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Collaborative Leadership in the Development of Integrated Land Data in Indonesia: A Systematic Literature Review

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ABSTRACT

This study examines the role of collaborative leadership in the development of integrated land data through a Systematic Literature Review (SLR) of 31 selected scholarly articles published between 2012 and 2025. The findings indicate that the successful development of integrated land data depends not only on technological advancement but also on the capacity of cross-sectoral leadership to foster coordination, institutional interoperability, and adaptive data governance. Standards and frameworks such as the Land Administration Domain Model (LADM), Indonesia's One Map Policy, and the Fit-for-Purpose Land Administration (FFP-LA) approach provide essential foundations for supporting land data integration in Indonesia. The study's principal finding confirms that collaborative leadership serves as the primary driving force behind the development of an integrated land data system by strengthening data governance, promoting standardization, and facilitating the adoption of technological innovation. Based on these findings, the study proposes a conceptual framework that positions collaborative leadership as the entry point for aligning data governance, international standards, and technological innovation to achieve an interoperable and sustainable land data system. The study recommends strengthening collaborative governance, enhancing institutional integration, and developing human resource capacity to support a sustainable national land administration system.

A. Introduction

Land administration constitutes one of the primary pillars of sustainable development and equitable spatial governance. According to the United Nations Global Geospatial Information Management (UN-GGIM), an effective land administration system provides the foundation for achieving the Sustainable Development Goals (SDGs), particularly those related to poverty alleviation, food security, economic growth, and the sustainable management of natural resources (Chen et al., 2024; UN-GGIM, 2018, 2022). Nevertheless, a substantial proportion of the population in developing countries still lacks adequate documentation of their land rights. Globally, approximately one billion people—or nearly a quarter of the world's adult population—do not feel secure regarding the certainty of their land and property rights (FAO, 2018; Prindex, 2021). This situation underscores that strengthening land administration systems remains a critical agenda in many countries.

In Indonesia, land administration challenges are becoming increasingly complex due to data and institutional authority fragmentation. Land data management remains fragmented across multiple institutions, such as the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN), the Ministry of Environment and Forestry (LHK), and the Ministry of Agriculture; because each operates under different standards, systems, and mandates, data interoperability has not yet functioned optimally (Siswanto, 2010; Widiyantoro & Rineksi, 2024). A study in East Kotawaringin Regency demonstrated that overlapping spatial utilization reached 38.24–50.89% of the total area due to poor human resource quality, budget constraints, and inadequate regulations (Wahyuningsih, 2024). These issues hinder the implementation of agrarian reform, spatial planning, land conflict resolution, and the acceleration of public service digital transformation.

Fundamentally, land administration is a comprehensive system encompassing land tenure registration, land-use regulation, property valuation, and spatial planning. The effectiveness of this system heavily depends on the availability of accurate, up-to-date, consistent, and interoperable data across agencies. Therefore, interoperability represents a primary prerequisite in the development of modern land administration systems. One internationally accepted standard is the Land Administration Domain Model (LADM) or ISO 19152, which provides a conceptual framework for integrating the spatial, legal, and social dimensions of land administration (ISO, 2025; Van Oosterom & Lemmen, 2015; Oukes et al., 2024).

International literature has demonstrated rapid advancements in the development of land administration technologies and standards. The Fit-for-Purpose Land Administration (FFPLA) approach offers faster, more adaptive, and affordable solutions for developing countries (Enemark et al., 2014; Balas et al., 2021). Furthermore, various digital innovations have begun to be implemented, such as blockchain to enhance the security and transparency of land transactions (Ansah et al., 2023; Rashid et al., 2025), the utilization of Unmanned Aerial Vehicles (UAVs) for more efficient spatial data acquisition (Junarto & Djurjani, 2020), and the development of three- and four-dimensional cadastral systems (3D/4D Cadastre) to accommodate the complexity of spatial rights (Kalogianni et al., 2020; Shahidinejad et al., 2024). These innovations illustrate that land administration transformation no longer relies solely on document digitalization but also on the establishment of integrated data ecosystems.

Indonesia has responded to these needs through the One Map Policy, which aims to unify national geospatial references at a 1:50,000 scale (President of the Republic of Indonesia, 2016). This policy was subsequently strengthened by Presidential Regulation Number 23 of 2021 and supported by Law Number 4 of 2011 concerning Geospatial Information, alongside Presidential Regulation Number 39 of 2019 concerning One Data Indonesia, which emphasizes the importance of data standards, metadata, interoperability, and shared reference codes. Despite these policy advancements, the implementation of land data integration at the operational level still faces various obstacles, particularly regarding cadastral parcel data that requires higher precision, specifically up to a 1:5,000 scale or finer (Mustofa & Wahyuni, 2020; Nurwadjedi, 2020; Pinuji, 2016).

Previous studies have primarily focused on the development of data standards, spatial infrastructures, and technological innovations. In contrast, the dimensions of collaborative governance and collaborative leadership have received relatively inadequate scholarly attention. However, operational experiences from the One Map Policy and One Data Indonesia indicate that the

primary barriers to data integration often stem not from technological limitations, but rather from divergent institutional mandates, sectoral silos, inconsistent data standards, and weak inter-agency coordination. In practice, coordination among ATR/BPN, the Ministry of Environment and Forestry, and the Ministry of Agriculture frequently encounters deadlocks due to overlapping jurisdictions and ineffective data-sharing mechanisms (Hosseini, Atazadeh, & Rajabifard, 2025; Hull, 2024).

The literature on collaborative governance emphasizes that successful public sector collaboration requires leadership capable of building a shared vision, fostering trust, managing conflicts, and agreeing upon collaboration rules accepted by all actors (Ansell & Gash, 2008; Crosby & Bryson, 2010; Emerson et al., 2012). In the context of land data development, collaborative leadership acts as a critical link between technological innovation and data governance. Collaborative leadership enables various institutions to align standards, strengthen interoperability, and establish sustainable coordination mechanisms. Consequently, the successful integration of land data is determined not only by technological readiness but also by institutional capacity to manage cross-sectoral collaboration.

Against this background, the development of integrated land data represents a multidimensional phenomenon shaped by the interaction among geospatial information technology, data governance, and collaborative leadership. Although these three dimensions have been widely discussed independently in previous research, few studies have integrated them into a cohesive conceptual framework. Consequently, a comprehensive understanding of how technological innovation, data governance mechanisms, and collaborative leadership interact to support the successful integration of land data systems remains unavailable.

Therefore, this study aims to map the evolution of the literature regarding collaborative leadership, data governance, and land data integration technologies through a Knowledge and Publication Synthesis (KPS) approach. Subsequently, it analyzes the scientific and practical gaps that persist within the literature, particularly concerning cross-agency collaboration design, human resource readiness, data governance mechanisms, and the utilization of digital technologies in building land administration systems. Based on these analyses, this study develops a conceptual framework that elucidates the relationships among collaborative leadership, data governance, and technological capabilities as the foundation for integrated land data development. This framework is expected to contribute to the advancement of land administration theory while serving as an actionable reference for policymakers in strengthening national land data integration in a more operational, measurable, and sustainable manner.

B. Methods

1. Research Design

This study was designed as a Systematic Literature Review (SLR). Unlike traditional literature reviews, which are often narrative and subjective, an SLR is conducted using a systematic, explicit, and reproducible methodology to identify, select, evaluate, and synthesize all evidence relevant to a predefined research question (Kitchenham & Charters, 2007). This approach was adopted to ensure that the review of the literature on integrated land information was comprehensive and unbiased, thereby producing robust and defensible conclusions.

To achieve these objectives, this study adopted two primary methodological frameworks. First, the SPIDER framework was used to develop and guide the literature search strategy (Cooke, Smith, & Booth, 2012). Second, the entire review process and its findings were reported in strict accordance with the PRISMA 2020 guidelines to ensure transparency and completeness of reporting (Page et al., 2021). The application of PRISMA 2020 ensured that every stage of the review process, including identification, screening, eligibility assessment, and study inclusion, was clearly documented in a flow diagram, thereby enabling readers to evaluate the credibility and scope of the review.

2. Literature Search Strategy

The literature search was conducted systematically across several leading scientific databases to ensure broad coverage of the relevant literature. The search strategy consisted of the following components:

1. Keywords and Search Strings: Search terms were developed based on the SPIDER framework and focused on two thematic domains: (a) integrated land information, including land administration/cadastre, integrated land information, interoperability, SDI/geoportal, LADM, fit-for-purpose, blockchain, and UAV/AI; and (b) collaborative leadership and governance, including collaborative leadership, collaborative governance, interagency collaboration, data governance, and data sharing agreement.
2. Databases: Literature searches were conducted using the Scopus, Web of Science, and Google Scholar databases.
3. Selection Process: The selection process was performed independently by two authors. The first stage involved screening titles and abstracts, followed by a second stage consisting of full-text evaluation.

An overview of the conceptual framework is presented in the following sections describing the SPIDER framework and the inclusion and exclusion criteria, together with the SLR Search and Screening Protocol Flowchart (Figure 1).

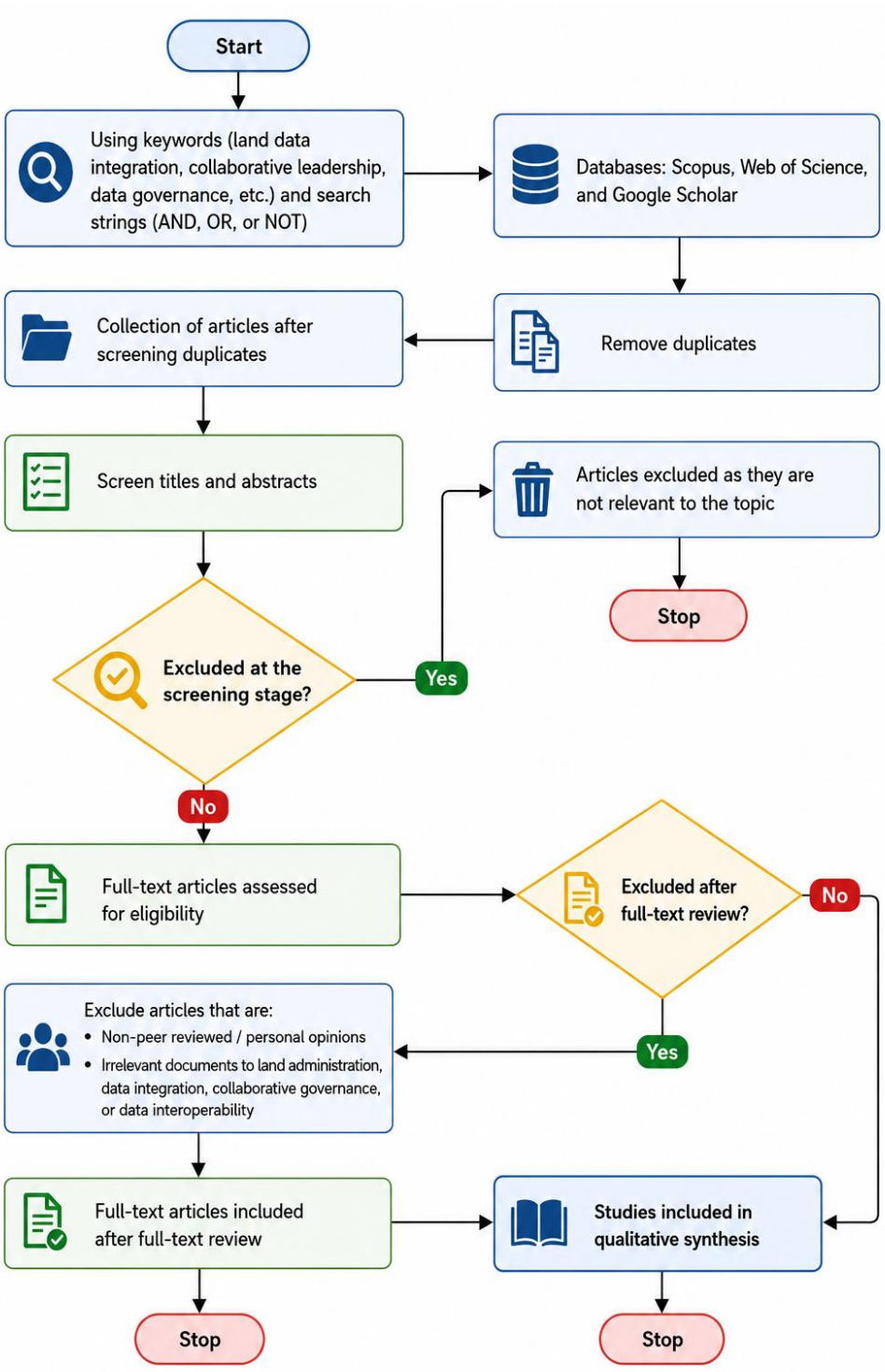

Figure 1. SLR Search and Screening Protocol Flowchart

3. SPIDER Framework

The SPIDER framework, which was specifically developed for research questions emphasizing qualitative and mixed-methods evidence, was employed because it is well suited for exploring the contexts, experiences, and implementation models of integrated land information systems (Cooke et al., 2012). During the *Sample* stage, the literature search was limited to articles published between *2012 and 2025* to capture recent developments in digital land administration, data governance, and collaborative governance. The *Phenomenon of Interest* stage focused on integrated land information and collaborative governance. The *Design* stage identified the research approaches adopted in the

selected studies. The *Evaluation* stage assessed indicators of successful data integration, including interoperability, data quality, and service effectiveness. Finally, the *Research Type* stage classified the studies into empirical and conceptual research to facilitate a comprehensive synthesis.

4. Inclusion and Exclusion Criteria

The inclusion criteria were as follows: (1) documents published in English or Indonesian; (2) studies that substantially addressed integrated land information development and/or collaborative leadership, collaborative governance, or data governance within the context of integrated land information; (3) peer-reviewed scholarly publications and reputable conference proceedings; and (4) credible policy literature providing implementation context, including legislation, reports published by international organizations (e.g., UN-GGIM), mainstream news releases, and official government portals containing policy-related information.

Before the exclusion stage was applied, each article that passed the initial screening was subjected to a quality assessment based on its substantive relevance to the research focus, the reputation of the publishing journal (e.g., indexed in Scopus or SINTA), and the clarity of the research methodology employed. This assessment was conducted to ensure the validity of the synthesis process within the Systematic Literature Review.

The exclusion criteria were subsequently applied in the following order: (1) duplicate documents; (2) personal opinion pieces or blogs without a clearly defined editorial review process; and (3) documents that did not explicitly address land information or land administration, or that were not relevant to data integration or collaborative leadership and governance.

C. Results and Discussion

1. Academic Literature Landscape

Data were analyzed using a thematic narrative synthesis. The process involved coding the key findings from each eligible article through a combination of deductive and inductive approaches. Initial deductive codes were developed based on existing conceptual frameworks (such as the pillars of land administration and technology components), while new inductive codes emerged organically from the data throughout the analytical process.

The resulting codes were grouped into themes representing the major patterns, gaps, and recommendations identified in the literature. In addition, supporting visualizations, including a word cloud (to display the most dominant keywords) and a topic network (to map relationships among concepts), were used to enrich the presentation of the findings. The literature selection results are presented in the PRISMA diagram and the initial literature matrix, which served as the basis for the synthesis. To visualize the literature selection process transparently, the literature screening stages are quantified in Table 1, and the corresponding PRISMA 2020 flow diagram is illustrated in Figure 2.

Table 1. Article Screening Stages

No.	Stage	Number of Articles	%
1	Identification from databases	150	100
2	After duplicate removal	130	87
3	Title and abstract screening	120	80

4	Exclusion (not relevant)	50	33
5	Full-text assessed	70	47
6	Full-text exclusion	39	26
7	Final studies analyzed	31	21

Source: Authors' data processing, 2026

Based on the PRISMA flow diagram (Figure 2), the literature selection process was conducted systematically and documented transparently (Haddaway, Page, Pritchard, & McGuinness, 2022). During the identification stage, searches of electronic databases retrieved 150 articles (referred to by Haddaway et al. as *records*). Before the screening process, 30 articles were removed because of duplication, 5 articles were excluded because they did not meet the inclusion criteria based on automated assessment, and another 5 articles were excluded for other reasons, such as inadequate bibliographic completeness. Consequently, 120 articles proceeded to title and abstract screening. At this stage, 70 articles were excluded because they were not relevant to the research topic. The remaining 50 articles were subsequently sought in full text, and all were successfully retrieved. Following the eligibility assessment of the 50 full-text manuscripts, no articles were excluded for being outside the study scope; therefore, all were considered eligible. However, during the final synthesis, only 31 research articles met all inclusion criteria and were included in this systematic literature review.

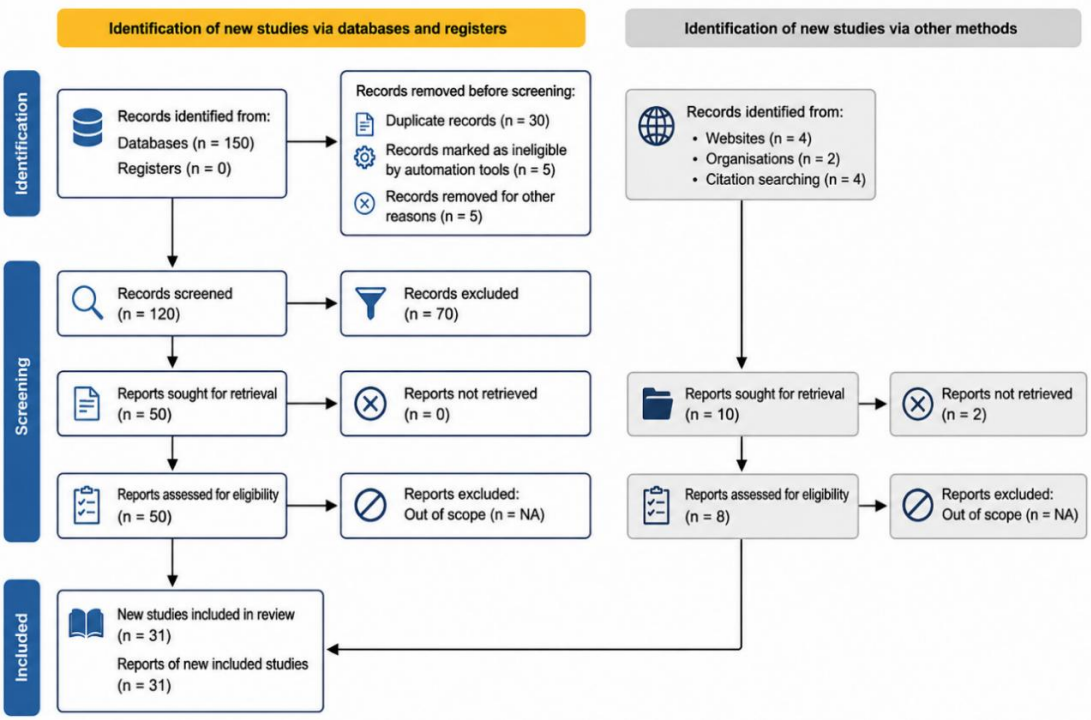

Figure 2. Detailed Conceptual Framework → PRISMA Flow Diagram
Source: Adapted from the technique proposed by Haddaway et al., 2022

The initial screening table included the title, author(s), publication year, journal, research objective, variables, study object, and research findings. The collected literature varied in terms of sample, topic, research design, study type, and geographical context (Table 2). The principal findings were as follows:

1. LADM supports interoperability across processes and datasets and formalizes SDG indicators to improve computational accuracy.
2. Three-dimensional and four-dimensional cadastral systems require appropriate DBMSs, unique identifiers, quality assurance procedures, and temporal versioning.
3. FFPLA proved efficient in Mozambique by reducing costs and processing time, increasing user satisfaction, and being well suited for mass land registration.
4. Emerging technologies, including blockchain and AI, demonstrated considerable potential; however, blockchain implementation depended on institutional factors, whereas AI served as a framework for smart Land Administration Systems (smart-LAS).
5. In the Indonesian context, the principal barriers to OMP were related to governance, including human resources, budget, regulations, and data bureaucracy, rather than purely technical constraints. Integration between SIP and IDSN requires strengthening the six elements of the IDS framework.
6. Data updating and public participation were also significant. UAVs were effective for baseline mapping and data updating, while Volunteered Geographic Information (VGI) and citizen participation accelerated the collection of land rights data and the detection of land disputes (Further details are presented in Table 2).

Collaborative leadership emerged as a central theme explaining why data integration frequently stalled despite the availability of appropriate technologies. The public-sector collaboration literature emphasizes the importance of facilitative leadership in establishing collaborative forums, creating a shared vision and legitimacy, and managing inter-organizational conflicts of interest (Ansell & Gash, 2008). In the context of data integration, collaborative leadership is also closely associated with data governance decisions, including who determines standards, who serves as the data steward, and how data quality and security are maintained. These decisions directly influence interoperability and cross-system data utilization (Khatri & Brown, 2010). Further details are provided in Appendix 1.

Table 2. Themes and Conceptual Focus

Literature Theme	Conceptual Focus	Technology/ Approach	Main Findings
Land data standardization	Integration of land administration data models	LADM	Enables system interoperability and integration of SDG indicators
3D/4D cadastre	Representation of complex spatial environments	Spatial DB, unique identifiers, versioning	Supports the management of spatial and temporal dimensions in cadastral systems
Fit-for-Purpose Land Administration	Large-scale land registration	Flexible needs-based approach	Reduces registration costs and processing time while increasing public satisfaction
Digital transformation	Modernization of land administration systems	Blockchain, AI	Offers potential improvements in transparency and efficiency of land administration
Land governance in Indonesia	Barriers to data integration	Regulatory and institutional arrangements	The primary constraints originate from institutional rather than technological factors
Community participation	Data collection and updating	UAV, VGI	Improves data updating and public participation

Literature Theme	Conceptual Focus	Technology/ Approach	Main Findings
Collaborative leadership	Cross-agency integration	Collaborative governance	Leaders should establish collaborative arenas and develop a shared vision
Data governance	Regulation of data use	Data governance framework	Determines standards, stewardship roles, and data quality control

Source: Authors' data processing, 2026

The visualizations presented in the previous chapter indicate that the literature on integrated land data has evolved around several major clusters: land data standardization, 3D/4D cadastre, Fit-for-Purpose Land Administration, digital transformation, land governance in Indonesia, community participation, collaborative leadership, and data governance. These clusters converge on a single overarching theme: the integration of the national land data system.

2. Leadership, Data Governance, and Technology Approaches to Land Data Integration

The analysis of the reviewed literature indicates that the development of integrated land data depends not only on technological innovation but also on an organization's capacity to manage digital transformation strategically. To understand these dynamics, the findings of this study were interpreted through several strategic management perspectives.

Collaborative leadership emerged as the common thread explaining why data integration frequently stagnates despite the availability of appropriate technologies. The public-sector collaboration literature emphasizes the importance of facilitative leadership in establishing collaborative arenas, creating a shared vision and legitimacy, and managing conflicts of interest among institutions (Ansell & Gash, 2008). In the context of data integration, collaborative leadership is also associated with data governance decisions—who determines standards, who serves as the data steward, and how data quality and security are maintained—which influence interoperability and cross-system data utilization (Khatri & Brown, 2010). Further details are presented in Table 3.

Table 3. Strategic Management Approaches Applied

Theoretical Perspective	Conceptual Focus	Organizational Implications	Relevance to Land Data Integration
AI-first organization	Data as the core of the organization's operating model	Integrated data architecture and rapid feedback mechanisms	Land administration systems require a data architecture capable of supporting AI
Digital ecosystem strategy	Orchestration of networks of partners and complementors	Cross-organizational collaboration through digital platforms	Data integration requires coordination among government agencies
Dynamic capabilities	Organizational adaptation to change	Integration and recombination of organizational competencies	Land administration agencies need the capability to adapt to emerging technologies
Organizational ambidexterity	Exploration of innovation versus exploitation of legacy systems	Maintaining a balance between stability and innovation	New integrated systems must remain compatible with existing systems
Open strategy	Strategy as an inclusive social practice	Stakeholder participation	Land data strategies should involve multiple stakeholders

Theoretical Perspective	Conceptual Focus	Organizational Implications	Relevance to Land Data Integration
Business Model Innovation	Experimentation with service delivery models	Development of data-driven value propositions	Land data can serve as the foundation for data-driven public services
Behavioral strategy	Psychological and social influences on decision-making	Emotional, framing, and power-related factors	Data integration is influenced by organizational dynamics and institutional interests

Source: Authors' data processing, 2026

Second, the literature indicates that the successful integration of land administration systems increasingly depends on an organization's ability to manage digital ecosystems involving multiple actors and institutions. In this context, organizations not only develop internal technologies but must also orchestrate networks of partners and complementors within a digital ecosystem platform (Adner, 2017; Cusumano, Gawer, & Yoffie, 2019).

Third, digital transformation in land administration requires the development of dynamic capabilities, defined as an organization's ability to continuously build, integrate, and reconfigure its competencies in response to technological advances and changes in the policy environment (Shiferaw & Amentie Kero, 2024).

Fourth, organizations are also required to develop organizational ambidexterity, namely the ability to simultaneously explore new innovations while exploiting existing systems. Within the public sector, organizational ambidexterity is essential for maintaining a balance between the stability of established administrative systems and the need for digital innovation (Hamblin, Plimmer, Badar, & Lasthuizen, 2024).

Fifth, the open strategy and strategy-as-practice perspectives emphasize the importance of stakeholder involvement in organizational strategy formulation. These perspectives view strategy not merely as a formal document but as a series of social practices involving multiple actors in the decision-making process (Hautz, Seidl, & Whittington, 2017; Seidl, Ma, & Splitter, 2024).

Sixth, the concept of Business Model Innovation (BMI) serves as a framework for translating technological innovation into value propositions that can be implemented in practice. This approach emphasizes iterative experimentation and validation in designing data-driven service models (Andreini, Bettinelli, Foss, & Mismetti, 2022).

Seventh, the behavioral strategy perspective highlights that strategic decisions are not entirely rational but are also shaped by psychological and social factors, including heuristics, emotions, framing, and organizational power dynamics (Cristofaro, Augier, Lovallo, Abatecola, & Leoni, 2024).
When applied to the development of integrated land data systems, these conceptual perspectives collectively point to the need to design a data architecture capable of supporting AI technologies, establish cross-institutional ecosystem governance, strengthen organizational capabilities, and develop collaborative mechanisms that enable continuous innovation.

3. Systematic Literature Analysis Based on the SPIDER Framework

The literature analysis using the SPIDER framework demonstrates that the development of integrated land data is a dynamic and multidisciplinary field of research. Under the Sample dimension, the literature corpus was dominated by reputable international journal articles addressing both global

contexts and cross-country comparative studies. Journals such as Land Use Policy and Land served as the principal publication outlets in the field of land administration. At the national level, important contributions were also published in journals such as BHUMI, JIANA, and Region, which examine the implementation of land policies and technologies within the Indonesian context.

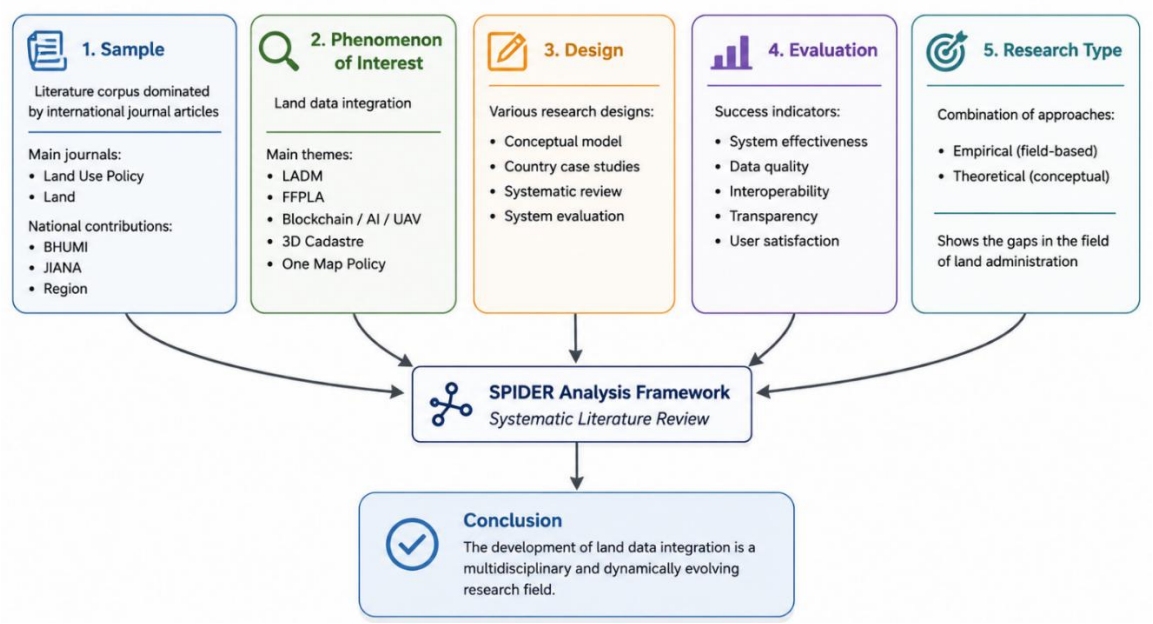

Figure 3. Systematic Analysis Diagram Based on the SPIDER Framework
Source: Authors' data processing, 2026

Under the Phenomenon of Interest dimension, the research primarily focused on the integration of land administration systems and land data. The major themes identified included land data standardization through the Land Administration Domain Model (LADM) (Lemmen et al., 2015), the Fit-for-Purpose Land Administration (FFPLA) approach (Balas et al., 2021), the application of digital technologies such as blockchain, artificial intelligence (AI), and unmanned aerial vehicles (UAVs) (Ansah et al., 2023), three-dimensional cadastral representation (Kalogianni et al., 2020), and national integration policies such as Indonesia's One Map Policy (*Kebijakan Satu Peta*) (Pinuji, 2016).

Under the *Design* dimension, the reviewed studies employed diverse research designs, ranging from conceptual studies proposing land administration system models (Hosseini et al., 2025), implementation case studies conducted in specific countries (Okembo et al., 2024), systematic literature reviews (Shahidinejad et al., 2024), to system evaluation studies assessing the performance of operational land administration systems (Nugroho, 2023).

The *Evaluation* dimension indicates that the success of land data integration was generally assessed using several key indicators, including system effectiveness (cost, processing time, and service coverage), data quality (accuracy and validity), system interoperability, and governance dimensions such as transparency and user satisfaction.

Under the *Research Type* dimension, a balance was observed between empirical studies based on field data and theoretical studies developing conceptual frameworks. This combination suggests that land administration has reached a certain level of maturity in both theoretical development and practical innovation.

4. Research Gaps and Conceptual Implications

Although the literature on integrated land data development has expanded rapidly, this synthesis identified several important research gaps that warrant further investigation (see Figure 4 and Table 4).

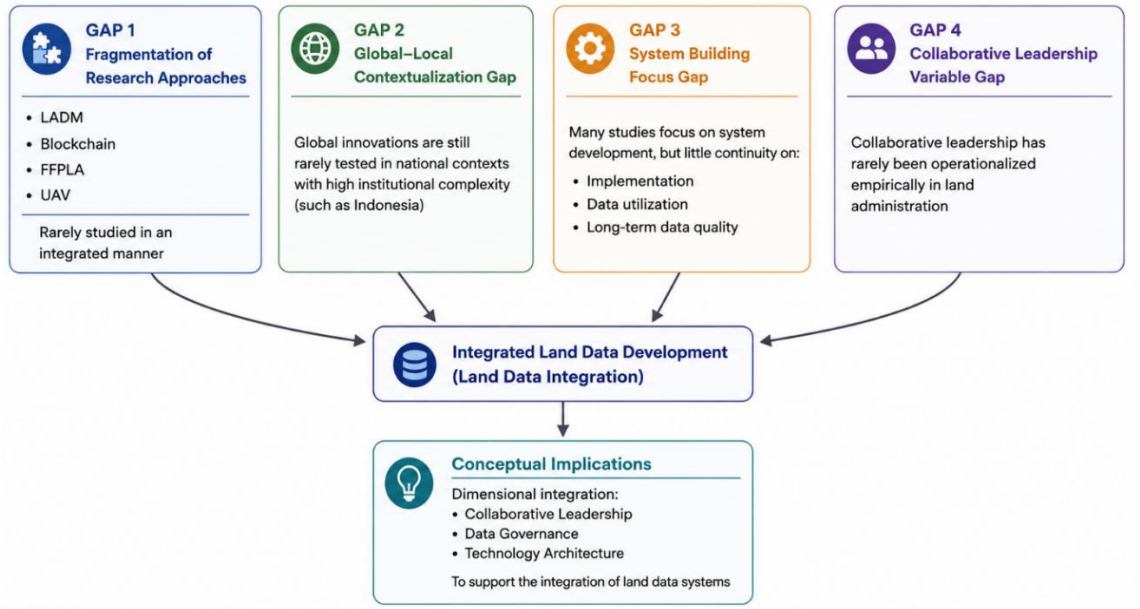

Figure 4. Research Gaps and Conceptual Implications
Source: Authors' data processing, 2026

Table 4. Research Gaps

Gap Category	Description	Research Implications
Fragmentation of research approaches	Many studies examine technologies or standards separately (LADM, blockchain, FFPLA, UAV)	Integrative research is needed to combine these approaches within a single implementation framework
Global–local contextualization	International innovations have rarely been tested in countries with highly complex legal and institutional environments	Additional empirical studies are needed in national contexts such as Indonesia
Focus on system development	Most studies emphasize system development	Further research should address system sustainability, including financing, data updating, and long-term data quality
Collaborative leadership	Leadership variables are rarely operationalized in land administration studies	Future research should examine the relationship between collaborative leadership and data governance

Source: Authors' data processing, 2026

First, the literature continues to exhibit fragmented research approaches. Many studies focus on individual aspects of land administration, such as data standardization, blockchain technology, or the FFPLA approach. However, relatively few studies investigate the comprehensive integration of these approaches—for example, how LADM standards can be implemented in practice through the FFPLA approach supported by blockchain technology and UAVs.

Second, a gap exists in contextualizing global solutions within local settings. Many innovations developed in the international literature have not been thoroughly evaluated in countries with complex legal, social, and institutional environments such as Indonesia.

Third, most existing studies continue to focus on the system building phase, whereas the maintenance and long-term sustainability (system sustaining) of land administration systems have received comparatively limited attention. Nevertheless, the success of integrated land data systems depends substantially on sustainable financing, effective data updating mechanisms, and long-term data quality management.

Fourth, the land administration literature remains relatively limited in operationalizing the concept of collaborative leadership and explicitly linking it to data governance. However, collaborative governance theory suggests that leadership and institutional design are often the primary determinants of the success or failure of cross-organizational collaboration (Crosby & Bryson, 2010; Emerson et al., 2012; Huxham & Vangen, 2013).

These findings indicate that the development of integrated land data is not merely a technical or technological challenge but also one of leadership, institutional governance, and inter-organizational collaboration design. Accordingly, future research should develop a conceptual framework that integrates collaborative leadership with data governance and technological architecture in the development of integrated land data systems. The proposed conceptual framework is presented in Figure 5.

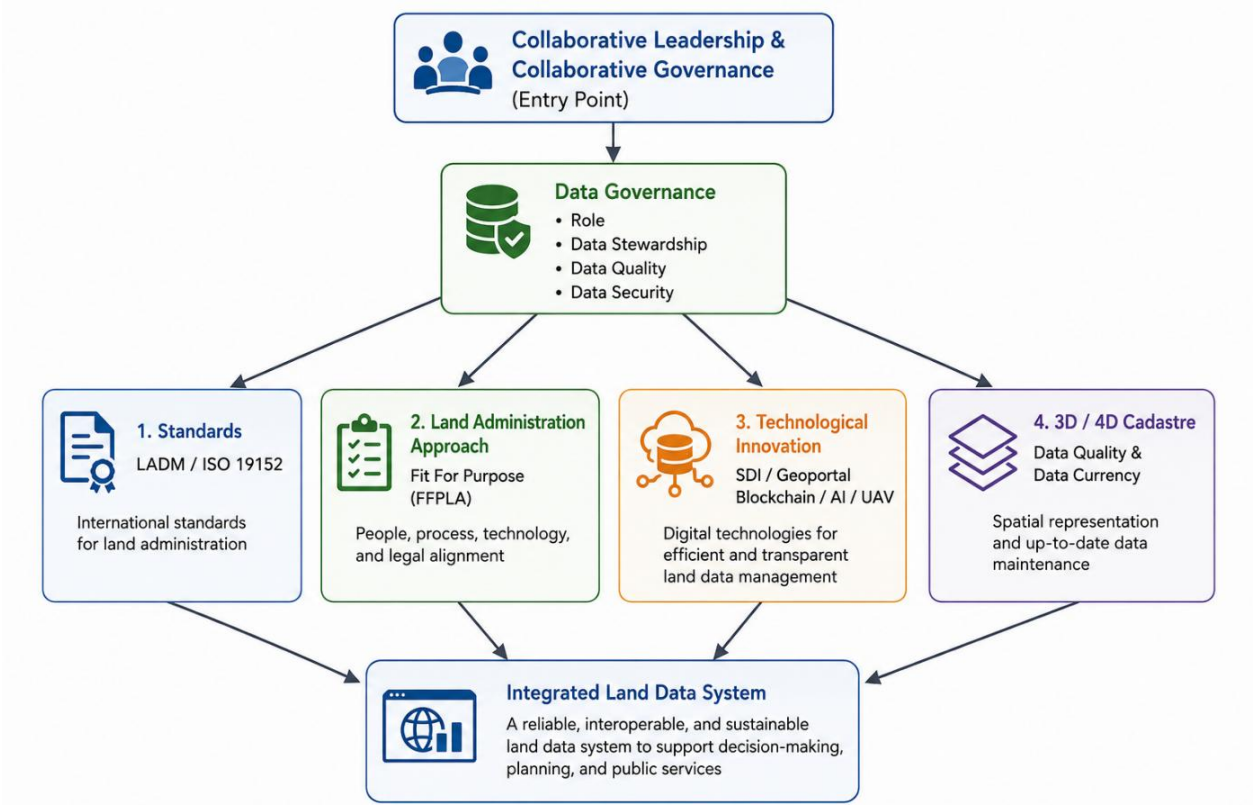

Figure 5. Proposed Conceptual Framework: "Collaborative Leadership and Governance → Integrated Land Data"
Source: Authors' data processing, 2026

One of the principal findings of this study indicates that collaborative leadership can no longer be regarded merely as an organizational support factor but rather as the primary driving force behind the development of integrated land data systems. Based on these findings, this study proposes a conceptual framework that integrates collaborative leadership, data governance, international

standardization, technological innovation, and cadastral modernization into a unified pathway for land data system development. This framework extends the existing land administration literature, which has traditionally focused primarily on technical and technological aspects, by positioning collaborative leadership as the catalyst that aligns cross-sector stakeholders, strengthens data governance, and facilitates the effective implementation of technology. Consequently, the proposed conceptual model not only contributes to the advancement of land administration theory but also offers a strategic framework for governments and other stakeholders seeking to establish integrated, interoperable, and sustainable land data systems.

D. Conclusion

This study aims to identify key research themes, analyze existing gaps, and formulate a conceptual framework linking collaborative leadership, data governance, and technological capability in integrated land data development. A systematic analysis of 31 publications classifies the evolution of the literature into three clusters: technological standardization (LADM, 3D/4D cadastre, blockchain, and artificial intelligence), implementation models (Fit-for-Purpose Land Administration [FFPLA], unmanned aerial vehicles [UAVs], and Volunteered Geographic Information [VGI]), and collaborative governance, all of which converge on the integration of national land data systems.

The proposed conceptual framework integrates six key elements: (1) collaborative leadership as the entry point; (2) data governance, including roles, stewardship, data quality, and security; (3) LADM/ISO standardization; (4) the FFPLA approach; (5) technological innovations, including geoportals, blockchain, UAVs, and artificial intelligence; and (6) the strengthening of 3D/4D cadastre together with data quality assurance and updating procedures. The framework demonstrates that successful land data integration depends not only on technological capability but also on leadership that orchestrates interagency collaboration and establishes effective data governance.

This review contributes three primary deliverables to the land administration discourse: (1) a knowledge map of prevailing research topics and methodologies; (2) a SPIDER-based literature matrix; and (3) a strategic roadmap for future research addressing current limitations in integration, local contextualization, system sustainability, and leadership dynamics. Ultimately, this study contributes to the advancement of land administration theory while providing a policy foundation for the operational and sustainable implementation of integrated land data systems.

This study has several limitations. First, the number of articles meeting the inclusion criteria is relatively limited and therefore does not fully represent the breadth of global land administration research. Second, most of the analyzed literature remains conceptual in nature, indicating that empirical validation of the relationships among collaborative leadership, data governance, and system interoperability is still required. Third, the proposed conceptual framework has not yet been validated through field-based research.

E. Recommendations

To address the identified gaps and advance the proposed conceptual framework, future studies should transition from conceptual exploration to empirical validation. The following four strategic avenues are recommended (see also Figure 5):

1. Holistic Technology Integration: How can isolated technological approaches (e.g., LADM, FFPLA, blockchain, and UAVs) be synthesized into a single, cohesive implementation framework rather than being examined separately?
2. Contextualization of International Solutions: What are the specific institutional and legal barriers to adapting global standards (such as LADM) to highly complex local administrative environments like Indonesia, and how can they be mitigated?
3. Long-Term System Sustainability: Beyond initial system development, what operational governance arrangements, sustainable financing models, and periodic data updating mechanisms are required to ensure the long-term viability of land administration systems?
4. Collaborative Leadership and Data Governance: How do specific dimensions of collaborative leadership—such as shared vision, trust building, joint decision-making, and conflict management—empirically influence data quality, interagency interoperability, and the execution of data-sharing agreements?

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Appendix

Table A1. Selected Articles

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
1	3D Cadastral Database Systems—A Systematic Literature Review	(Shahidinejad et al., 2024)	2024	ISPRS International Journal of Geo-Information	To analyze the literature on 3D cadastral databases to identify approaches and technologies for data storage and management.	Conceptual data model, query types, evaluation metrics, DBMS, visualization technologies, data preparation, data transformation, ETL process.	Literature on 3D cadastral databases.	The study provides insights for selecting appropriate standards, technologies, and DBMSs for designing 3D cadastral database systems.
2	3D land administration: A review and a future vision in the context of the spatial development lifecycle	(Kalogianni et al., 2020)	2020	ISPRS International Journal of Geo-Information	To review the current state of land administration systems and introduce a future vision within the spatial development lifecycle.	Legal, technical, and organizational aspects of 3D land administration.	Land Administration Systems (LASs) within the spatial development lifecycle.	A cross-sectoral approach and the use of standards such as LADM and BIM/IFC are required for effective system integration.
3	A Land Administration Data Exchange and Interoperability Framework for Kenya and Its Significance to the Sustainable Development Goals	(Okembo, Morales, Lemmen, Zevenbergen, & Kuria, 2024)	2024	Land	To develop a land administration interoperability and data exchange framework for Kenya that supports the Sustainable Development Goals.	ISO Framework for Enterprise Interoperability (FEI), Kenya Land Administration Domain Model (LADM) profile.	Land administration system in Kenya.	The developed interoperability framework supports SDG achievement through data integration and stakeholder validation.
4	A systematic review of the institutional success factors for blockchain-based land administration	(Ansah et al., 2023)	2023	Land Use Policy	To identify and analyze the institutional factors critical to the successful adoption	Institutional factors (regulations, organizations, culture).	Blockchain-based land administration projects.	Success requires the coexistence and interaction of all institutional factors, not merely a

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
					of blockchain-based land administration.			supportive regulatory environment.
5	All for one and one for all? Exploring the nexus of land administration, land management and land governance	(Hull, 2024)	2024	Land Use Policy	To examine the similarities and differences among land administration, land management, and land governance through bibliometric analysis.	Land administration, land management, and land governance concepts.	Scientific publications in the land domain.	Each concept is distinct but overlaps with the others; the findings are useful for domain identity and curriculum design.
6	Berbagi pakai data spasial pertanahan pada penyusunan rencana detail tata ruang (*Sharing land spatial data in the preparation of detailed plans spatial policy*)	(Widiyantoro & Rineksi, 2024)	2024	Region: Jurnal Pembangunan Wilayah dan Perencanaan Partisipatif	To examine the current state of land spatial data sharing in the Netherlands and Indonesia for detailed spatial planning.	Technology, human resources, data standards, policies/regulations, data.	Spatial Data Infrastructure (SDI) in the Netherlands and Indonesia.	The Netherlands has succeeded due to strong support across all five variables, whereas Indonesia continues to face challenges in several aspects.
7	Beyond PICO: The SPIDER tool for qualitative evidence synthesis	(Cooke et al., 2012)	2012	Qualitative Health Research	To describe the SPIDER search tool as an alternative to PICO for qualitative evidence synthesis and mixed-methods research.	Sample, Phenomenon of Interest, Design, Evaluation, Research Type.	Search strategies for qualitative and mixed-methods research.	SPIDER requires further refinement and evaluation as an alternative to PICO for qualitative research.
8	Bridging Sustainable Development Goals and Land Administration: The Role of the ISO 19152 Land Administration Domain Model in SDG Indicator Formalization	(Chen et al., 2024)	2024	Land	To formalize SDG indicators using the LADM standard and propose extensions for its revision.	SDG indicators (1.4.2, 5.a.1, 14.5.1, 11.5.2).	Land Administration Domain Model (LADM).	The approach eliminates ambiguity, improves computational efficiency, and produces more accurate indicator values.

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
9	Deriving requirements for integrated and standardised cadastre profile from the legacy Board of Revenue and the contemporary land administration systems	(Ahsan et al., 2025)	2025	Survey Review	To examine the requirements for integrating and standardizing land administration systems in Islamabad, Pakistan, using LADM.	Land ownership, value, use, and development.	Land administration system in Islamabad, Pakistan.	Systematic transformation is required to convert legacy revenue sketch maps into accurate 2D/3D geospatial data.
10	Development of a Methodology and Model for Land Administration Data Dissemination Processes	(Križanović & Roić, 2023)	2023	Land	To develop a methodology and model for land administration data dissemination processes.	Registration and data dissemination processes.	Land administration data dissemination processes.	The methodology and model provide guidance for process modeling while addressing organizational and technological challenges.
11	Enhancing land management policy in Bangladesh: A blockchain-based framework for transparent and efficient land management	(Rashid et al., 2025)	2025	Land Use Policy	To improve Bangladesh's land management system through a blockchain-based framework that enhances transparency and efficiency.	Blockchain, smart contracts, IoT, AI.	Land management system in Bangladesh.	The framework improves transparency, reduces corruption, and increases efficiency in land management.
12	Evaluation of Land Information System Development in The National Land Agency	(Mustofa, 2020)	2020	BHUMI: Jurnal Agraria dan Pertanahan	To document and evaluate the development of the Land Information System (LIS) at the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN).	Information system structure, SDLC, Enterprise GIS.	Development of the Land Information System at ATR/BPN.	The study provides an overview of the LIS from multiple perspectives and highlights opportunities and future development challenges.

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
13	Hybrid governance and land purchase strategies in a state-subsidised housing project in a rural South African town	(Barry & Roux, 2019)	2019	Survey Review	To investigate hybrid governance and land acquisition strategies in a subsidized housing project in South Africa.	Registration accessibility, registration usability, risk awareness.	Off-register land transactions in a subsidized housing project.	Continuous maintenance of land tenure rights and active community-based organization (CBO) involvement are crucial for sustaining secure land rights.
14	Implementasi Kebijakan Satu Peta dalam Rangka Penyelesaian Tumpang Tindih Pemanfaatan Ruang Kabupaten Kotawaringin Timur (*Implementation of the One Map Policy to Resolve Overlapping Spatial Utilization in East Kotawaringin Regency*)	(Wahyuningsih, 2024)	2024	Jurnal Ilmu Administrasi Negara ASIAN (Asosiasi Ilmuwan Administrasi Negara)	To analyze the causes of overlapping spatial utilization and develop strategies for its resolution in East Kotawaringin Regency.	Human resource quality, budget capacity, regulatory weaknesses.	Overlapping spatial utilization reaching 38.24%–50.89% in East Kotawaringin Regency.	Improved human resource capacity, adequate budget allocation, and better regulatory arrangements are required.
15	Implementing data exchange and interoperability on LADM country profiles using the ISO framework for enterprise interoperability standard	(Oukes et al., 2024)	2024	Land Use Policy	To implement data exchange and interoperability for LADM country profiles using the ISO enterprise interoperability framework.	Business, process, service, and data interoperability.	LADM country profiles.	FEI provides effective guidance for implementing LADM-based land administration systems.
16	Integrasi Sistem Informasi Pertanahan dan Infrastruktur Data Spasial Dalam Rangka Perwujudan One Map Policy (*Integration of*	(Pinuji, 2016)	2016	BHUMI: Jurnal Agraria dan Pertanahan	To identify and analyze the critical integration points between the Land Information System and the National	Six SDI elements: policy, standards, access, data, human resources, technology.	Integration of the Land Information System and the National Spatial	Effective integration requires comprehensive development of all six SDI elements rather

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
	Land Information Systems and Spatial Data Infrastructure in the Context of Realizing the One Map Policy)				Spatial Data Infrastructure through Geo-KKP implementation.		Data Infrastructure.	than partial implementation.
17	Integrating decentralised land administration systems with traditional land governance institutions in Ghana: Policy and praxis	(Biitir, Nara, & Ameyaw, 2017)	2017	Land Use Policy	To examine the integration of decentralized land administration systems with traditional land governance institutions in Ghana.	Record keeping, personnel quality, office facilities.	Customary Land Secretariats (CLSs) in Ghana.	Maintaining local registries and strengthening the revenue-generation capacity of CLSs are critical for successful implementation.
18	Kebijakan Satu Peta Mencegah Konflik di Bidang Administrasi Pertanahan (*The One Map Policy Prevents Conflicts in Land Administration*)	(Silviana, 2019)	2019	Administrative Law and Governance Journal	To examine the implementation of the One Map Policy in land administration for preventing land administration conflicts.	Legal certainty of land rights.	Implementation of the One Map Policy in land administration.	Accelerating land registration is necessary to ensure legal certainty and support the One Map Policy.
19	Land Administration Standardization for the integration of cultural heritage in land use policies	(Gogolou & Dimopoulou, 2015)	2015	Land Use Policy	To explore the use of LADM for integrating cultural heritage into land use policies.	Rights, Restrictions, and Responsibilities (RRRs) related to cultural property.	Immovable cultural heritage in Greece.	LADM serves as a fundamental tool for developing spatial infrastructure for archaeological heritage.
20	Optimalisasi Implementasi Kebijakan Satu Peta Untuk Penyelesaian Konflik Penggunaan Lahan di Indonesia (*Optimizing the Implementation of*	(Nurwadjedi, 2020)	2020	Jurnal Pembangunan dan Administrasi Publik	To formulate policy directions for open access to thematic geospatial information in order to resolve land use conflicts.	Data acquisition procedures, data access, network infrastructure, data distribution bureaucracy, human resources.	Thematic geospatial information (e.g., forest status and spatial plans).	Bureaucratic procedures are the most important criterion, followed by adequate infrastructure and human resources.

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
	the One Map Policy for Resolving Land Use Conflicts in Indonesia)							
21	Pemanfaatan Teknologi *Unmanned Aerial Vehicle* (UAV) untuk Pemetaan Kadaster (*Utilization of UAV Technology for Cadastral Mapping*)	(Junarto & Djurjani, 2020)	2020	BHUMI: Jurnal Agraria dan Pertanahan	To evaluate the capability of UAV technology for acquiring and updating geospatial data for a multipurpose cadastre.	Mapping methods, processing, quality control.	UAV applications in cadastral mapping.	The resulting products effectively support base map production, land-use conversion monitoring, and digital services.
22	Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement	(Moher et al., 2009)	2009	PLoS Medicine	To revise the QUOROM reporting guideline into PRISMA to improve the reporting quality of systematic reviews and meta-analyses.	Reporting quality of systematic reviews.	Systematic reviews and meta-analyses in healthcare.	PRISMA provides the preferred reporting guideline for systematic reviews and meta-analyses.
23	Registration of apartments and office spaces in 3D land administration – A case study in Croatia	(Vucic, Vranic, Sutherland , & Van Oosterom, 2024)	2024	Land Use Policy	To present a conceptual model for a 3D cadastre in Croatia focusing on the registration of apartments and office spaces.	Building register, unique identifiers.	Land Administration System (LAS) in Croatia.	The proposed methodology establishes intuitive unique identifiers for buildings and their components.
24	The fit for purpose land administration approach-connecting people, processes and technology in mozambique	(Balas et al., 2021)	2021	Land	To conceptualize, develop, and evaluate a Fit-for-Purpose Land Administration approach tailored to Mozambique (FFPLA-MOZ).	People, processes, technology.	Large-scale land registration program in Mozambique.	FFPLA-MOZ reduced costs and processing time while improving data and work quality.

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
25	The Implementation of LADM Versioned-Object Class for Representing Spatio-Temporal of Cadastre 4D Objects	(Sulistyawati, Aditya, & Santosa, 2018)	2018	BHUMI: Jurnal Agraria dan Pertanahan	To develop a 4D spatial data model compatible with Indonesia's land administration system for representing changes in 3D boundary geometry over time.	LADM Versioned-Object class.	Strata title ownership in Indonesia.	Visualization of 4D cadastral objects was implemented using the LADM Versioned-Object class and deployed on the web.
26	The Land Administration Domain Model	(Lemmen et al., 2015)	2015	Land Use Policy	To align land administration data models with societal drivers and technological opportunities using LADM.	Parties, basic administrative units, spatial units.	Land Administration Domain Model (LADM).	LADM provides a globally standardized vocabulary for land administration and supports sustainability.
27	The Land Administration Domain Model (LADM): Motivation, standardisation, application and further development	(Van Oosterom & Lemmen, 2015)	2015	Land Use Policy	To facilitate efficient land administration through a flexible and widely applicable domain model.	Versioning/history, integration with source documents, 2D/3D geometry.	ISO 19152:2012 Land Administration Domain Model (LADM).	LADM functions as an international knowledge base and focal point for land administration.
28	Towards intelligent land administration systems: Research challenges, applications and prospects in AI-driven approaches	(Hosseini et al., 2025)	2025	Land Use Policy	To investigate AI-driven approaches for land administration functions and present a future vision for intelligent land administration systems.	AI applications for tenure, value, use, and development.	Land Administration Systems (LASs) worldwide.	A conceptual framework was introduced for developing intelligent AI-driven land administration systems.
29	Towards Quality Management	(Visnjevac, Soskic, &	2024	ISPRS International Journal of	To analyze and present quality management	Geometric and alphanumeric data.	3D cadastral systems.	Quality management procedures require further development to

No.	Title	Author(s) (Year)	Year	Journal	Research Objective	Variables	Research Object	Research Findings
	Procedures in 3D Cadastre	Mihajlovic, 2024)		Geo-Information	procedures for the design, implementation, and maintenance of 3D cadastral systems.			satisfy country-specific requirements.
30	Validity and Reliability of Cadastral Map for Complete Systematic Land Registration in Kalisari and Tlogopandogan Villages, Demak Regency, Indonesia	(Nugroho, 2023)	2023	BHUMI: Jurnal Agraria dan Pertanahan	To evaluate the validity and reliability of cadastral maps produced under the Complete Systematic Land Registration (PTSL) program in two villages of Demak Regency.	Map content validity, map reliability.	PTSL cadastral maps in Kalisari and Tlogopandogan Villages.	The map in Tlogopandogan demonstrated high validity and reliability due to compliance with regulations, whereas the map in Kalisari showed lower validity and reliability.
31	VGI-based spatial data infrastructure for land administration	(Naghavi, Alesheikh, Hakimpour, Vahidnia, & Vafaeineja d, 2022)	2022	Land Use Policy	To design and develop a Volunteered Geographic Information (VGI)-based Spatial Data Infrastructure model for public participation in land administration in Iran.	Volunteered Geographic Information (VGI), citizen participation.	Land administration system in Iran.	The VGI-based SDI supports voluntary land rights data collection and integrated land management.

Source: Authors' data processing, 2026