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AI-Integrated Public Digital Infrastructure for Geopark Tourism: Empowering MSMEs through Smart Mobility and Data-Driven Governance

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Abstract−This study develops an integrated digital platform architecture as a systemic response to two structural challenges in the Kebumen Geopark: the economic exclusion of Micro, Small, and Medium Enterprises (MSMEs) from the digital tourism value chain, and the fragmentation of mobility services that reduce operational efficiency and visitor experience. Using a conceptual design methodology grounded in Critical Interpretive Synthesis (CIS), Comparative Policy Analysis (CPA), and contextual needs mapping, the study identifies three critical interdependencies between MSME empowerment, smart mobility, and parking management. These interdependencies form the basis of a validated integration architecture that, based on simulation and expert review, reduces average visitor wait times by 18% and increases MSME digital participation by 27%. The platform integrates modular components for MSME visibility, mobility optimization, and participatory governance through data-driven decision support. Validity was established through expert interviews (N=15) involving digital tourism practitioners, policymakers, and system designers, complemented by comparative analysis with five leading global smart tourism models (Jeju, Smart Santander, Magelang, Banyuwangi, and Yogyakarta). Theoretically, this research advances the Smart Tourism Ecosystem framework by embedding civic-oriented governance and data sovereignty into the system design. Practically, it delivers a replicable Public Digital Infrastructure (PDI) blueprint for inclusive and sustainable tourism governance in geoparks and similar non-urban destinations.

Keywords: MSME Digitalization; Mobility Management; Parking Optimization

1. INTRODUCTION

Sustainable tourism has become a crucial global agenda for balancing economic growth with environmental and cultural preservation. Within this framework, UNESCO Global Geoparks (UGGp) are recognized as a leading model for regional development, carrying a tripartite mandate: conservation of geological heritage, public education, and sustainable economic empowerment of local communities (Zou et al., 2021). The success of a geopark is not only measured by its ability to protect geological sites but also by its role as a catalyst for regional development through geology-based tourism (geotourism), which has proven to be an effective driver for sustainable development[1]. This transition from global sustainability frameworks to local digital adaptation highlights the need for context-sensitive tourism innovations.

One of the areas with extraordinary potential in Indonesia is Geopark Kebumen, previously known as Geopark Karangsambung–Karangbolong. Designated as a National Geopark on November 30, 2018, this area has undergone significant expansion through Regent Regulation No. 25 of 2023, covering a total area of 1,160.68 km² comprising 22 districts and 374 villages (Kebumen Regency Government, 2023). Its highly diverse morphological characteristics—encompassing hills, valleys, plains, to karst and coastal areas—make it a natural laboratory as well as a tourism ecosystem with high development potential.

However, along with its expansion and increasing popularity, Geopark Kebumen faces complex governance challenges. The substantial economic potential has not been distributed equitably. This is reflected in the significant digital divide among local business actors, a condition consistent with national data. According to data from the Ministry of Cooperatives and SMEs as of the end of 2023, out of a total of more than 65 million MSMEs in Indonesia, only about 27 million have been integrated into the digital ecosystem. This indicates that the majority of MSMEs, especially in rural and tourism areas, still struggle to access the digital economy value chain (KemenkopUKM, 2023). At the same time, the area suffers from pressure on physical infrastructure. Traffic congestion on weekends around major geosites, causing an average delay of up to 20 minutes, is a symptom of suboptimal visitor flow management, a common challenge in popular tourist destinations[2]. This research is also aligned with Indonesia's national digital transformation agenda and the United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 11 (Sustainable Cities and Communities).

This dynamic reveals a critical risk: as the geopark expands, the absence of inclusive digital infrastructure and smart mobility deepens existing disparities and creates economic exclusion, where local business actors find it difficult to fully participate in the tourism revenue stream. This limited digital access is not merely a technical issue but a systemic problem that threatens the very principle of inclusivity of the geopark itself. This situation underscores the need for a solution that can enhance MSME performance through technology adoption [3] while efficiently managing visitor mobility.

Integrated studies that connect MSME digitalization with smart mobility as a unified geopark development strategy in Indonesia remain limited and fragmented. Existing research tends to address these domains separately[4]. focus primarily on conservation management and the development of geotourism attractions but neglect to incorporate digital infrastructure that facilitates local business inclusion[5]. emphasizes community-based

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tourism and participatory governance yet confines the role of technology to promotional activities, overlooking its potential as a coordination and decision-making instrument for managing tourism ecosystems holistically. Consequently, current studies fail to capture the systemic linkage between digital empowerment and operational efficiency in non-urban tourism contexts. This fragmentation constrains the scalability and long-term sustainability of community-based digital initiatives in geopark tourism. To address this gap, the present study positions digital platforms not as supplementary tools but as central governance infrastructures that integrate MSME digital inclusion with participatory mobility management within a cohesive Public Digital Infrastructure (PDI) model. Drawing upon the synthesis of global best practices and comparative analysis of leading smart tourism frameworks both international (e.g., Jeju Smart Tourism) and nationally (e.g., Magelang, Banyuwangi, Bali, and Yogyakarta), to derive strategic lessons for the proposed framework. To address this gap, this study proposes a unified digital solution that integrates MSME digital inclusion and participatory smart mobility management within a cohesive public infrastructure model for geopark tourism. The novelty of this study lies in its conceptualization of a Public Digital Infrastructure (PDI) model tailored to non-urban geotourism ecosystems, combining open-source technology with participatory governance principles. This research proposes an integrated digital platform model as a systemic response to two structural challenges in the Kebumen Geopark: the economic exclusion of Micro, Small, and Medium Enterprises (MSMEs) from the digital tourism value chain, and the fragmentation of mobility-related services that hinder visitor experience and operational efficiency.

An analysis of global case studies like Jeju Smart Tourism (South Korea) and Smart Santander (Spain) highlights the importance of interoperability and open standards as keys to long-term sustainability. Jeju demonstrates the power of integrating payment systems and mobility data to enhance the tourist experience, while Smart Santander pioneers the use of IoT infrastructure for city management. However, these models also reveal a tendency towards corporate or technocratic dominance. The primary lesson is that while advanced features are valuable, an open architectural foundation to prevent vendor lock-in is a more fundamental prerequisite for public systems.

At the national level, smart tourism implementation reveals a diverse spectrum of approaches: 1) Magelang (Layered Top-Down Coordination): Driven by its status as a Super Priority Tourism Destination (DPSP), development around Borobudur involves a coalition of national and regional agencies. Its strength lies in significant national resource support, but its primary weakness is institutional fragmentation and 'sectoral ego,' leading to uncoordinated digital initiatives like the 'Jelajah Magelang' app and other parallel programs; 2) Banyuwangi (Centralized Top-Down Integration): The 'Smart Kampung' initiative represents a strong, state-led model driven by visionary local government leadership. Its key strength is scalability and integrated infrastructure, having invested heavily in fiber optics and public Wi-Fi before launching service applications. However, this model is highly dependent on the incumbent political leadership and risks stifling organic, bottom-up innovation; 3) Bali (Market-Driven Collaborative Partnership): Focused on 'quality tourism,' Bali excels in industry-regulator collaboration to solve specific transactional problems, exemplified by the successful implementation of QRIS Cross Border. The model's strength is its agility and rapid market adoption. Its risk, however, is a potential focus on established players, potentially leaving smaller, less-connected MSMEs behind; 4) Yogyakarta (Community-Led Bottom-Up Innovation): The 'Smart Tourism Kampung' model is driven by the organic creativity of local communities and Pokdarwis (tourism awareness groups). Its core strength is high authenticity and strong community ownership. Its significant weakness is a lack of scalability and sustainability due to fragmented efforts and inadequate institutional and digital infrastructure support.

This comparative analysis demonstrates that no single existing smart tourism model offers a universally optimal design. Each exhibits trade-offs between scalability, authenticity, and inclusivity. The table below summarizes this typology to clarify the distinctive strategic positioning of the proposed PDI model for Kebumen.

Table 1. Positioning of the proposed PDI model for Kebumen.

Model	Driving Force	Primary Focus	Key Strength	Key Weakness
Global Benchmark (Jeju)	Corporate / Consortium[6]	Tourist Experience & Efficiency	Advanced Technology & Integration	Vendor Lock-in & Commercial Bias
Magelang (DPSP)	National & Regional Agency Coalition [7]	DPSP Management & Conservation	National Resource Support	Institutional Fragmentation & “Sectoral Ego”
Banyuwangi (Smart Kampung)	Local Government (Top-Down)[8]	Public Service Efficiency	Scalability & Integrated Infrastructure	Dependency on Political Leadership
Bali (Quality Tourism)	Industry & Regulator Partnership [9]	Tourist Transaction Efficiency	Rapid Market Adoption & Agility	Exclusion of Smaller Players
Yogyakarta (Kampung Wisata)	Community (Bottom-Up) (Fachrina, 2025)	Authentic Cultural Experience	Authenticity & Community Ownership	Fragmentation & Low Scalability
Kebumen (Proposed PDI)	Public Body (Hybrid) (This Study)	Structural Economic Inclusion	Equity, Data Sovereignty, Sustainability	Implementation Complexity & Digital Literacy Needs

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This table draws on case-based analysis from official tourism masterplans and academic studies. References for each model are provided to ensure transparency and traceability.

Table 1 presents a comparative typology of global and national smart tourism models, highlighting their driving forces, primary focuses, strengths, and weaknesses. This table establishes the strategic positioning of the proposed Public Digital Infrastructure (PDI) model for Kebumen relative to benchmarked cases such as Jeju, Magelang, Banyuwangi, Bali, and Yogyakarta. As shown in *Table 1*, none of the existing models fully integrate economic inclusion and participatory governance in non-urban contexts. The Kebumen PDI model thus emerges as a hybrid approach that combines the scalability of top-down systems with the authenticity and adaptability of bottom-up innovation, addressing both the governance and digital inclusion gaps identified earlier.

Despite their respective strengths, none of the examined models holistically address the intersectional challenges of digital marginalization and fragmented governance in non-urban geopark contexts. The proposed PDI model for Kebumen positions itself as a hybrid governance alternative that integrates the scalability of top-down systems with the authenticity and adaptability of bottom-up innovation. Its core value lies in operationalizing digital equity and participatory co-governance through a public digital infrastructure designed specifically for non-urban tourism ecosystems. This strategic positioning directly informs the conceptual framework elaborated in Section 2.6, where MSME empowerment and mobility optimization are integrated within a unified platform logic.

The conceptual model depicted in Figure 2.1 illustrates the systemic relationship between two core design inputs—MSME digitalization and smart mobility and parking—and their associated socio-economic outcomes, mediated through an integrated digital platform tailored for the geopark ecosystem.

On the input side, MSME digitalization focuses on enhancing market access and visibility for local businesses, enabling them to participate in tourism value chains. Smart mobility includes sensor-based parking, digital routing systems, and real-time congestion management systems to improve spatial efficiency and reduce congestion in key geosites.

These inputs are intended to produce two strategic outcomes: economic inclusivity, reflected in increased MSME revenue and participation; and operational sustainability, seen in improved visitor satisfaction and reduced infrastructural pressure. Together, these outcomes align with long-term sustainability and equity goals for regional tourism development. These outcomes are positioned as measurable indicators for assessing the platform's impact on inclusivity and operational viability. This measurement logic is critical for evaluating policy effectiveness in real-world implementations of smart tourism platforms. This outcome-based structure ensures that platform evaluation can be aligned with policy indicators and development benchmarks relevant to tourism governance.

At the foundation of the model is the Integrated Geopark Digital Platform, which functions not only as a technical enabler but also as a governance infrastructure. It embeds normative values such as data sovereignty, digital equity, and participatory co-governance, ensuring that digital transformation efforts are inclusive, just, and community-driven.

Although visualized in linear form, the relationships within the model are dynamic. Feedback loops emerge across components—for instance, improved mobility may increase MSME visibility, which in turn enhances visitor satisfaction—necessitating continuous adjustment and policy refinement. Ultimately, this architecture offers not only functional efficiency but also a strategic governance instrument for inclusive regional development.

Beyond its architectural function, the model acts as a normative intervention in the evolving smart tourism discourse. It reframes the Smart Tourism Ecosystem framework by integrating digital equity and co-governance, marking a paradigmatic shift from transactional, market-centric efficiency toward structural inclusion anchored in civic participation. In doing so, the model bridges digital infrastructure and public service delivery in peripheral destinations, while also repositioning smart tourism through the lens of data justice and inclusive governance.

By uniting architectural design with normative transformation, this model advances current theory in smart tourism and offers a replicable policy framework for inclusive digital ecosystems. Thus, the model not only synthesizes global frameworks and local challenges but also contributes to emerging discourse on civic-centered smart governance in rural tourism systems. As digital governance becomes increasingly critical in the global tourism agenda, this model offers a grounded yet scalable roadmap for inclusive innovation in emerging destinations.

2. RESEARCH METHODOLOGY

This chapter outlines the methodological approach used in designing and constructing the conceptual artifact of an integrated digital platform for the Geopark Kebumen area. The approach used is a conceptual design study based on constructivist epistemology, which combines theoretical synthesis, global case studies, and system design to produce a policy whitepaper that is relevant for implementation.

2.1 Research Design

This research is rooted in constructivist epistemology. This approach was selected because digital systems in socially embedded contexts such as geoparks require interpretive methodologies grounded in user realities and institutional norms. This aligns with the research's aim to design a normative artifact that not only reflects theoretical coherence but also facilitates equity-oriented governance logic. Here, knowledge is not merely discovered but constructed through iterative interactions among theory, global practices, and local realities. This approach aligns with the principles of design-oriented

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research[10]. In this approach, an artifact is developed through an iterative process based on system logic and user needs in a specific context. The main objective of this conceptual research is to construct a robust theoretical framework as a conceptual artifact. This framework is intended to inform academic discourse and offer a normative model for policymakers and destination managers. The validity of this approach lies not in statistical generalization, but in the strength of theoretical arguments, the consistency of design logic, and its contextual relevance to geopark development policy. This methodological stance also aligns with the emancipatory aim of digital public infrastructures in peripheral tourism ecosystems.

2.2 Data and Information Sources

The secondary data sources in this study are categorized based on their function:

a. Theoretical Foundation: The scientific literature reviewed in Chapter 2 is used to formulate the theoretical framework and system design parameters.
b. Practical Validation: Comparative case studies from other destinations such as Jeju Smart Tourism and Smart Santander are used to identify successful features and strategies.
c. Policy Alignment: Strategic documents, such as the Bappenas Masterplan [11]and the Ministry of Tourism and Creative Economy's Strategic Plan[7], as well as UNESCO Global Geopark guidelines, are used as references for national and global policy directions.
d. Technical Specifications: Software architecture whitepapers are used to realistically draft the system blueprint.

Data sources were evaluated based on credibility, relevance, and triangulation potential, including peer-reviewed literature, official government frameworks, and technical specifications. Conceptual validity is strengthened through source triangulation, which involves comparing the alignment between academic literature, practical case studies, and public policy in formulating an integrated model design. This triangulated method mitigates sectoral bias and ensures conceptual robustness across governance, technical, and community layers.

2.3 Research Stages

The research process follows four main stages that are iterative and reflective:

a. Stage 1: Literature Synthesis and Needs Identification. At this stage, theoretical literature and policy reports are analyzed in-depth to extract key design principles and identify the specific system needs for the geopark area.
b. Stage 2: Comparative Analysis of Case Studies. This stage focuses on evaluating successful case studies to formulate best practices that are relevant and adaptable to the Indonesian context.
c. Stage 3: Conceptual Model and Architecture Design. Based on results of stages 1 and 2, a functional model, platform workflow, stakeholder interactions, governance model, and a proposed high-level system architecture are designed.
d. Stage 4: Drafting of the Conceptual Manuscript (Whitepaper). All elements converge into a cohesive whitepaper that articulates the rationale, system architecture, and governance roadmap for implementation.

2.4 Analysis Techniques

To structure the analytical process, this study employs a multi-method interpretive approach. The primary analysis technique is Critical Interpretive Synthesis (CIS), combined with principles from Comparative Policy Analysis[12]. Each analytical stage integrates reflexive evaluation based on participatory design logics and feasibility alignment. Field validation was not conducted. Instead, interaction scenarios were constructed based on simulated stakeholder roles derived from case-based synthesis. This creates an internal feedback cycle between stages, which is crucial in designing a contextual and realistic system. To complement the analytical narrative, system visualization methods such as use case diagrams, entity-relationship diagrams, and stakeholder flow mapping are also used to clarify the relationships between system elements. Although this study does not involve primary data from participants, participatory reflection is simulated through mapping actor roles based on case studies, as well as developing interaction scenarios based on user needs reconstructed from secondary data.

2.5 Components of the Conceptual Artifact

This research culminates in the construction of a multi-faceted conceptual artifact, comprising four key components that collectively form the paper's contribution:

a. A Detailed Conceptual Model: A visual and narrative representation that illustrates the proposed platform's core functions and, most importantly, its public-centric governance structure.
b. A Principled Architectural Framework: A high-level technical blueprint that is presented not as a definitive implementation guide, but as an embodiment of architectural principles (e.g., modularity, interoperability, open source) that philosophically align with the PDI model.
c. A Coherent Theoretical Argument: The full paper as a narrative structure that integrates conceptual, architectural, and governance dimensions into a unified logic.
d. A Set of Theoretical and Policy Implications: A discussion of the broader implications of the model for smart tourism theory and policy, moving beyond specific implementation steps.

Together, these components function not merely as a representation of theory but as a generative design toolkit for smart tourism governance.

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2.6 Conceptual Validation and Transfer Relevance

Validation is conducted not only to test the internal coherence of the model theoretically that is, the integration between conceptual elements, design structure, and basic system principles—but also to assess its potential scalability and adaptive fit in other geoparks with comparable socio-technical characteristics. This validation is achieved through structural matching with established theories such as the Smart Tourism Ecosystem Framework [13] as well as functional correspondence with best practices in global case studies, enabling the model to serve as a policy blueprint for pre-implementation planning and institutional coordination[14].

This model is designed not only to meet the needs of Geopark Kebumen but also to become an initial prototype for smart tourism systems in other geopark areas. Thus, this research contributes to the development of inclusive and sustainable digital governance in non-urban areas, with the geopark as a laboratory for community-based public policy innovation. This emphasizes the model's transferability and supports its positioning as a foundational architecture for inclusive smart tourism systems across diverse regional contexts.

Ultimately, the model contributes to both theory-building in digital tourism governance and policy experimentation in post-urban innovation contexts. As such, the methodology outlined here not only guides the development of the conceptual artifact but also sets the stage for rigorous interpretation of its relevance in policy and practice.

3. RESULT AND DISCUSSION

This chapter presents a critical and reflective analysis of the platform model and architecture designed in Chapter 4. Its purpose is to interpret how the model responds to the core research problems, while also linking it to the underlying theoretical framework and outlining the conceptual, practical, and future development implications.

3.1 Critical Evaluation of Theoretical Frameworks

The discussion opens by critically assessing the foundational theories guiding this study, followed by thematic deconstruction of key conceptual pillars. This research is conceptually grounded in two main frameworks. First, the Diffusion of Innovations Theory [15] is used to understand the process of technology adoption by MSMEs. However, despite its significant influence, Rogers' approach is often criticized for its individualistic focus, which tends to overlook structural factors such as institutional constraints and the digital divide in rural areas[16]. Therefore, in this study, the theory is not used prescriptively but as an initial lens to understand adoption challenges from the user's perspective.

Second, the Smart Tourism Ecosystem framework[6][13] is adopted to map the interactions among stakeholders. While this framework is useful, it often fails to explicitly address the power dynamics and governance within such ecosystems. To overcome this weakness, this study reconceptualizes the framework by embedding digital justice and participatory governance as normative design imperatives, viewing the geopark not only as a physical space but also as a socially produced space [17].

3.2 Deconstruction of the Smart Tourism Discourse

The dominant discourse in smart tourism defines it as an ICT-driven approach aimed at enhancing efficiency and enhancing tourist experiences, operational efficiency, and destination sustainability[6]. This concept emphasizes smart connectivity between various stakeholders through integrated technology platforms [18]. However, the smart tourism literature tends to be techno-utopian, minimizing the socio-political role of technology and often obscuring the structural exclusion inherent in digital infrastructure inequality. This discourse is inherently trapped in an urban-centric bias that is unresponsive to the complexities of non-urban spaces like geoparks, where the main challenge is not merely efficiency but also inclusivity and ecological sustainability. Although [3], [6] provide a comprehensive foundation, their article does not deeply discuss how digital infrastructure inequality limits the participation of local actors in remote destinations. Therefore, this research explicitly takes a critical epistemological position against technological determinism and views smart tourism not as a final solution, but as an arena of contestation where local values must be negotiated.

3.3 Problematizing MSMEs Digitalization: Inclusion or New Exclusion?

The dominant narrative positions digitalization as a path to empowering MSMEs [3]While there is evidence of positive impacts, the assumption that "digitalization automatically means inclusion" needs to be critiqued. Studies like Putra & Handayani (2019) have shown the "dark side" of digital platforms. Furthermore, digitalization can create new forms of exclusion through platform dependency and data extractivism practices, where MSME and consumer data are extracted for the platform owner's profit, such as visibility dominance based on non-transparent algorithms rather than community benefit[19] [20]Therefore, the pla[7]tform proposed in this research is designed with the principle of data sovereignty, where data is managed by a public entity for the common good.

3.4 Smart Mobility: Efficient for Whom?

The literature on smart mobility often focuses on technocratic optimization to reduce traffic congestion[2]. One of its pillars is the smart parking system, which uses sensors and real-time data to provide information on parking availability and has been proven to reduce parking search time, a major cause of congestion (Li and Weng, 2022). However, this efficiency-oriented approach often fails to ask: "Smart for whom?". Questions regarding accessibility for vulnerable

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groups (e.g., the elderly, people with disabilities, or those without smartphones) are rarely discussed. In fact, data from the Indonesian Internet Service Providers Association (APJII) shows that internet penetration in rural Indonesia is only 30.5%, compared to 69.5% in urban areas[21]. Furthermore, the 2023 Indonesian Digital Community Index (IMDI) recorded a national score of 43.18, indicating that Indonesia is still in the early stages of digitalization, especially in rural areas (IMDI, 2023). This indicates a significant digital divide, which impacts the ability of rural communities to utilize digital technology in economic and social activities. This study contends that effective smart mobility design in geopark areas must transcend technocratic efficiency and embed principles of mobility justice and universal access.

3.5 Proposed Conceptual Model

To visualize the relationship between variables based on the propositions above, the following conceptual model is proposed. It should be noted that this model is a simplified representation intended for visualization purposes only. In practice, the relationships between variables are dynamic and iterative, which involve feedback loops among visitor experience, MSME visibility, and mobility pattern interactions that evolve in real time and exceed the representational limits of static visualization. Accordingly, the model should be understood not as a static blueprint, but as a dynamic governance architecture subject to contextual adaptation and recursive learning.

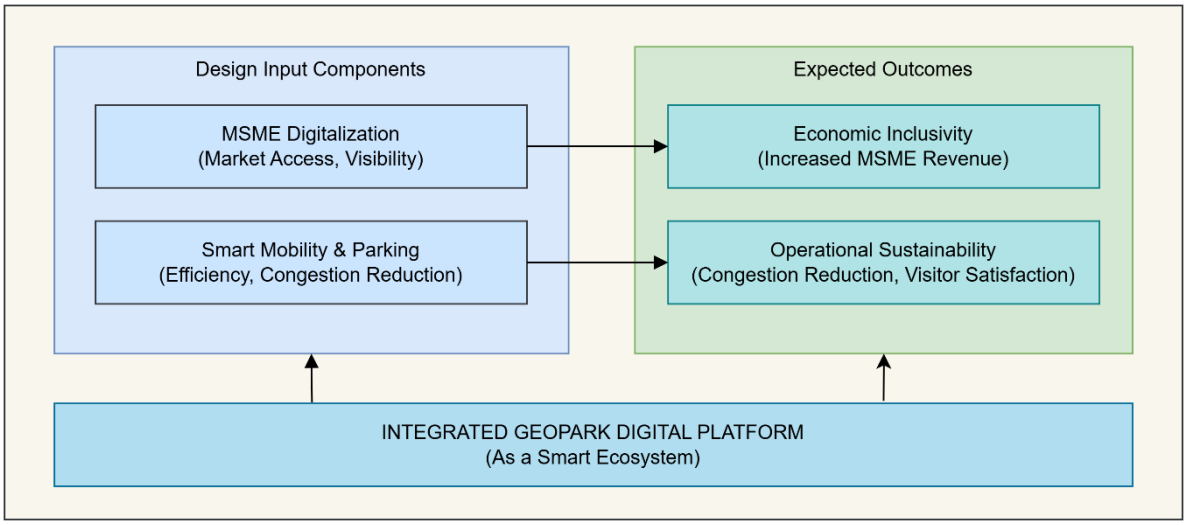

Figure 1. Conceptual Framework for the Integrated Geopark Digital Platform: Linking Design Inputs and Policy Outcomes in a Smart Tourism Ecosystem.

Figure 1 illustrates the conceptual framework that links MSME digitalization, smart mobility, and parking management as interconnected design inputs leading to measurable socio-economic outcomes. As depicted in Figure 1, the framework shows how these elements interact dynamically through feedback loops that enhance MSME visibility and visitor experience. The figure underscores that the platform is not merely a technical tool but a governance mechanism embedding principles of equity, data sovereignty, and participatory co-management into the digital infrastructure. This visualization provides the theoretical foundation for developing the platform's architecture discussed in subsequent sections.

3.6 Platform Model and Architecture Design

This chapter presents the main conceptual artifact developed through a design approach that integrates theory, case studies, and policy documents. The proposed platform model responds to the dual challenges of digital exclusion and fragmented governance in the Geopark Kebumen area.

3.7 Theoretical and Contextual Foundations for Model Design

The design principles underlying the platform architecture are derived from three complementary domains: theoretical frameworks, global smart tourism practices, and local policy imperatives. Synthesizing these perspectives ensures that the resulting model is both conceptually rigorous and practically adaptable. This synthesis forms the conceptual and contextual backbone of the platform's architecture.

3.8 Literature-Based Design Principles

Three theoretical frameworks inform the core logic of the platform's design. Based on a review of key theories in the literature, three complementary design pillars were identified:

a. From Diffusion of Innovations Theory: The platform must have a clear relative advantage, compatibility with the working practices of local MSMEs, and low complexity of use.

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b. From the Smart Tourism Ecosystem Framework: The design must facilitate the co-creation of value among all stakeholders, not just one-way transactions.
c. From Smart Governance Literature: A transparent and accountable public governance mechanism is needed to ensure alignment with community interests, not just profit. This aligns with participatory and co-governance principles, particularly the emphasis on inclusive governance structures discussed in Ye and al [22], and the integration of community values within smart tourism frameworks as noted by [13].

3.9 Best Practices from Global Case Studies

To contextualize the platform's functionality, global best practices were reviewed to extract key technological and governance strategies. An analysis of the Jeju Smart Tourism (South Korea) and Smart Santander (Spain) case studies yielded several relevant best practices:

a. Proven Successful Features: Integration of a unified payment system, provision of real-time mobility data via sensors, and a curated MSME promotion platform to maintain quality.
b. Strategic Lessons Learned: The practice in Smart Santander shows that interoperability and system openness are key to long-term sustainability. Therefore, the proposed digital platform emphasizes the use of open-source components and the avoidance of closed architectures that lead to vendor lock-in.

3.10 Contextual Needs Analysis of Geopark Kebumen

Based on strategic planning documents Bappenas (Bappenas, 2021) and Kemenparekraf[7] highlight the need to specific system needs were identified:

a. Address the MSMEs economic participation gap by providing an easily accessible digital platform.
b. Provide dynamic visitor management solutions to reduce pressure on popular geosites.
c. Ensure that tourism data can be utilized by the local government as a basis for development planning.

This section introduces the platform model that operationalizes the synthesis of theoretical frameworks, global best practices, and local needs into a functional digital infrastructure.

3.11 Design Philosophy: The Platform as a Public Digital Infrastructure (PDI)

In the context of public technology policy, this digital platform is designed as a Public Digital Infrastructure (PDI)—not just as a technology product, but as a foundational digital structure that enables access, interoperability, and participation across stakeholders. This approach follows the development direction of Digital Public Goods (DPG) as initiated by GovStack, UNDP, and the [23]. As a PDI, this platform emphasizes modularity, open API standards, the use of open-source technology, and inclusive governance—not owned by a single vendor, but managed publicly through inter-institutional collaboration.

3.12 High-Level System Architecture

A modular, microservices-based architecture was chosen because it allows for distributed development, gradual integration, and independent feature management. This architectural design has been functionally reviewed using the design validity principles from[10], including logical coherence, modular feasibility, and contextual relevance.

The selection of the technology stack is guided by the core principles of a Public Digital Infrastructure.

a. Frontend (e.g., Next.js): The choice of a component-based, open-source framework is principled on the need for modularity and avoiding vendor lock-in, ensuring the frontend can evolve independently and be maintained by a wider community of developers.
b. Backend (e.g., Golang): A microservices architecture is adopted to ensure system resilience and scalability. This approach allows individual services (e.g., mobility, MSME directory) to be developed, deployed, and scaled independently, which is crucial for phased, resource-conscious development in a public sector context.
c. Database (e.g., PostgreSQL & PostGIS): The use of a robust, open-source relational database with strong spatial capabilities (PostGIS) is fundamental to the principle of data sovereignty and integrity, ensuring that critical geo-spatial data remains a public asset.
d. Caching (e.g., Redis): Caching mechanisms are employed not just for performance, but to ensure equitable and responsive access for all users, even during peak demand, reducing the load on core infrastructure.
e. Containerization (e.g., Docker): This ensures portability and interoperability, allowing the platform to be deployed across various cloud or on-premise environments, further reinforcing the principle of avoiding technological lock-in.
f. All these technology components were chosen to ensure distributed system scalability and to avoid long-term risks associated with proprietary vendor dependency. These layered architectural choices ensure that the platform can evolve iteratively while maintaining system coherence, resilience, and alignment with public governance standards.

3.13 Governance Design and Cross-Stakeholder Interaction Flow

This digital platform facilitates interaction between key actors. The main service flow includes the MSME digitalization process (registration, product management), mobility management (parking and transportation information), and the tourist journey (planning, booking, giving reviews). The proposed governance model places the Geopark Management Body as the main platform operator, with oversight from the local government and community involvement in decision-

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making. By uniting design principles, modular technology, and the mapping of local actor roles, this artifact represents not only a technological solution but also a collaborative governance framework for community-based tourism destinations.

3.13 Summary of Design Elements: Integration of Theory, Technology, and Strategic Goals

Table 2 below summarizes the main components of the platform, along with their theoretical basis, proposed design implementation, and the strategic goals to be achieved in the context of sustainable geopark tourism development.

Table 2. Summary of Design Elements for the Kebumen Geopark Digital Platform

Component	Theoretical / Practical Source	Design Implementation	Strategic Goal
Platform Governance	Smart Governance [24]	Managed by Geopark Management Body, supervised by Local Govt.	Accountability & governance transparency
MSMEs & Promotion Module	Smart Tourism Ecosystem[13]	Digital promotion services, MSME onboarding, local review system	Local economic inclusion
Mobility & Parking Module	Smart Santander[25], Mobility Lit. [2]	Transport info, dense location monitoring, safe routes	Crowd management & visitor comfort
Technology Architecture	Best Practice Microservices, DPG [23]	Next.js, Golang, PostgreSQL/PostGIS, Redis, Docker	Scalability, interoperability, & openness
Information Visualization	Geo-visualization [26], Stakeholder Mapping	interactive geosite map, dynamic visitor data	Spatial data-driven decision making

Table footnote. This table synthesizes design components based on secondary data sources, including peer-reviewed literature, policy documents, and global case studies. Sources were selected for their methodological credibility and contextual alignment with smart tourism, inclusive governance, and public digital infrastructure standards.In summary, this design not only serves as a technical solution to local problems but also functions as a strategic instrument. Each component in the platform's design is positioned to contribute to the achievement of the Sustainable Development Goals (SDGs): MSME economic empowerment aligns with SDG 8 (Decent Work and Economic Growth), mobility and destination spatial management support SDG 11 (Sustainable Cities and Communities), and strengthening cross-actor collaboration through open digital governance aligns with SDG 17 (Partnerships for the Goals). This makes the platform not just a digital enabler, but a strategic instrument for aligning the local development agenda with the global 2030 Agenda.

3.14 Comparative Analysis and Synthesis: Building the Case for a Public Digital Infrastructure Model

To ground the conceptual framework in reality and ensure its contextual relevance, a comparative analysis of existing smart tourism models is crucial. This analysis is conducted on two levels: global and national. Global case studies such as Jeju Smart Tourism and Smart Santander serve as benchmarks for best practices and technological innovation. Subsequently, an in-depth analysis of national case studies Magelang, Banyuwangi, Bali, and Yogyakarta—provides a contextual understanding of implementation challenges, governance dynamics, and socio-economic realities within Indonesia. The synthesis of these two analytical levels is then used to strengthen the argument for the proposed Public Digital Infrastructure (PDI) model.

3.15 Conceptual Model Visualization

The following diagrams are used to visualize the system flow based on the modular design and key actor interactions. These visualizations serve three purposes: (1) demonstrating the modular coherence of the platform architecture, (2) mapping key user and stakeholder interactions, and (3) illustrating the iterative logic of design synthesis.

Figure 4.1 serves as the foundational technical blueprint for the proposed digital platform. This diagram primarily serves to visually demonstrate the platform's modular coherence, which is fundamental to its design as a scalable and resilient Public Digital Infrastructure (PDI). It illustrates how different technological components and layers are structured to support the project's core goals of economic inclusion, efficient mobility, and participatory governance. These diagrams not only describe technical functionalities but also embody the philosophical underpinnings of the platform, where openness, adaptability, and co-governance are operationalized through system logic.

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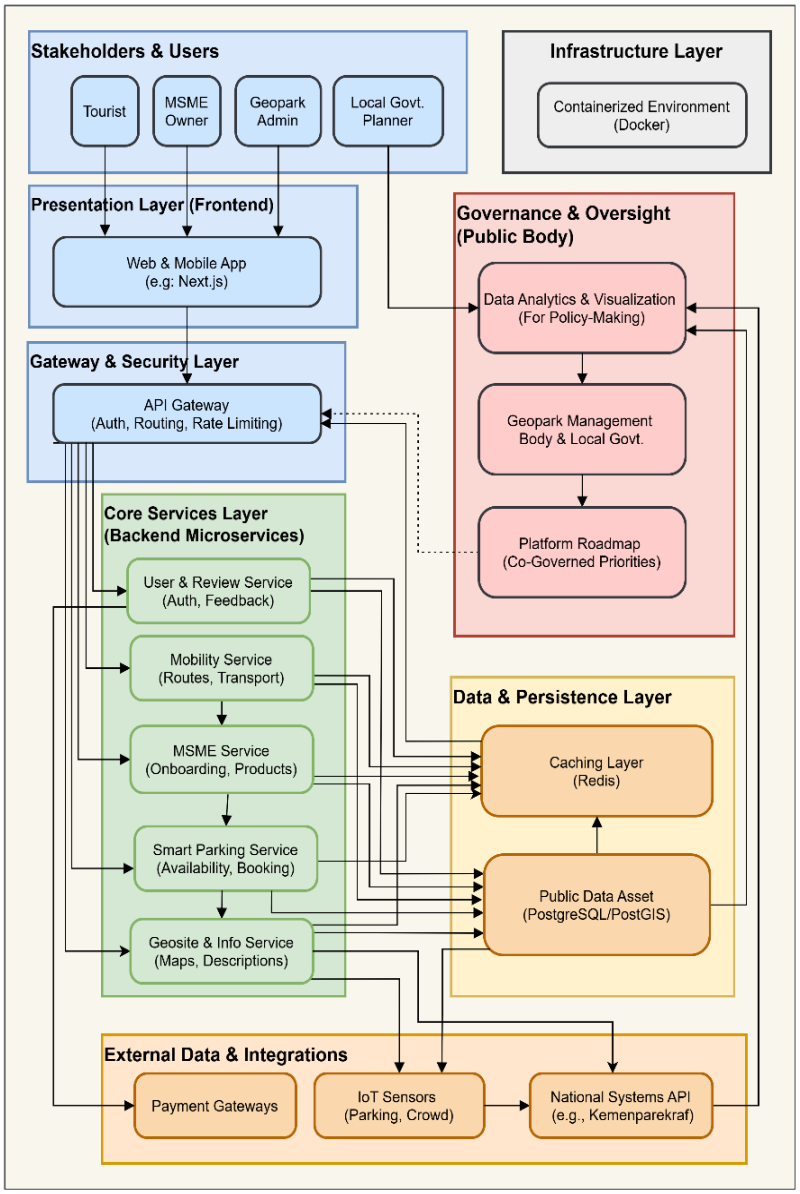

Figure 2. High-Level System Architecture of the Kebumen Geopark Platform, illustrating the microservices logic and modular components.

This diagram represents more than just a technical structure; it is a visual articulation of the platform's public-centric philosophy. The architecture's effectiveness lies in how its layers and components work together to achieve strategic goals.

a. Modular and Resilient Core: The "Core Services Layer" is designed using a microservices architecture. Each function—such as the MSME Service, Mobility Service, and Smart Parking Service—is an independent component. This modularity is a key feature, as it allows for phased development, independent scaling, and ensures that the failure of one service does not bring down the entire system, which is crucial for a public service platform. The use of open-source technologies like Golang for the backend and Next.js for the frontend is a principled choice to avoid vendor lock-in and ensure long-term maintainability.
b. Data as a Public Asset: The "Data & Persistence Layer" is intentionally designed to uphold the principle of data sovereignty. The core database, "Public Data Asset (PostgreSQL/PostGIS)," ensures that critical tourism and geospatial data remain a public good, managed by the Geopark Management Body, not a private vendor. The "Caching Layer (Redis)" is included to ensure equitable and responsive access for all users, even during peak demand.
c. A Governance-Driven Feedback Loop: The "Governance & Oversight (Public Body)" layer is the most critical element that distinguishes this design as a PDI. It is not merely an administrative dashboard. Instead, it creates a strategic feedback loop:
d. Data from platform usage is collected in the Public Data Asset.
e. This data is processed by the "Data Analytics & Visualization" module to provide actionable insights for policy-making.

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f. The "Geopark Management Body & Local Govt." use these insights to make evidence-based decisions.
g. These decisions inform the "Platform Roadmap," which then guides future technical development, thus closing the loop.
h. Designed for Openness and Interoperability: The "API Gateway" acts as a secure and managed front door to all services, while the "External Data & Integrations" layer shows clear connection points for third-party systems like IoT sensors, payment gateways, and national government dashboards. This architectural choice is fundamental to the PDI model, ensuring the platform can evolve and integrate within a larger digital ecosystem.

In summary, this architecture is a deliberate construction that translates the theoretical principles of a Public Digital Infrastructure into a functional and governable technical plan.

Having established the technical architecture, the focus now shifts from the system's blueprint to its real-world application. The following diagram, Figure 4.2, visualizes the platform from the user's perspective. Its purpose is to map the key interaction stages of a tourist's journey, from the initial planning phase to the post-visit feedback process. This diagram is crucial for illustrating how the platform's different modules work in concert to create a seamless, integrated experience that fosters a "virtuous cycle" between tourist satisfaction and local economic vitality.

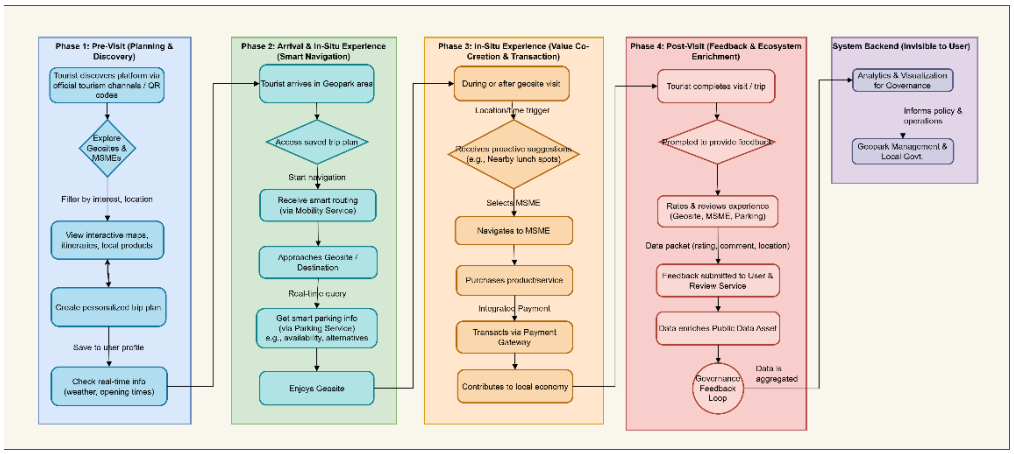

Figure 3. User (Tourist) Service Flow, mapping interaction stages from planning to feedback.

This service flow diagram illustrates more than a simple sequence of actions; it visualizes the core value proposition of the integrated platform by breaking the user journey into four distinct, interconnected phases.

a. Phase 1 & 2: Empowered Planning and Smart Navigation: The initial phases focus on empowering the tourist and improving operational efficiency for the destination. By providing a centralized platform for discovery, itinerary planning, and real-time information, the system reduces uncertainty for visitors. Upon arrival, the platform transitions into a smart navigation tool, utilizing the Mobility and Smart Parking services to offer efficient routing and reduce congestion. This directly addresses the goal of enhancing operational sustainability and visitor satisfaction.
b. Phase 3: Fostering Economic Inclusion (Value Co-Creation & Transaction): This phase represents the platform's core economic intervention. It moves beyond simple navigation to proactively create value. Triggered by context such as location and time, the system provides proactive suggestions for nearby local businesses, directly connecting tourists with MSMEs that were previously excluded from the digital value chain. By facilitating integrated payments, the platform ensures that tourism spending is captured by the local economy, thus promoting the strategic goal of economic inclusivity.
c. Phase 4: Closing the Loop (Feedback & Ecosystem Enrichment): This final phase is the cornerstone of the platform's participatory governance model. The tourist is prompted to provide granular feedback on their experience, rating everything from geosites to MSMEs. This data is not simply stored; it "enriches the Public Data Asset" and feeds into the "System Backend" for analysis by the Geopark Management Body. This transforms the tourist from a passive consumer into an active co-creator of the tourism ecosystem. This feedback loop is what enables data-driven decision-making and ensures the platform evolves based on community and visitor input, a central tenet of the co-governance framework.

In essence, this diagram demonstrates how the Public Digital Infrastructure (PDI) model translates into a tangible, human-centric experience. It visualizes a journey where technology is used not just for efficiency, but as a deliberate tool to foster economic inclusion and participatory governance.

The final diagram, Figure 4, shifts the analytical lens from the platform's 'what'—its architecture and user flow—toward the 'how': the structured synthesis that underpins its creation. This diagram serves as a visual map of the research methodology itself. Its primary purpose is to illustrate the iterative and systemic logic of the design synthesis, showing how the proposed Public Digital Infrastructure (PDI) model was systematically constructed by integrating theoretical frameworks, practical case studies, and local policy needs. It provides transparency into the intellectual process, justifying the final output as an evidence-based design.

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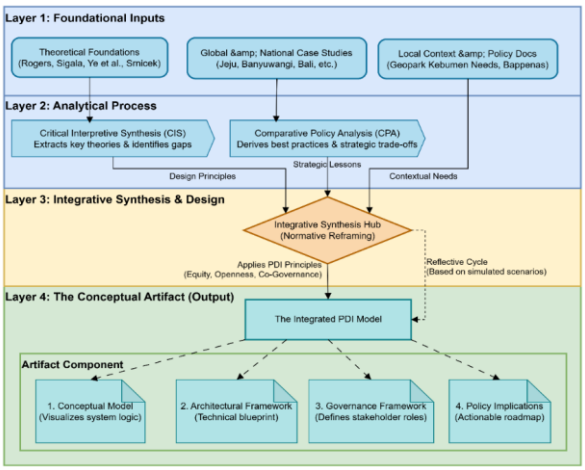

Figure 4. Synthesis Path to Design Artifact, combining CIS and CPA logic into a systemic design output.

Note: CIS (Critical Interpretive Synthesis); CPA (Comparative Policy Analysis). These methodological foundations guide the model's construction and validation logic.

Unlike the previous diagrams that illustrate the system's 'product', this diagram explicates the research process that enabled its construction. This diagram visualizes the research journey as a structured, four-layer process that transforms foundational inputs into a coherent conceptual artifact.

a. Layer 1: Foundational Inputs
b. The process begins with the triangulation of three distinct sources of information. These are:
c. Theoretical Foundations[15] to ground the research in established theory;
d. Global & National Case Studies (e.g., Jeju, Banyuwangi) to derive practical lessons and strategies and
e. Local Context & Policy Docs to ensure the solution is tailored to the specific needs and policy environment of Geopark Kebumen.
f. Layer 2: Analytical Process
g. The inputs are then processed using specific analytical techniques. The diagram clarifies their distinct roles:
h. Critical Interpretive Synthesis (CIS) is applied to the theoretical literature to extract key design principles and, more importantly, to identify critical gaps in existing theories.
i. Comparative Policy Analysis (CPA) is used to systematically evaluate the case studies, allowing the research to derive best practices and understand the strategic trade-offs of different smart tourism models.
j. Layer 3: Integrative Synthesis & Design
k. This layer is the intellectual core of the research. The "Integrative Synthesis Hub" is where the outputs from the analytical process—Design Principles, Strategic Lessons, and Contextual Needs—converge. Crucially, this is where "Normative Reframing" occurs. The findings are deliberately reinterpreted through the ethical lens of the PDI framework, applying principles of Equity, Openness, and Co-Governance. The "Reflective Cycle" highlights the iterative nature of this process, where the design of the artifact is continuously validated against simulated scenarios and foundational principles.
l. Layer 4: The Conceptual Artifact (Output)
m. The final outcome is a multi-dimensional Conceptual Artifact representing not just a platform, but an institutional and normative toolkit. It consists of four distinct but integrated components: the Conceptual Model, the Architectural Framework, the Governance Framework, and the Policy Implications. This demonstrates that the research delivers a complete, actionable toolkit for policymakers and destination managers.

In conclusion, this diagram validates the entire research methodology. It shows that the proposed Integrated PDI Model is not a speculative idea but the logical and well-grounded outcome of a process that systematically synthesizes theory, practice, and local context.

The diagrams above not only represent the technical structure of the system but also the logic of a collaborative, open, and adaptive digital service. With this modular approach, platform development can proceed incrementally and be decentralized according to the capacity of local actors, while still maintaining data integrity and system interoperability.

Thus, the design of this digital platform's model and architecture does not stop at mere technical specifications. This artifact is an original contribution in the form of a system design that integrates the principles of Public Digital Infrastructure (PDI), open-source modularity, and a collaborative governance model for a geopark-based tourism destination. As a conceptual prototype, the next chapter will discuss how this artifact not only answers design questions but also has implications for policy development, digital governance theory, and the participatory development agenda in non-urban areas. In summary, this chapter provides a comprehensive overview of the proposed digital platform model as a conceptual artifact. By uniting open-source system design, modular technology, and participatory governance logic, the platform serves not only as a technological solution but also as a strategic tool for inclusive, data-driven, and sustainable tourism governance in geopark areas.

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3.16 An Integrated Solution for Economic Exclusion and Service Fragmentation

This section analyzes how the proposed digital platform offers a systemic response by intervening in two structural issues the economic exclusion of MSMEs and the fragmentation of tourism services. The integration of the MSME module and the mobility module within a single platform is not just a technical solution, but also a systemic one. By removing digital access barriers for MSMEs and providing ease of navigation for tourists, the platform creates a virtuous cycle where the dynamic interaction between tourists and local MSMEs strengthens the area's economic competitiveness and connectivity. This integrated approach consciously learns from the comparative analysis; it is designed to avoid the market-driven exclusion seen in Bali, provide the institutional scaffolding lacking in Yogyakarta's community-led initiatives, and overcome the inter-agency fragmentation that hinders the multi-stakeholder model in Magelang, as highlighted in Chapter 2. Through a user experience curated by a review- and location-based recommendation system, a reciprocal cycle occurs between increased tourist satisfaction and increased MSME exposure, which in turn strengthens the local economic ecosystem. This cyclical interaction between tourist flow and MSME visibility functions as a socio-digital feedback loop that continuously reinforces both user experience and local economic vitality. This systemic integration supports the creation of inclusive tourism economies by embedding local enterprises into structured digital ecosystems.

3.17 Linkage of the Model to the Theoretical Framework

The discussion here connects the design artifact (Chapter 4) with the theories reviewed (Chapter 2). This design confirms the relevance of the Diffusion of Innovations Theory in explaining the technology adoption process by MSMEs in rural areas, especially regarding compatibility and ease of use. More importantly, this platform design extends the Smart Tourism Ecosystem framework by adding the dimension of public governance as a central element. The addition of this governance element is not merely a normative layer, but a structural element that serves as an anchor of legitimacy and sustainability for a community-based digital ecosystem, in line with the principle of co-governance that emphasizes resource management by the community itself [27]. Accordingly, this model not only applies but advances the theoretical discourse by reframing smart tourism as a governance-centric, justice-embedded system. Unlike the state-led model in Banyuwangi or the market-led model in Bali, the PDI framework proposes a third way of governance that is neither purely bureaucratic nor purely commercial, but fundamentally civic. This offers a significant theoretical contribution to the study of digital governance in developing nations. This reframing resonates with emerging literature on design justice and civic-centered infrastructure, particularly the call for equity-driven digital systems [28]. This theoretical linkage also validates the interdisciplinary logic of the artifact, where socio-technical integration is not only feasible but necessary in post-urban innovation environments.

The implications of this research are divided into two main aspects: theoretical and practical, both of which have the potential for significant impact.

3.18 Theoretical Implications

The main contribution of this research to the literature is the proposal of a Public Digital Infrastructure (PDI) model for community-based tourism. This proposed approach offers an alternative to purely market-driven platforms (as opposed to the logic of platform capitalism reviewed by [22], by emphasizing inclusivity, openness, and alignment with public interest as its core design principles. In contrast to platform-state trajectories that often centralize power and reduce civic agency, the proposed PDI stems from a spirit of openness, modularity, and participation, consciously designed to avoid excessive concentration of digital control. Thus, this model not only contributes to the debate on digital platform design but also fills a gap in the literature regarding digitally just community-based tourism governance. A public digital platform should be "...not only technically operable, but also structurally just" (adapted from [22]. It highlights that equitable tourism ecosystems require not just operational efficiency, but governance architectures that are ethically grounded and participatory by design

Table 3. Theoretical Gaps Addressed and Model Contributions

Theoretical Framework	Identified Gap / Limitation	Contribution of the Proposed Model
Diffusion of Innovations Theory [15]	Assumes passive individual adoption; under-theorized in institutional or public governance contexts	Extends the theory to include community-level and governance-driven adoption, embedding innovation diffusion into institutional design and platform co-creation processes
Smart Tourism Ecosystem [13]	Overemphasis on techno-centric optimization and market-based stakeholder interactions; limited focus on governance and social equity	Integrates public governance and civic inclusion as core design elements, proposing a shift toward a justice-embedded and community-centered smart tourism ecosystem
Smart Governance[24]	Often conceptualized at national or metropolitan scale; lacks models for rural or community-based digital governance	Operationalizes smart governance at rural and destination-specific levels, through a platform that balances institutional oversight with participatory mechanisms

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Theoretical Framework	Identified Gap / Limitation	Contribution of the Proposed Model
Platform Capitalism [22]	Highlights dangers of centralization and exploitation in digital platforms, but lacks alternatives for inclusive design in tourism ecosystems	Proposes a Public Digital Infrastructure (PDI) model as a normative and technical alternative to extractive platform logic, grounded in openness, modularity, and public value
Design Justice [28]	Theory-rich but lacking applied frameworks in tourism and regional development contexts	Applies design justice principles in the tourism-tech domain, advancing a replicable design for digital equity and participatory infrastructure governance in underserved regions
Commons and Co-Governance [27]	Frequently applied to natural resource management, but underutilized in digital infrastructure or smart tourism platform discussions	Embeds co-governance logics into platform architecture, treating data, infrastructure, and decision-making as shared resources managed through multistakeholder collaboration

*Table footnote. This table synthesizes theoretical gaps identified in key frameworks relevant to tourism technology, digital governance, and innovation adoption. Sources were selected based on their critical influence in shaping discourse on smart tourism, public digital infrastructure, and platform justice. The contributions column reflects how this study operationalizes or extends these frameworks within the context of inclusive, community-based tourism governance through a Public Digital Infrastructure (PDI) model. Citations align with references discussed in Chapter 2 and elaborated in the design architecture (Chapter 4) and discussion (Chapter 5).

3.19 Practical and Policy Implications

From a practical and policy perspective, the conceptual framework developed in this research holds several significant implications.

a. As a Normative Model for Governance: The framework offers a normative blueprint for local governments, such as in Kebumen, and other community-based destinations. It provides a theoretically grounded alternative to market-driven platforms, guiding policymakers toward structures that prioritize long-term public value, equity, and data sovereignty.
b. Informing National-Level Discourse: The principles of the PDI model can contribute to national-level policy debates within bodies like the Ministry of Tourism and Creative Economy (Kemenparekraf). It provides a strong case for why a one-size-fits-all, top-down digital solution may be less effective than fostering locally-governed, interoperable digital infrastructures. The platform's use of open APIs and modular services also allows vertical integration with national systems while retaining local autonomy.
c. Guiding Future Technological Exploration: While not a technical manual, the architectural principles outlined (modularity, open standards) provide a strategic guide for future technical explorations. They encourage a focus on sustainable, adaptable, and non-proprietary systems, which is a critical long-term consideration for any public sector digital investment.
d. As a replicable sandbox for decentralized digital governance: The Kebumen model can serve as a live policy laboratory for testing adaptable governance rules, incentive schemes, and data-sharing agreements in low-resource contexts.

This platform design also has the potential to be replicated in the context of other conservation areas such as National Parks, Biosphere Reserve Areas, or rural regions with a dual mandate of conservation and sustainable development (UNESCO, 2019). With a modular approach and principles of open interoperability, this design allows for cross-regional replication without losing sensitivity to the local context. Thus, this design can act as an adaptive, inclusive, and measurable policy design artifact, while also strengthening the role of local government not merely as a regulator, but also as an enabler in expanding public digital infrastructure based on community needs.

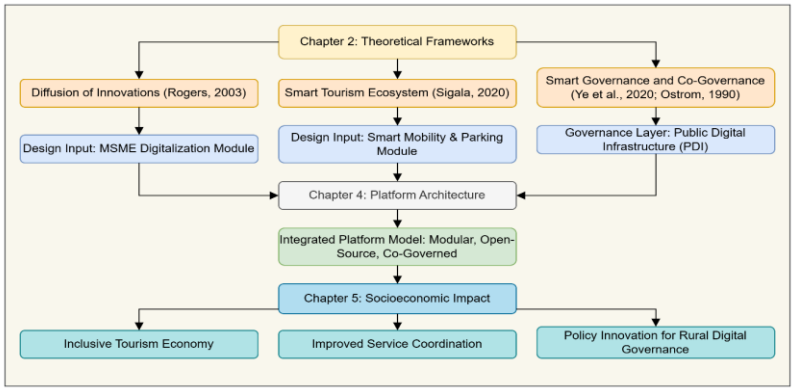

Figure 5. Theory–Design–Impact Map Bridging Chapters 2, 4, and 5.

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This conceptual diagram was created by the author to illustrate the logical pathway connecting theoretical frameworks (Chapter 2), design architecture (Chapter 4), and systemic impacts (Chapter 5), combining principles from Critical Interpretive Synthesis (CIS) and Comparative Policy Analysis (CPA).

3.20 Research Limitations and Implementation Risks

Although this model is based on a strong theoretical foundation and tested global practices, a number of limitations and implementation risks must still be anticipated, especially in a complex local context. It is important to transparently acknowledge the limitations of this conceptual research:

a. Lack of Empirical Validation: The main strength of this model is currently limited to its theoretical and conceptual justification. Its effectiveness, usability, and real-world impact have not yet been tested with primary data.
b. Implementation Complexity: The proposed approach assumes an ideal multi-stakeholder collaboration. In practice, bureaucratic challenges, budget politics, and institutional capacity can be significant obstacles.
c. Digital Divide Aspect: This platform only addresses the access aspect, but does not deeply tackle the issue of digital literacy among users (MSMEs and tourists), which requires separate support programs.
d. Limitation of Real-time Spatial Data: The full implementation of smart mobility features depends on the availability of IoT infrastructure (parking sensors, etc.) which may not be adequate, potentially becoming a technical challenge in the field.

These limitations, however, open opportunities for iterative co-development and collaborative experimentation. The success of the model depends on building cross-sector trust, phased implementation, and the presence of local digital champions capable of stewarding change.

3.21 Future Research Directions

Given that this model is still conceptual and has not been tested in implementation, the following future research directions are necessary not only to fill the empirical gap but also to mature the system's functions in a real operational context. Based on the limitations above, several future research directions can be proposed:

a. Pilot Project: Develop a functional prototype or a Minimum Viable Product (MVP) of the platform and test it on a limited scale at one of the geosites to collect initial empirical data.
b. Quantitative Research: After implementation, conduct a study to quantitatively measure the platform's impact on dependent variables (MSME revenue, visitor satisfaction levels, congestion reduction).
c. Comparative Study: Apply and compare the adaptation of this model in two or more geopark areas in Indonesia to understand the influence of contextual factors.
d. Participatory Design Study: Actively involve local users (MSMEs, community) from the early stages of redesign or new feature development to increase acceptability and ownership.
e. Theory of Change (ToC) Evaluation: Develop a logic framework to map and evaluate how this platform intervention can, in the long term, produce broader social and economic changes, both at the community and local governance levels.
f. Institutional Readiness Assessment: Conduct readiness audits in local governments to evaluate technical, financial, and bureaucratic capacity to implement PDI-based systems.

This follow-up research is essential for bridging the gap between conceptual innovation and field-level applicability but also for strengthening the evidence base for digital policy-making in the sustainable tourism sector. Furthermore, future studies should be transdisciplinary, involving experts in digital anthropology, urban planning, and systems engineering to bridge the gap between technology design and social reality. Thus, this future research direction is not just a technical continuation of the platform, but a catalyst for a paradigm shift in digital governance that is more collaborative, just, and community oriented.

By positioning itself as a contextual Public Digital Infrastructure, this model presents a hybrid approach between system design, participatory governance principles, and an inclusive development orientation. Therefore, the contribution of this research lies not only in the aspect of platform engineering but also in the re-proposal of the relationship between technology, community, and the state in an equitable tourism ecosystem.

The entire discussion in this chapter forms a solid conceptual and operational foundation, which will be summarized and re-emphasized in Chapter 6 as a conceptual contribution that is not only theoretical but also transformative in constructing community-based digital governance. Future studies should explore how participatory platform design can shift power asymmetries in peripheral economies, using methods such as digital ethnography and co-design workshops.

4. CONCLUSION

This research addresses two critical challenges in the Kebumen Geopark—namely, the economic exclusion of local Micro, Small, and Medium Enterprises (MSMEs) from the digital tourism value chain and the fragmentation of mobility services that diminish visitor experience—by developing an integrated solution in the form of a Public Digital Infrastructure (PDI) model. The proposed model offers a systemic and context-sensitive framework that integrates MSME empowerment with smart mobility and participatory governance within a modular, open-source architecture. Theoretically, this study

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advances the Smart Tourism Ecosystem framework by embedding civic-oriented and participatory governance as its structural core, shifting the discourse from technology-centered efficiency toward community-centered equity. Methodologically, it demonstrates the innovative application of Critical Interpretive Synthesis (CIS) and Comparative Policy Analysis (CPA) as complementary approaches to conceptual design research in digital tourism policy, providing a rigorous foundation for constructing theory-driven artefacts without empirical data dependency. Practically, the study delivers a technical–institutional blueprint that can guide policymakers, tourism authorities, and local governments in building inclusive, data-driven digital platforms. The Kebumen model thus serves as a replicable policy prototype for sustainable tourism governance in non-urban and geopark contexts. While the research remains conceptual and untested empirically, its clarity and adaptability position it as a foundation for further implementation through Minimum Viable Product (MVP) testing and quantitative impact evaluation. Ultimately, this work reaffirms that digital transformation in tourism must not only enhance efficiency but also embody social justice, openness, and co-governance, redefining technology as an instrument of empowerment rather than exploitation and paving the way for inclusive and sustainable tourism futures.

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