Repositioning the Village Development Index as AI-Enabled Rural Infrastructure: Strategic Pathways for Financial Innovation and Inclusive Growth in Indonesia

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ABSTRACT
This study systematically reviews Indonesia's Village Development Index (Indeks Desa Membangun or IDM) from 2015 to 2025, tracing its evolution from a basic rural classification tool to a multidimensional, digitally compatible infrastructure with untapped potential for artificial intelligence (AI) integration. Applying the PRISMA protocol, this review synthesizes 32 peer-reviewed articles to evaluate IDM's conceptual development, methodological challenges, and opportunities for embedding AI into rural governance systems. Recent enhancements, such as IDM+, Precision Village Data (DDP), and smart village frameworks, demonstrate significant strides toward intelligent policy design. However, persistent fragmentation and minimal AI adoption hinder its strategic impact. This paper argues that IDM's transformation offers a timely opportunity to align with AI-driven financial innovation. By leveraging machine learning, geospatial analytics, and real-time dashboards, IDM can be reimagined as a dynamic infrastructure to inform ecological fiscal transfers, rural credit scoring, and micro-insurance modeling. These capabilities mirror how AI is used in financial services to gain competitive advantage through risk profiling, predictive analytics, and inclusive market expansion. As such, this paper positions IDM as a tool for development measurement and a potential backbone for inclusive financial systems in emerging economies. The findings highlight key pathways for integrating AI into rural development indices, with implications for digital governance, innovative financing, and long-term socio-economic transformation.

Keywords: *Village Development Index, Smart Village, PRISMA, Indonesia.*

1. INTRODUCTION

In the era of data-driven governance, rural development in Indonesia faces dual imperatives: bridging socio-economic disparities and harnessing technology to transform public policy execution. With more than 75,753 villages across the archipelago (BPS, 2024), Indonesia's government has adopted the Village Development Index (Indeks Desa Membangun, IDM) as a core tool for evaluating village progress and allocating fiscal resources. While IDM has played a central role in directing village funds and informing strategic interventions, its underlying conceptual framework remains under-theorized, particularly amid the global shift toward AI-enabled policy intelligence.

This study responds to a critical gap in the literature by systematically reviewing IDM's evolution from 2015 to 2025. It traces the index's technical and conceptual development—including innovations such as IDM+, Precision Village Data (DDP), and smart village systems—and interrogates the extent to which these enhancements have prepared IDM for integration with artificial intelligence (AI) platforms. Such integration is essential to modernize rural financial governance, strengthen data credibility, and enable predictive, real-time policymaking, especially as the financial industry increasingly relies on AI to drive competitive advantage.

By applying the PRISMA protocol, this review synthesizes findings from peer-reviewed, open-access studies to identify methodological inconsistencies, data challenges, and underutilized opportunities for AI adoption. It aims to reposition IDM not merely as a rural classification tool but as a strategic digital infrastructure that, when integrated with AI, can support fiscal targeting, microfinance innovation, and inclusive economic planning—mirroring AI's transformative impact on financial industries globally.

1.1. Research Questions:

a. How has the Village Development Index (IDM) evolved from 2015 to 2025 regarding conceptual design, policy application, and integration of digital and AI technologies?

b. What research gaps exist in the current literature on IDM?

2. METHODOLOGY

This study adopted a systematic literature review (SLR) method to identify, select, and synthesize relevant research on Indonesia's Village Development Index (IDM). A systematic literature review method was chosen for several reasons. First, this method allows researchers to obtain a comprehensive and objective topic overview by collecting and analyzing published studies. As such, it minimizes bias in the selection and interpretation of data, thereby producing more accurate and reliable conclusions (Kitchenham and Charters, 2007). Second, this method follows a well-defined and well-documented protocol, such as Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), which ensures that the selection and analysis processes are conducted transparently and can be replicated by other researchers (Moher et al., 2009). Third, systematic literature reviews help to identify research gaps that have not yet been explored, serving as a foundation for more innovative and impactful future studies. This method is widely used across various disciplines, including medicine, social sciences, and engineering, to systematically and methodologically filter information from diverse sources. Fourth, by synthesizing findings from studies with varying methods and outcomes, systematic literature reviews generate more substantial evidence and provide a solid foundation for decision-making across fields (Snyder, 2019).

Applying the PRISMA protocol strengthens the methodological rigor of a systematic literature review and increases its potential for publication in high-impact journals that require strict reporting standards. This process involves the following stages: literature identification, screening, and selection, as well as data extraction and synthesis.

3. RESULTS AND DISCUSSION

Articles in this systematic review were selected through rigorous and structured stages to ensure the quality and relevance of the sources used. Initially, 112 articles were identified from academic databases such as Google Scholar, ScienceDirect, and DOAJ using the keywords “Indonesia” AND “village development index” OR “Indeks Desa Membangun.” These articles were then classified based on several criteria, including the year of publication, accessibility (only open-access articles), and relevance to the study's focus. Following the initial screening of the titles and abstracts, the number of articles was reduced to 37. Subsequently, full-text reviews were conducted to assess further the methodological quality, content relevance to the research topic, and contribution of each study to the understanding of the Village Development Index (IDM) in the Indonesian context. Based on the final selection, 32 articles met all the inclusion criteria and were deemed suitable for further analysis in this literature review. This rigorous selection process was intended to yield an in-depth, evidence-based, and contextually relevant synthesis.

This review identified studies reflecting IDM’s conceptual progress and policy application between 2015 and 2025. Analysis reveals a significant transformation from a static development classification tool into a more multidimensional and digitally informed policy instrument. However, persistent methodological fragmentation and limited AI adoption constrain IDM's strategic potential.

3.1. Evolution Toward Intelligent Policy Infrastructure

The literature indicates that the Indonesian government introduced the Village Development Index (IDM) in 2015 to classify villages into five categories: independent, advanced, developing, underdeveloped, and severely underdeveloped (Ardi, 2021). This concept is rooted in the principles of sustainable development, encompassing the economic, social, and environmental dimensions.

IDM conceptual development reflects dynamic progress in comprehensively comprehending, designing, and assessing rural development. In response to evolving development contexts and emerging challenges, researchers and policymakers have significantly contributed to refining IDM's theoretical and technical foundations, making it more relevant and adaptable to field needs. One of the significant milestones is the development of IDM Plus (IDM+), which incorporates environmental sustainability indicators such as natural resource management and climate action into the IDM framework to promote greener and more sustainable village governance. It is recommended to use IDM+ as a basis for ecological fiscal transfer schemes from districts to villages, thereby expanding the function of

IDM from a measurement tool to a fair and adaptive policy instrument (Mecca et al., 2020). Integrating ecological indicators into village scoring aligns with sustainable development goals and opens the door for AI-driven ecological fiscal transfer models—analogous to green scoring mechanisms used in ESG-based financial services.

The IDM concept also continues to evolve in response to challenges in the digital era, including the smart village framework, which emphasizes the role of information and communication technology (ICT) as a critical enabler of data-driven and participatory rural development. Factors such as the availability of village information systems, community participation, and local leadership are key elements in shaping an index responsive to contemporary developments (Susilowati et al., 2025). Efforts to strengthen village data infrastructure have become more tangible through the emergence of the Precision Village Data (Data Desa Presisi, DDP) concept, which combines census-based, spatial, and participatory approaches to produce more accurate representations of village conditions (Sjaf et al., 2022). These data architectures are structurally compatible with AI systems, providing rich input layers for machine learning algorithms, natural language processing, and geospatial modeling. If properly leveraged, such systems could support intelligent policy simulations, anomaly detection in village data reporting, and predictive modeling of development trajectories.

3.2. Research Gaps and Strategic Alignment with AI-Driven Governance

Although the Village Development Index (IDM) has been widely used to assess rural development in Indonesia, its application has been primarily centered on practical use and short-term program evaluations. This emphasis has not been sufficiently balanced with developing theoretical frameworks or in-depth comparative analyses, leaving several essential research gaps unexplored.

One of the key shortcomings is the lack of comparative studies between the IDM and other village development indices at the international level. To date, minimal research has compared the IDM with indices similar to those used in different countries. Such studies are crucial for identifying the strengths and limitations of IDM in a global context and uncovering opportunities to adopt international best practices to enhance its effectiveness. Research, such as the development of the Smart Village concept, has begun to explore paths toward internationalization by comparing technological and social innovation aspects at the village level in Indonesia. However, these approaches are limited to localized exploration without systematically comparing global experiences (Susilowati et al., 2025).

In addition, there is a significant lack of research on the long-term impacts of IDM-based policies. Existing studies have primarily focused on implementation processes and short-term outcomes, whereas comprehensive evaluations of IDM's long-term effects of IDM on rural economic sustainability, social resilience, and overall community well-being are scarce. This shortfall presents a compelling opportunity for applying AI-powered time series forecasting and causal inference models, which could enhance policymakers' ability to anticipate development trajectories and measure the persistence of policy outcomes over time.

For instance, studies on IDM implementation in Mempawah Regency (Moan Bura, 2021) and Ciamis (Herawan et al., 2023) mainly describe changes in village status over a short period (2–3 years) without investigating the sustainability of development outcomes. This reinforces the need for research focused on long-term transformations and their impacts on rural socioeconomic structures. Longitudinal studies are urgently needed to assess how IDM-based policies can drive sustainable structural changes and identify the key factors influencing their long-term effectiveness.

Another notable research gap lies in the data collection methodologies used to compile IDM. Currently, variations in the data collection processes across different regions can lead to measurement inconsistencies, making in-depth analysis more difficult. The transition from IDM to the broader Village Index reflects a shift in methodology and measurement focus, which may impact data consistency across regions and periods. In this context, the Precision Village Data (Data Desa Presisi, or DDP) approach proposed by Sjaf et al. (2022) offers a promising solution by introducing a more accurate and structured census-spatial-participatory method. However, there is still limited research that comprehensively examines the effectiveness of this method compared with conventional IDM data collection practices. Furthermore, discrepancies in the composition of village data collection teams, often consisting of village officials, community leaders, and other local actors, can also result in variations in data quality and accuracy.

Currently, the data collection for Indonesia's Village Development Index (IDM) follows the guidelines established by the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration (Kemendesa PDTT). This process involved forming data collection teams at the village level, consisting of village officials, community leaders, and other local representatives responsible for gathering IDM data. Then, IDM data are made publicly accessible

through official platforms such as Portal Satu Data Indonesia, which hosts IDM data from 2022 katalog.data.go.id and 2024 data.go.id.

Despite these efforts, challenges remain regarding the standardization of data collection methodologies. Variations in the composition of village data teams and the methods employed may result in data quality and accuracy. Research, such as the Mismatch of Village Development Indicators by Harmadi et al. (2020b), highlights that several indicators within the IDM are not implementable or do not align with the authority and context of certain villages. This reflects the need for harmonizing indicators and a more participatory and context-sensitive data-collection process. AI-enabled data validation tools, alongside the deployment of standardized dashboards, offer a promising path toward harmonizing data inputs. These technologies could establish real-time feedback mechanisms that support local governments in identifying anomalies, correcting errors, and making timely, evidence-based decisions.

On the other hand, methodological studies employing advanced statistical approaches, such as LR-GLASSO (Yunus et al., 2024), demonstrate the potential for improving the estimation and classification processes of village development data. However, such innovations have not yet been widely adopted in national data systems. Therefore, further efforts are necessary to ensure the consistent application of methodological standards across regions, including comprehensive training of data collectors and the establishment of effective verification mechanisms.

IDM's integration with financial systems remains underdeveloped. Although it has informed aspects of public budgeting, its potential utility in private financial services—such as rural microfinance, credit risk profiling, and insurance modeling—has not been fully realized. Through the strategic application of AI, IDM could be transformed into a robust rural scoring infrastructure. This would enable more sophisticated financial inclusion strategies, facilitate risk-adjusted fiscal transfers, and support performance-based public-private partnerships to enhance rural resilience and economic vitality.

These gaps underscore a critical juncture for IDM. The framework possesses the foundational architecture necessary for AI integration, yet its evolution into a brilliant governance tool depends on a deliberate process of redesign, standardization, and scalable technological investment. IDM can move beyond its current utility by addressing these areas and become a dynamic engine for inclusive, data-driven rural development.

4. CONCLUSION

This study provides a systematic review of the evolution and application of Indonesia's Village Development Index (IDM), shedding light on its transformation into a data-driven policy instrument. Incorporating ecological and digital indicators through IDM+ and developing the Precision Village Data (DDP) framework represent early attempts to embed intelligence and granularity into rural development assessments. These innovations, while promising, remain underutilized in unlocking the full potential of artificial intelligence (AI) for public sector modernization and financial sector innovation.

As the financial industry increasingly turns to AI to gain a competitive edge, integrating AI into national development indices such as IDM presents a unique opportunity. AI-driven analytics, natural language processing, and geospatial learning could dramatically enhance village-level development metrics' precision, responsiveness, and predictive power. This is especially relevant for financial institutions and public financing mechanisms aiming to target underserved areas more accurately and efficiently.

The findings of this review call for a rethinking of IDM not merely as a policy measurement tool but as a digital infrastructure capable of enabling intelligent, real-time, and inclusive financial strategies. In this context, IDM can evolve into a platform that supports credit scoring models for microfinance, risk-based rural insurance, and fiscal transfer algorithms based on ecological and socio-economic performance—all powered by AI.

To realize this vision, future research should focus on (1) Embedding AI into data collection and validation processes to reduce inconsistencies and enable adaptive measurement models; (2) Utilizing AI-powered longitudinal analytics to evaluate the structural impacts of IDM-based policies; (3) Developing AI-integrated dashboards for financial institutions and policymakers to simulate, monitor, and optimize resource allocation in rural areas.

Ultimately, leveraging AI within the IDM ecosystem offers a pathway to improve governance and rural development outcomes and a strategic opportunity for the financial industry to penetrate new markets with precision and purpose. The convergence of AI, village data systems, and financial services could become a cornerstone of equitable, sustainable, and competitive financial ecosystems in emerging economies.

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