumulated through the system are redeemable within the JX ecosystem, creating tangible value for sustainable behavior. Redemption options include: Digital vouchers for MSMEs (e.g., culinary discounts, free artisan products), Exclusive access to cultural events or off-the-map experiences, Transport upgrades (e.g., priority boarding for green mobility services), and Sustainability merchandise, including reusable travel kits and community-sourced crafts.

By linking gamification rewards directly to local supply chains, the system reinforces regional circular economies and provides participating MSMEs with increased visibility and footfall. Moreover, by making ESG-positive behavior economically beneficial for the traveler, the platform reduces reliance on regulation and increases voluntary adoption of sustainable practices.

Beyond its immediate engagement objectives, the ESG Gamification & Reward Engine is envisioned as a soft regulatory tool—a means by which tourism stakeholders can guide aggregate behavior patterns toward desirable societal outcomes. By incorporating behavioral economics into digital tourism design, this module supports public policy objectives such as reducing carbon footprint in tourism-heavy corridors, improving waste management compliance, promoting local

economic multiplier effects, and shaping ethical consumption patterns among tourists. The gamified model also offers an analytics backend, through which policymakers can evaluate behavior trends, test policy incentives, and develop adaptive tourism governance frameworks. In this way, the engine supports evidence-based tourism management while maintaining user-centricity and voluntary participation.

The Integrated Events & Festival Calendar within the JX platform functions as a strategic coordination and planning module designed to streamline provincial tourism event management, enhance destination marketing efficiency, and optimize visitor flow across Central Java. By consolidating the promotion ecosystem, this module reduces fragmentation among local government stakeholders and facilitates data-driven decision-making for tourism stakeholders at various levels of government.

At the heart of this module lies a real-time, dynamic calendar dashboard that aggregates cultural festivals, art exhibitions, culinary fairs, religious commemorations, and adventure-based gatherings from across all 35 regencies and cities in Central Java. This aggregation is facilitated through a structured event submission system, which allows local organizers (e.g., tourism offices, village cooperatives, cultural groups) to register events through a standardized form that includes metadata such as event type, expected attendance, thematic focus, ticketing details, and ESG relevance. A verification and moderation workflow, where events are reviewed by provincial tourism authorities before being published to the calendar interface.

This structured approach ensures uniformity in content quality and branding coherence across the region, enabling cohesive destination storytelling. One of the key value propositions of this module is the automated scheduling conflict detection system, underpinned by rule-based logic and spatial-temporal analytics. By visualizing potential clashes and synergies, the platform fosters collaborative scheduling and complementary programming, reducing resource duplication and improving return on investment (ROI)on tourism spending. The Events Calendar module also includes an embedded analytics dashboard that generates insights into search and interest trends, based on user interaction with event pages; temporal demand cycles, highlighting high and low seasons for various event types; geographic heatmaps, showing regional concentration of tourist engagement, until demographic preferences, identifying which types of users are attracted to which kinds of events (e.g., religious pilgrims, music tourists, culinary explorers).

These insights are made available to both public and private stakeholders, enabling data-driven marketing strategies, targeted promotions, and adaptive event design. Over time, these analytics will feed into provincial tourism planning documents and investment roadmaps. The long-term roadmap for this module includes a set of technologically enhanced features that align with global trends in smart tourism infrastructure: Crowd control modelling: Using historical attendance, booking data, and mobility inputs from the JX Mobility Hub to simulate and forecast congestion risks at major events; AI-based demand forecasting: Leveraging machine learning to predict attendance figures and logistical requirements based on real-time variables (e.g., weather, transport availability, social media sentiment) until Virtual/hybrid festival integration: Enabling local events to reach a wider audience through livestreaming, virtual booths, and interactive AR/VR experiences, thus

ensuring inclusivity for users unable to attend physically. These capabilities will significantly improve the resilience, accessibility, and sustainability of event-based tourism, particularly in the context of climate volatility, pandemic contingencies, and infrastructure limitations in rural destinations.

Development Path and Scalability Strategy

The development trajectory of Jateng Explore (JX) is conceptualized around an agile, human-centered innovation framework, designed to enable iterative prototyping, continuous feedback incorporation, and alignment with the diverse needs of Central Java's tourism ecosystem. Drawing on design thinking and DevOps principles, the JX roadmap aims to remain adaptive to emerging insights, infrastructural limitations, and socio-cultural complexities within the region.

To date, the project has focused on early-stage system design and contextual scoping through co-creation workshops with key stakeholder groups—such as local tourism offices, MSMEs, religious and cultural institutions, environmental organizations, and accessibility advocates. These activities informed the conceptual architecture of JX and helped identify the core service components most relevant to Central Java's urban-rural tourism dynamics.

Currently, JX is in an advanced conceptual and prototype planning phase. Select core modules—including Destination Intelligence, Smart Booking, Halal & Inclusive Tourism Engine, and the Digital MSME Marketplace are undergoing initial simulations and internal testing. Plans for pilot testing in selected regencies (e.g., Banyumas, Magelang, Semarang) are being formulated to reflect a diversity of tourism typologies, though full operational deployment has not yet occurred.

To support future scalability and robustness, the development strategy outlines several forward-looking technical and operational priorities. Migration toward a cloud-native microservices structure is planned to enable flexible scaling, modular development, and high system uptime in varied geographic and traffic conditions. This aligns with Indonesia's digital infrastructure goals under the Ministry of Communication and Digital's cloud-first policy.

Future iterations will explore the integration of AI-powered recommendation systems, visitor flow prediction models, and ESG-based behavioral analytics, based on secure, anonymized user interactions to improve relevance, efficiency, and sustainability. An open API framework is being conceptualized to enable seamless integration with third-party services such as transport providers, booking platforms, digital wallets, and public service apps, laying the groundwork for a tourism-as-a-service (TaaS) model across Java.

A privacy-centric identity layer using self-sovereign identity technologies is being explored to enable personalized experiences without compromising data autonomy. This feature will allow users to selectively disclose preferences while retaining full control over their personal information. JX is envisioned as an interoperable node within Indonesia's broader digital transformation agenda, with planned alignment to Satu Data Indonesia, Wonderful Indonesia, and provincial data lakes. This would position JX as both a regional innovation and a federated component of the national tourism infrastructure.

This roadmap underscores a strategic transition from siloed tourism platforms to an integrated, cross-sector digital ecosystem. While JX remains in its conceptual

and prototype phases, its design anticipates future readiness for institutional scaling, policy integration, and technical deployment—positioning it as a model for inclusive and intelligent tourism governance in other Indonesian provinces.

User Onboarding Journey

The effectiveness and scalability of the JX platform are heavily reliant on a seamless, intuitive onboarding process that accommodates a wide range of users across varying levels of digital fluency, socio-economic background, and stakeholder roles. The onboarding strategy is meticulously structured to facilitate three primary user personas: Tourists/Travelers, Local Vendors/MSMEs, and Government/Tourism Authorities; each with their unique interaction pathways, digital needs, and functional access.

Tourist/Traveler Onboarding Pathway

Recognizing the diversity of Central Java's inbound and domestic tourist profiles—ranging from Gen-Z digital natives to intergenerational family travelers—the traveler onboarding process follows a mobile-first design ethos that prioritizes usability, contextual relevance, and personalization. Key elements include:

(i) Multi-channel registration: Users may create an account via mobile application or responsive web portal, utilizing flexible credential options including email, mobile number, or federated logins through Google, Apple ID, or social media (e.g., Facebook, Instagram).
(ii) Preference-based profiling (optional): Upon first login, users are offered the opportunity to input personal preferences such as religious affiliation, dietary restrictions, budget range, travel purpose, and accessibility needs. This data is handled in strict accordance with data privacy standards and is used exclusively to enrich personalized content delivery.
(iii) Conversational onboarding via AI chatbot: A built-in natural language chatbot serves as the user's first point of interaction, walking them through key platform features including smart itinerary generation, transportation and accommodation options, event calendar access, and reward point tracking.
(iv) Geo-contextual recommendations: Based on GPS location (subject to permission), users immediately receive nearby attractions, MSMEs, and eco-friendly mobility options, enhancing immediate engagement and relevance.

This approach fosters rapid user activation, minimizes cognitive friction, and lays the groundwork for personalized, sustainable travel behavior.

Local Vendor/MSME Onboarding Pathway

For the JX platform to serve as a meaningful enabler of grassroots economic development, MSME inclusion, particularly among low-digital-literacy groups is paramount. Accordingly, the onboarding flow for vendors, artisans, homestay providers, culinary operators, and guides emphasizes accessibility, legitimacy, and economic empowerment. MSMEs are offered multimedia orientation materials, including short video tutorials, step-by-step guides, and voice-note explainers delivered via WhatsApp and Telegram to bridge digital skill gaps in rural or remote areas.

Business onboarding integrates with national ID systems (e-KTP), the OSS-RBA platform (Online Single Submission Risk-Based Approach), and optional halal certification databases (BPJPH), ensuring legitimacy while reducing bureaucratic overhead. Upon verification, vendors gain access to a product and service listing portal, where they can manage pricing, inventory availability, images, service descriptions, and multilingual tags. A dashboard analytics interface provides insights into customer engagement, transaction trends, and ESG badge performance. Ongoing training modules, delivered in collaboration with banks, BUMDes, and tourism polytechnics, enable microentrepreneurs to access microfinancing, branding support, and service quality certification, gradually raising their competitiveness in the digital tourism economy.

This onboarding channel aligns with JX's inclusivity mission, ensuring digitally underserved MSMEs are not only present on the platform but actively engaged and empowered.

Government and Tourism Authority Onboarding

To enable coordinated and data-driven tourism governance, Jateng Explore (JX) includes a structured onboarding process for tourism authorities at the provincial, regency, and city levels. The process begins with the Central Java Provincial Tourism Office and expands to all 35 regencies and cities, ensuring each local government can manage its own tourism data while the province maintains real-time oversight across the entire region. This model fosters consistency, reduces fragmentation, and enhances evidence-based planning and decision-making.

The Central Java Provincial Tourism Office initiates the onboarding process and serves as the system super-admin, assigning institutional roles and access protocols. Tourism offices at the regency and city levels are onboarded in stages, with access tailored to their jurisdictional responsibilities, such as managing attractions, events, and MSME data. Government users log in through a secure admin portal, with hierarchical credentials based on their institutional roles (e.g., provincial office, city tourism unit, village tourism coordinators). Local authorities can input, edit, and verify tourism-related data, including destinations, cultural events, business registries, and ESG indicators, using validated forms to ensure data quality and consistency.

A central analytics dashboard aggregates data from all participating regencies and cities, allowing the provincial government to monitor tourism flows, infrastructure demand, economic impact, and sustainability metrics across the region. The platform includes automated tools to support policy alignment, regulatory reporting, and tourism grant application tracking at both local and provincial levels. Through this onboarding system, JX enables local governments to actively manage and contribute to digital tourism initiatives, while empowering the provincial government to coordinate, support, and monitor tourism development seamlessly across Central Java's 35 regencies and cities.

Design Philosophy: Accessibility, Mobility, and Equity

The overall onboarding framework adheres to mobile-first UX/UI principles, optimized for low-bandwidth environments and device interoperability (Android Go, KaiOS, and basic web browsers). Furthermore, it incorporates accessibility features

such as screen reader compatibility, scalable font sizes, haptic feedback options, and voice-navigation toggles, enabling equitable participation regardless of ability or digital fluency. By centering onboarding around empathy, inclusion, and contextual adaptability, JX lays a robust foundation for sustained user engagement, network growth, and cross-sectoral platform legitimacy.

The success of a digital tourism ecosystem like JX is inextricably linked to its capacity to deliver an intuitive, accessible, and culturally resonant UX. To this end, the JX interface has been designed around a context-aware UX framework that adapts dynamically to a user's location, behaviors, and personal preferences, ensuring that functionality, aesthetics, and inclusivity coalesce to support diverse user journeys.

Context-Aware and Adaptive User Interface

The core of JX's UX approach lies in its real-time contextual adaptation, enabling the platform to provide situationally relevant content and functions. This adaptability is operationalized through the following components. The home screen of the JX platform displays personalized recommendations that are algorithmically curated based on a combination of factors, including geolocation, time of day, cultural calendar events, past behavior, and user-declared preferences (e.g., halal needs, accessibility requirements, budget range). For instance, a user near Semarang during Eid holidays may receive suggestions related to halal culinary spots, heritage mosque tours, and celebratory events.

The system provides real-time notifications on contextual variables such as weather conditions, crowd density at attractions, transport disruptions, and health protocols (e.g., mask requirements or vaccination checks during certain festivals). These notifications are designed to enhance safety, convenience, and travel efficiency. Recognizing the varying quality of mobile data networks across rural and coastal regions of Central Java, JX incorporates an offline access mode that allows users to retrieve saved itineraries, QR-coded tickets, and map navigation tools without an active internet connection. This feature significantly improves reliability in mobility-critical use cases.

The integration of natural language voice interaction, enabling users, especially the elderly or visually impaired, to navigate the platform, request information, and manage bookings through spoken commands in Bahasa Indonesia and regional dialects (e.g., Javanese). This is planned to be powered by an on-device AI assistant to support offline capability. In designing for cultural coherence and regional pride, the JX visual interface draws inspiration from Javanese artistic heritage, integrating stylistic elements such as:

(i) Motif usage
Traditional batik patterns (e.g., Parang, Kawung) and keraton architectural lines are subtly embedded into backgrounds, frames, and iconography to reflect a sense of place without overwhelming modern functionality.

(ii) Typography and icon design
Custom typefaces and vector icons are optimized for clarity and legibility, employing a minimalist design system with high contrast ratios, clear spacing, and responsive scaling for various screen sizes (including older low-resolution devices).

(iii) Color palette

A carefully curated palette inspired by natural and cultural elements, such as terracotta, indigo, rice paddy green, and temple stone grey, evokes both aesthetic warmth and regional identity.

This cultural-technical hybridity ensures that the interface resonates emotionally with local users while maintaining international usability standards.

Ethical, Inclusive, and Sustainable Interaction Design

Beyond technical efficiency, JX's UX strategy embeds ethical principles into the interaction design. User preferences related to religion, dietary restrictions, or accessibility needs are processed anonymously and stored locally where feasible, ensuring compliance with data minimization and user agency principles. The system avoids religious or cultural presumptions by presenting parallel travel options (e.g., halal and non-halal culinary trails) and allowing users to refine content based on their own values, rather than imposed defaults.

The UI periodically nudges users to explore eco-friendly options, such as public transport or waste exchange points, with ESG badges and micro-reward visualizations tied to gamified incentives. This holistic UX approach transforms the JX platform from a transactional tool into a values-driven digital companion, optimizing both the user journey and the collective tourism experience in Central Java.

Conclusion

The transformation of Central Java's tourism sector through the JX platform marks a strategic leap toward achieving smart, inclusive, and sustainable tourism governance. Anchored in Indonesia's broader digital transformation agenda, particularly the acceleration of Digital Public Infrastructure (DPI) and the national vision of Golden Indonesia 2045, the development of JX responds directly to the multifaceted challenges confronting regional tourism, ranging from digital fragmentation and stakeholder silos to limited data-driven policymaking and the lack of inclusivity in tourist experiences.

Through modular architecture, JX enables an integrated ecosystem where diverse components, such as destination intelligence, thematic tourism module, halal and inclusive tourism personalization, smart itinerary planning, MSME digital marketplaces, ESG-based gamification, and province-wide event synchronization can operate both independently and collaboratively. Each module is designed not merely as a technical solution but as a policy instrument to address key developmental goals: improving visitor satisfaction, enhancing local economic participation, ensuring religious and cultural harmony, and promoting environmentally responsible tourism behaviors.

The platform's development approach, rooted in agile and participatory design, ensures that the system is adaptable, locally contextualized, and responsive to the dynamic needs of users, ranging from travelers and MSMEs to government authorities. By combining advanced technologies such as AI-driven personalization, real-time analytics, and mobile-first user interfaces, with grassroots capacity building

and user-centric onboarding processes, JX positions itself as a digitally inclusive enabler for all tourism actors.

Moreover, the user journey and experience design of JX reflects a deliberate commitment to accessibility, personalization, and cultural relevance. The platform provides seamless onboarding for tourists of varied backgrounds, empowers MSMEs through digital financial tools and visibility, and equips local governments with actionable intelligence for policy formulation and destination management.

Critically, JX serves as a prototype for public sector-led platform innovation, demonstrating how government institutions, when empowered by agile digital ecosystems, can catalyze not only economic recovery but also long-term social equity and ecological stewardship. The integration of ESG metrics and behavioral gamification signifies a forward-looking stance, where tourism is not only managed as an economic sector but governed as a system of values and sustainable practices.

Looking ahead, the potential for scaling JX is substantial, both horizontally across other provinces and vertically into national digital tourism infrastructures. Continued investment in cloud-native capabilities, interoperable APIs, and stakeholder-driven innovation will be essential to ensuring system resilience, cybersecurity, and long-term adaptability.

In summary, Jateng Explore represents a flagship model for regional digital innovation, bridging policy, technology, and cultural insight to realize a tourism sector that is smart, inclusive, sustainable, and equitable. It not only redefines the digital experience of exploring Central Java but also establishes a replicable framework for tourism governance across the Indonesian archipelago and beyond.

Policy Recommendations

The development and early-stage deployment of Jateng Explore (JX) mark a pivotal milestone in Central Java's digital tourism transformation. To ensure long-term sustainability and scale its impact, several strategic policy directions are recommended. First, JX should be institutionalized as part of the province's DPI, formalized through gubernatorial or regional regulations to provide legal legitimacy, define stakeholder roles, and ensure consistent funding and cross-sectoral integration. Second, a multi-stakeholder governance model should be established to maintain inclusivity and participatory oversight, involving local government agencies, tourism associations, MSME cooperatives, academia, and civil society organizations.

Third, JX must be embedded into Central Java's official development instruments such as the Medium-Term Regional Development Plan (RPJMD) and the Provincial Tourism Master Plan (RIPPDA), enabling data-driven policy implementation across planning and budgeting cycles. Fourth, technical interoperability with national platforms such as Satu Data Indonesia, Satu Peta, BRIN's Data Hub, and the Ministry of Tourism's National Tourism Dashboard should be pursued through standardized APIs and secure data exchange protocols. Fifth, to drive equitable adoption, a Digital Inclusion Acceleration Scheme should be launched to empower rural MSMEs through training, onboarding to QRIS/NFC payments, content creation support, and fiscal incentives such as grants or soft loans.

Sixth, the platform's ESG-related modules, such as gamified transport rewards, local product incentives, and waste tracking, require policy alignment to enable circular economy practices in tourism. Local governments should collaborate with

private actors to operationalize ESG points as redeemable credits beyond tourism, expanding their societal value. Seventh, universal accessibility standards must be mandated across public and private tourism infrastructure to align with JX's inclusive features like voice navigation and smart assistance for disabled users. Eighth, ethical safeguards must be established for the platform's religious profiling engine, ensuring data transparency, opt-in mechanisms, and algorithmic fairness to prevent cultural or religious bias.

Ninth, a hybrid financing model combining provincial budgets, national innovation grants, and private sector investment should be adopted to secure JX's long-term viability, potentially through the creation of a dedicated Digital Tourism Development Fund. Finally, Central Java should position JX as a national pilot for Indonesia's Smart Tourism agenda, advocating for policy alignment at the national level and leveraging the platform as a scalable model for other provinces to replicate, thus contributing to the broader digital transformation of Indonesia's tourism ecosystem.

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