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Unlocking Indonesia's Floating Solar Potential: A PPP Regulatory Review

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ABSTRACT

Indonesia possesses significant potential for the development of Floating Solar Power Plant, or Floating Photovoltaic (FPV) systems, with an estimated capacity of 14,701.71 MWp. Nevertheless, the actual utilization of FPV remains very low. The Ministry of Public Works (MPW) seeks to optimize the use of multipurpose dams as FPV sources through the Public-Private Partnership (PPP) scheme. According to the data released by the Directorate of Dams and Lakes, Directorate General of Water Resources, 257 out of 259 dams nationwide are considered suitable for FPV development. Despite this potential, the implementation of PPP schemes for FPV projects has encountered stagnation. The preliminary evaluations reveal regulatory misalignment between MPW and PT PLN (Persero), which has resulted in a two-stage procurement process that is inefficient and legally ambiguous. These inefficiencies have led to adverse impacts on the government, private sector entities, and society. This study employs a qualitative approach with a Normative Legal Review Gap Analysis framework. The findings highlight the need for regulatory harmonization among MPW, the Ministry of Energy and Mineral Resources, and PT PLN (Persero). Such harmonization would facilitate the establishment of joint Contracting Agencies, a single-stage procurement process, and greater tariff certainty. The study offers policy recommendations that serve as a reference for cross-sectoral regulatory integration and enhance institutional coordination in the development of FPV infrastructure on MPW dams, thereby contributing to Indonesia's Net Zero Emissions target by 2060.

Keywords: Dams; Floating Solar Power Plant; PPP; Procurement; Regulation

ABSTRAK

Indonesia memiliki potensi Pembangkit Listrik Tenaga Surya (PLTS) Terapung dengan estimasi kapasitas listrik yang dihasilkan mencapai 14.701,71 MWp. Namun, pemanfaatan PLTS Terapung masih relatif rendah sehingga Kementerian Pekerjaan Umum (PU) mendorong optimalisasi pemanfaatan bendungan multiguna sebagai sumber PLTS Terapung melalui skema Kerja sama Pemerintah dan Badan Usaha (KPBU). Data Direktorat Bendungan dan Danau, Direktorat Jenderal Sumber Daya Air, menunjukkan sebanyak 257 dari 259 bendungan yang tersebar di seluruh Indonesia memiliki potensi besar untuk dikembangkan sebagai PLTS Terapung. Namun, terdapat beberapa kendala yang menghambat pelaksanaan KPBU PLTS Terapung sehingga mengalami stagnasi. Berdasarkan evaluasi awal terhadap pelaksanaan KPBU PLTS Terapung yang sedang berjalan, terdapat disharmoni regulasi pengadaan antara Kementerian PU dengan PT PLN (Persero), sehingga proses pengadaan dilakukan 2 (dua) tahap dan berjenjang. Akibatnya, terjadi inefisiensi proses dan ketidakpastian hukum yang memicu kerugian bagi seluruh pihak termasuk Pemerintah, Badan Usaha, dan masyarakat. Penelitian ini menggunakan pendekatan kualitatif dan kerangka Normative Legal Review Gap Analysis. Hasil penelitian menunjukkan perlunya harmonisasi regulasi antara Kementerian PU, Kementerian ESDM, dan PT PLN (Persero) agar dapat mengakomodasi pelaksanaan PJPK Gabungan, pengadaan 1 (satu) tahap, dan kepastian besaran tarif. Penelitian ini menawarkan rekomendasi penyusunan regulasi lintas sektor dan koordinasi kelembagaan dalam pengembangan infrastrukutur PLTS Terapung untuk mendukung program Net Zero Emission tahun 2060.

Kata Kunci: Bendungan; KPBU; Pengadaan; PLTS Terapung; Regulasi

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INTRODUCTION

Indonesia has formally committed to achieving Net Zero Emissions (NZE) by 2060. To realize this target, the government has applied five key principles: (1) expanding the use of New and Renewable Energy (NRE); (2) cutting back on fossil fuels; (3) promoting the adoption of electric vehicles in the transportation sector; (4) increasing electricity consumption in residential and commercial sectors, and (5) utilizing Carbon Capture and Storage (CCS) technologies (Ministry of Energy and Mineral Resources Press Release dated October 8, 2021 on *Principles and Government Roadmap to Achieve Net Zero Emission*).

In line with the first principle—enhancing the utilization of NRE—the National Electricity General Plan (*Rencana Umum Kelistrikan Nasional* or RUKN) for the period of 2024–2060, as stipulated in the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 85 of 2025, outlines progressive targets for the renewable energy share in the primary energy mix: 21% by 2030, 41.3% by 2040, 64.7% by 2050, and 73.6% by 2060.

Indonesia, as a country rich in natural resources, has enormous potential for the development of NRE sources. According to the National Energy General Plan (*Rencana Umum Energi Nasional* or RUEN), as outlined in Presidential Regulation No. 22 of 2017, the country's NRE potential is estimated at 443.2 GW, with the largest share of 207 GW deriving from Solar Power Plants (SPP). This potential is attributed to Indonesia's equatorial position with an average solar radiation intensity of around 4.8 kilowatt-hours per meter square (kWh/m2/day). Despite this favorable solar profile, the current utilization of solar power remains extremely low, at merely 0.04%. Consequently, the development of solar power plants, including Floating Solar Power Plants (FSPPs), represents a major opportunity for expanding the country's renewable energy portfolio.

A comprehensive study by IESR (2025) maps Indonesia's solar energy potential in detail, strengthening the argument regarding the vast untapped resource. The report identifies a technical potential of 336.5 GW of ground-mounted solar power plants spread across 781 potential locations throughout the country. Following a financial feasibility analysis that considered various economic parameters, 165.9 GW of this total potential was found to be economically viable for development at 290 locations.

The Ministry of Public Works (MPW), as the government agency responsible for integrated and sustainable water resources management, promotes the optimization of multipurpose reservoirs and dams as sources

of electricity generation, including Floating Solar Power Plants, also known as Floating Solar Photovoltaic (FPV) systems, in support of the NRE mix target of 21% by 2030. According to data from the Directorate of Dams and Lakes (Dit. Benda), Directorate General of Water Resources (DJSDA), as of March 2025, MPW oversees 259 dams across Indonesia, 11 of which were constructed after 2024. Of these, 257 dams are identified as suitable for FPV installation, with a combined inundation area of 73,508.54 hectares and an estimated electricity generation capacity of 14,701.71 megawatt-peak (MWp) (Directorate of Water Resources Infrastructure Financing [Dit. PPISDA], 2025).

To optimize the utilization of dams for FPV development, MPW collaborates with private entities through the Public-Private Partnership (PPP) scheme. According to the Regulation of the Minister of National Development Planning/Head of the National Development Planning Agency Number 7 of 2023 concerning the Implementation of Public-Private Partnerships in Infrastructure Provision, PPP refers to a collaborative arrangement between the government and private sector entities for infrastructure development in the public interest. This partnership is implemented in accordance with technical specifications predetermined by the relevant Minister, Head of Institution, Regional Head, State-Owned Enterprise, or Region-Owned Enterprise. The scheme may involve the partial or full mobilization of private sector resources and must ensure an equitable allocation of risks between the parties. Through this mechanism, business entities are expected to play an active role in government infrastructure projects, thereby reducing reliance on the state budget.

However, challenges persist in the implementation of the PPP scheme, particularly during the transaction phase. A primary concern lies in the procurement process for the Implementing Agency (*Badan Usaha Pelaksana* or BUP), which will be further examined in the discussion section. This process involves the selection of a private entity to serve as the cooperation partner of the Government Contracting Agency (GCA) in executing the PPP project. The procurement follows the procedures outlined in the Regulation of the Government Procurement Policy Agency (*Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah* or LKPP) Number 1 of 2025 concerning Procurement Procedures for Public-Private Partnerships in Infrastructure Provision.

According to Presidential Regulation of the Republic of Indonesia Number 112 of 2022 concerning the Acceleration of the Development of New and Renewable Energy for Electricity Supply, Article 14 Paragraph 4 stipulates that the purchase of electricity generated by Floating Solar Power Plants, where the land is provided by the government, shall be carried out through a direct selection mechanism. This process includes a series of activities ranging from document submission to the signing of the Power Purchase Agreement (PPA), including document evaluation and electricity tariff negotiations.

As a result, following the procurement process conducted by the Ministry of Public Works, the selected Implementing Agency is required to undergo a second selection process at PT PLN (Persero), in which it must compete with other bidders. This dual-stage procurement mechanism reflects inefficiencies and procedural redundancies, contributing to legal and investment uncertainties. Such conditions may discourage private sector participation in PPP initiatives for dam-based renewable energy

projects, particularly in the development of floating solar power plants.

This regulatory misalignment may hinder the government's efforts to increase the share of NRE in pursuit of the NZE target by 2060. Thus, this study seeks to examine the regulatory inconsistencies between the Implementing Agency procurement process at the Ministry of Public Works and PT PLN (Persero). To address these challenges, the study proposes potential solutions aimed at streamlining the regulatory framework and enhancing institutional coordination. This research adopts a qualitative approach, specifically the Normative Legal Review and Gap Analysis method.

LITERATURE REVIEW

Public-Private Partnership (PPP)

The World Bank (2021) defines PPP as a long-term contract between a private party and a government entity for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance.

PPP constitutes a collaborative arrangement between the government and private sector entities to deliver public infrastructure based on specifications predetermined by the Minister, Head of Institution, Regional Head, State-Owned Enterprise (SOE), or Region-Owned Enterprise (ROE). This collaboration may utilize partial or full resources of the business entities, with an emphasis on equitable risk-sharing among stakeholders, in compliance with Presidential Regulation Number 38 of 2015 on Public-Private Partnership in Infrastructure Provision.

Kurdi and Syafitri (2024) identify several key roles played by PPP in Indonesia's infrastructure development. First, the scheme helps address government budget constraints by reducing reliance on the State Budget (APBN). Second, it enables the procurement of complex infrastructure projects by optimizing private-sector capabilities in design, construction, and operation—competencies that are often beyond the government's reach. Third, PPP facilitates risk-sharing between the public and private sectors, ensuring that the government does not bear the full burden in the event of project failure. Last, private sector involvement in infrastructure management fosters a check-and-balance mechanism that promotes more optimal and efficient management.

In addition, PPP schemes contribute to improved budgeting by reducing unforeseen expenditures and mitigating the risk of project delays. They also enhance the quality of public services through innovations and efficiencies introduced by private entities. Moreover, PPP increases accountability by involving various stakeholders in oversight processes, including the Government Contracting Agency (GCA), business entities, and lenders (Zainuddin & Hasanah, 2025).

There are two primary PPP funding models based on the source of investment returns: (1) user charge schemes, in which revenue is generated directly from service users, and (2) availability payment schemes, wherein payments are made by the government based on the availability of the service, irrespective of usage levels.

A wide range of infrastructure types can be developed under PPP schemes, including economic and social infrastructure, such as roads, water resources and irrigation systems, potable water supply, wastewater management systems, telecommunications and information, electricity infrastructure, and other categories of public infrastructure,

as per Regulation Number 7 of 2023 issued by the Minister of National Development Planning/Head of the National Development Planning Agency concerning the Implementation of Government and Business Entity Cooperation in Infrastructure Provision.

There are two types of PPP schemes: solicited and unsolicited. A solicited PPP is initiated by a public authority—such as a Minister, Head of Institution, Regional Head, or Director of an SOE—while an unsolicited PPP is proposed by a business entity.

The **solicited PPP** process comprises four main phases: planning, preparation, transaction, and management. The *planning* stage includes activities such as identifying potential PPP projects, determining appropriate funding schemes, and planning the budgets. It also encompasses public consultation processes, proposing projects for inclusion in the PPP project list, and preparing the official PPP plan list. The *preparation* stage involves conducting a feasibility study, implementing supporting activities, and exploring market interest. The pre-feasibility study typically comprises strategic, economic, commercial, financial, and managerial analyses. Upon the completion of the feasibility study and the necessary supporting activities, the Government Contracting Agency (GCA) may advance to the *transaction* stage. This phase includes determining project locations, selecting an Implementing Agency, executing the PPP contract, and completing financial arrangements for infrastructure provision. Once the Implementing Agency secures the necessary project financing, the *management* phase begins. This stage involves administering and supervising the PPP agreement, managing the construction process, overseeing service delivery, and planning for the project's termination and asset handover at the end of the contract.

The **unsolicited PPP** process consists of three stages: preparation, transaction, and management. The *preparation* phase begins with the submission of a Letter of Interest (LoI) and supporting documents by a potential private proponent. If the proposed PPP project is approved, the GCA issues a letter of approval to proceed; otherwise, a rejection notice is sent to the business entity. Following approval, the prospective proponent prepares a feasibility study along with additional supporting documentation. These documents are then evaluated by the GCA, which includes assessing market interest and conducting public consultations. If the evaluation results are favorable, the GCA issues an initiative approval letter; otherwise, a rejection letter is provided.

The transaction and management stages of unsolicited PPPs mirror those of solicited PPPs. The *transaction* stage includes determining the project location, procuring the Implementing Agency, signing the PPP agreement, and securing the financing necessary for infrastructure provision by the Implementing Agency. Furthermore, during the *management* stage, activities involve overseeing and supervising the implementation of the PPP agreement, which includes the construction process, service delivery, and the transition phase at the end of the agreement period.

To ensure the success of a PPP project—particularly during the transaction stage, where achieving financial close is critical—adequate risk allocation alone is often insufficient. Thus, additional support mechanisms are required to enhance the project's attractiveness to investors and lenders. Government guarantees are key components of Indonesia's PPP framework, designed at mitigating specific risks and strengthening private sector confidence. For this purpose, the government provides a

centralized guarantee facility through *PT* Penjaminan Infrastruktur Indonesia (Persero), also known as the Indonesia Infrastructure Guarantee Fund (IIGF), a state-owned enterprise under the Ministry of Finance.

IIGF's primary role is to provide guarantees for financial risks arising from the actions or omissions of the GCA, including political risks and the risk of contract default. With such guarantees, the creditworthiness and bankability of PPP projects can be substantially enhanced. This support can ultimately lower the cost of capital for private entities and offer assurances to lenders, thereby encouraging greater private sector involvement in strategic infrastructure development, such as Floating Solar Power Plants. As emphasized by Wibowo and Puspita (2024), government support—particularly in the form of infrastructure guarantees—is vital to ensuring the financial viability of PPP projects. This facility not only serves as a risk mitigation instrument but also acts as a strong signal of government commitment, which enhances investor and lender confidence and helps prevent technically feasible strategic projects from becoming unbankable.

Table 1. Literature review framework

Theme	Subtheme	Literature
PPP Projects	-	- Presidential Regulation Number 38 of 2015 concerning Government Cooperation with Business Entities in the Provision of Infrastructure - Regulation of the Minister of National Development Planning/Head of the National Development Planning Agency Number 7 of 2023 concerning the Implementation of Government and Business Entity Cooperation in the Provision of Infrastructure - Regulation of the Minister of Public Works and Public Housing Number 2 of 2021 concerning Procedures for Implementing Government Cooperation with Business Entities in the Provision of Infrastructure - Regulation of the Public Procurement Policy Agency Number 1 of 2025 concerning Procurement Procedures for Government and Business Entity Cooperation in the Provision of Infrastructure
Water Resources	-	- Law Number 17 of 2019 concerning Water Resources
	Dams	- Regulation of the Minister of Public Works and Public Housing Number 7 of 2023 concerning the Second Amendment to the Regulation of the Minister of Public Works and Public Housing Number 27/PRT/M/2015 concerning Dams
Electricity	-	- Presidential Regulation Number 112 of 2022 concerning the Acceleration of Renewable Energy Development for Electricity Supply - Decree of the Minister of Energy and Mineral Resources Number 85 of 2025 concerning the National Electricity General Plan

Utilization of PU Dams for Floating Solar Power Supply

Indonesia possesses a solar power potential of 207 GW, as outlined in the National Energy General Plan (RUEN) under Presidential Regulation Number 22 of 2017. This substantial potential stems from the country's strategic position along the equator, which results in high levels of solar radiation across the archipelago. Despite this geographic advantage, the current utilization

of solar PhotoVoltaic (PV) energy remains limited—accounting for only 0.04% of the total potential. To address this significant gap, the development of Floating Solar Power Plants by optimizing the use of dams managed by the Ministry of Public Works is expected to contribute to the government's efforts in accelerating the development of sustainable and efficient energy infrastructure.

Projects such as the Cirata Floating Solar PV Plant with a capacity of 192 MWp / 142 MWac exemplify the potential of utilizing water resources to generate renewable energy while minimizing land use (Marupa et al., 2022). Compared to rooftop or ground-mounted systems, floating solar PV offers several key advantages: they optimize the use of reservoir space, can be operated in hybrid configurations alongside hydropower, reduce surface water evaporation, and increase energy yield efficiency up to 10% due to the lower ambient temperatures over water surfaces (Hidayat et al., 2022).

To support this initiative, the Ministry of Public Works has revised regulatory provisions through the Regulation of the Minister of Public Works Number 7 of 2023, which amends the previous Regulation Number 27/PRT/M/2015 on Dams. The amendment increases the acceptable limit for floating solar installations from a maximum of 5% to 20% of the reservoir's inundation surface area at the normal water level. This allowance is granted under the condition that key factors such as dam functionality, structural safety, and environmental, social, economic, and cultural impact assessments are carefully assessed. Additionally, the installation process must prioritize safety precautions to mitigate risks associated with structural failure, hydraulic failure, and seepage, especially under extreme conditions such as earthquakes, where structural loading risks may be higher (Rinaldi et al., 2021).

Marupa et al. (2022) emphasize that the placement of solar panels in floating solar power plants requires careful technical evaluation, including towards factors such as flow velocity, wave height, and sediment dispersion. These are vital to ensure the system's efficiency and resilience against environmental variability. Pujianto et al. (2024) argued that the performance of floating solar PV systems can be enhanced through simulation tools such as PVSyst. Their study found that simulations yielded superior performance ratios (PR) compared to manual calculations, highlighting the importance of a data-driven approach in evaluating the feasibility of solar PV projects in Indonesia.

To accelerate the optimization of dam utilization for floating solar power generation, the Ministry of Public Works has opened opportunities for cooperation with business entities through PPP schemes. This framework provides the necessary legal and institutional basis for developing NRE infrastructures. Supervision by government officials is important to prevent delays and failures, which are often attributed to prolonged concession periods. Shidqi and Firmansyah (2024) highlight the importance of accountability mechanisms in PPP projects to ensure that project objectives are achieved.

Furthermore, a solid understanding of applicable regulations and best practices in PPP implementation is crucial during the planning and preparation stages of infrastructure development (Maulana, 2021). This ensures the sustainability and efficiency of large-scale initiatives such as floating solar power plants. Kartikasari and Retnaningsih (2024) also argue that, as seen in the development of the National Capital City (IKN) under the PPP model, clear and consistent regulatory frameworks on PPP funding play a decisive role in attracting private sector investment.

The Toll Road PPP, one of the most successful Public-Private Partnership sectors in Indonesia, demonstrates that strong government commitment during project preparation, the presence of robust regulatory frameworks, and the implementation of transparent and competitive tender processes are critical success factors (Gaol et al., 2023). Supporting this view, the study by Atmo et al. (2017) reveals that PPP projects tend to outperform traditionally procured projects in terms of operational timing and service availability. These findings emphasize the importance of policy frameworks backed by larger international financing sources and reputable power plant developers.

The stages of delivering Floating Solar Photovoltaic (PV) infrastructure under a PPP scheme generally mirror those of other infrastructure projects. The distinction lies in the transaction stage, which involves dual procurement processes at both the Ministry of Public Works and PT PLN (Persero). In the Implementing Agency procurement phase for Floating Solar PV PPP projects, the bidding parameter is the contribution proposed for dam maintenance activities. Thus, the winner of the auction is determined based on the highest offered contribution.

Under Article 17 of Presidential Regulation Number 112 of 2022, PT PLN (Persero) publishes a list of selected renewable energy providers, known as the *Daftar Penyedia Terseleksi* (DPT) or Selected Providers List. The Implementing Agency designated by the Ministry of Public Works is expected to be registered in this list. Electricity procurement through the direct selection mechanism is conducted based on the lowest price offer, which is evaluated against the highest benchmark price. Once selected, the Implementing Agency proceeds to sign a Power Purchase Agreement (PPA) with PT PLN (Persero). Following the PPA signing, the Implementing Agency enters into a PPP Cooperation Agreement (*Perjanjian Kerja Sama* or PKS) with the Ministry of Public Works and subsequently seeks financial close by securing funding from financial institutions.

RESEARCH METHOD

This study employs a qualitative approach with a descriptive method. Specifically, the methodology used is a Normative Legal Review combined with a Gap Analysis. This methodology was selected to identify and evaluate inconsistencies within the regulatory framework governing the development of Floating Solar Power Plant (FSPP) projects under the PPP scheme on dams managed by the Ministry of Public Works.

The research methodology was implemented through the following systematic stages:

1. Establishment of the normative framework: The normative legal review involved identifying and analyzing relevant Indonesian laws and regulations as the benchmark (“norm”). Rather than comparing with international best practices, the study focuses on evaluating potential contradictions and disharmonies among domestic legal instruments. These include Presidential Regulations, ministerial regulations from the Ministry of National Development Planning (Bappenas), the Ministry of Public Works, and the National Public Procurement Agency (LKPP).

2. Identification and categorization of gaps: Regulatory gaps were identified by comparing existing practices with the intended legal and procedural standards. The primary criteria used to identify the regulatory gap include:

- Process inefficiency, such as the dual-stage, tiered procurement process required by the Ministry of Public Works and PT PLN (Persero).

- Legal uncertainty arising from the use of different procurement procedures and bidding parameters between the two institutions.

- Financial risk and project viability caused by tariff uncertainty, as electricity price negotiations only occur after the Implementing Agency is selected at the initial bidding process at the Ministry of Public Works.

3. Data sources and analysis: The research relies on a comprehensive review of primary and secondary documents, such as statutory regulations, project reports, academic articles, and publications from relevant institutions. This document-based analysis is enriched by the insights of the authors, who are directly involved as practitioners in the planning and implementation of PPP projects within the Ministry of Public Works. This professional experience enables a grounded understanding of how legal provisions are applied and how regulatory gaps impact project outcomes.

4. Limitations of the study: The authors acknowledge the limitations of this study. While the practitioner perspective provides valuable context and interpretations, no formal interviews were conducted with external stakeholders, such as regulatory bodies or private entities. Future research could be enhanced by incorporating such multi-stakeholder perspectives. Besides, given that this analysis is grounded in Indonesia's legal and institutional contexts, the results may not be directly applicable to other jurisdictions without careful consideration of local conditions.

DISCUSSION

PPP Contract Structure of Solar Power Plant Projects

Based on the list of projects included in the Public-Private Partnership (PPP) Plan List for 2024—commonly referred to as the PPP Book 2024—as outlined in the Ministerial Decree of the Ministry of National Development Planning Number 31 of 2024, the majority of PPP projects in Indonesia adopt the Design-Build-Finance-Maintain-Operate-Transfer (DBFMOT) contract structure. Variants such as DBFOM, DBFM, and other commonly used formats like Build-Operate-Transfer (BOT), Build-Own-Operate-Transfer (BOOT), and Build-Transfer-Operate (BTO) reflect similar project delivery mechanisms. In these models, the private sector not only constructs the project but is also responsible for its design, financing (through equity or debt), operation during the concession period, and eventual asset transfer back to the government at the end of the agreed term. Cost recovery for the private partner is typically achieved through user charges (APMG, 2016). According to the Presidential Regulation No. 112 of 2022, the concession period for renewable energy power plant projects is set between 25 to 30 years.

Institutional Structure of Hydropower and Floating Solar Power Plant PPP Projects

The successful implementation of PPP projects, particularly in the renewable energy sector, requires the government commitment, institutional capacity, and effective coordination among stakeholders. While private entities are responsible for executing the DBFMOT scope, the government remains accountable for ensuring that the quality and quantity of services delivered align with public interest as stipulated in the PPP agreement (World Bank, 2021).

In the case of Floating Solar PV and Hydropower PPP projects utilizing dams under the Ministry of Public Works, institutional mapping is carried out during the project preparation phase. The project's institutional structure is illustrated in Figure 1. The Minister of Public Works, serving as the Government Contracting Agency (GCA), delegates authority to the Director General of Water Resources to sign the PPP agreement with the selected Business Entity.

This implementing entity, typically a Special Purpose Vehicle (SPV) company, secures financing through a mix of equity (30%) and debt (70%) provided by lenders. As the entity responsible for project execution, the SPV enters into a Power Purchase Agreement (PPA) with PT PLN (Persero) for a capacity and concession period agreed upon by both parties. The SPV may then appoint contractors and consultants to manage construction, operation, and maintenance (O&M) activities for the hydropower or floating solar power plant, as well as for dam maintenance.

For dam O&M contractors, all activities must be approved, monitored, and evaluated by the local River Basin Authority. This oversight ensures that the proposed O&M activities are aligned with the functional needs of the dam or other water infrastructure and that they correspond to the contribution commitments made during the PPP auction process led by the Ministry of Public Works.

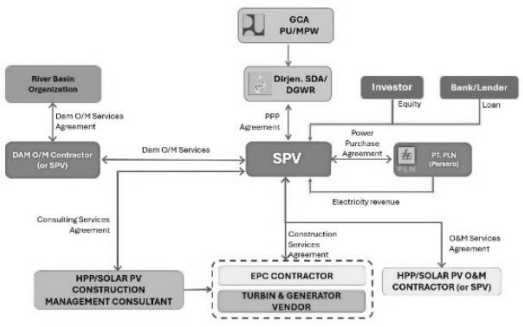

Figure 1. Institutional Structure of the PPP Project on Hydropower and Solar Power Plant at the Ministry of Public Works Dam

The Implementation Mechanism of Hydropower and Floating Solar Power Plant PPP in the Ministry of Public Works

Hydropower and Floating Solar PV PPP projects under the Ministry of Public Works are typically initiated by business entities (unsolicited). The procedure begins with the submission of a Letter of Interest (LoI) by the business entity to the Minister of Public Works, expressing its intention to develop a dam-based hydropower or floating solar power plant. This submission is accompanied by supporting documents that include: (1) a confirmation of conformity with the national water resources and electricity sector master plans; (2) an indication of the need for infrastructure provision; (3) a preliminary review of the project's technical, economic, and financial aspects; and (4) an initial identification of relevant project institutions.

In addition, the proposing entity must demonstrate its financial capacity through the submission of audited financial statements for the past three years and provide evidence of technical experience in implementing similar infrastructure projects. After receiving approval, the entity proceeds to prepare a feasibility study, which must include, at a minimum, five key studies: strategic, economic, commercial, financial, and management studies. The submission of this feasibility study must be accompanied by a draft prequalification document (Request for Qualification), a draft tender document (Request for Proposal), and a draft Government Cooperation Agreement with the business entity. Once these documents are deemed complete and compliant, the business entity is officially designated as the Project Proponent by the Minister of Public Works in their capacity as the GCA.

The next stage is the procurement of the Business Entities implementing PPP projects, which is conducted through two main stages,

i.e., pre-qualification (*request for qualification*) and auction (*request for proposal*). As the project initiator, GCA provides compensation in the form of the right to bid against the best bidder (right to match) during the auction. For hydropower and floating solar power plant PPP projects managed by the Ministry of Public Works, the auction is conducted using a single-stage format. The primary bidding parameter used to determine the winning business entity is the amount of proposed contribution to dam maintenance. The business entity that offers the highest contribution is selected as the winner of the PPP auction. Subsequently, the winning entity for hydropower projects will proceed through a direct appointment process with PT PLN (Persero), involving electricity tariff negotiations. In contrast, the winning entity for Floating Solar Power Plant projects is required to participate in a direct selection process (auction) at PT PLN (Persero).

Once the winning business entity is selected and signs a Power Purchase Agreement (PPA) with PT PLN (Persero), the Special Purpose Vehicle (SPV) formed by the entity signs a PPP Cooperation Agreement with the Minister of Public Works. The SPV is granted 12 months to reach financial close, signifying that the project is financially ready to proceed. At this stage, the SPV must secure the required funding, e.g., through loans or credit agreements, and ensure that the funds are available for disbursement.

Following the transaction stage, the PPP project enters the management stage, which is the final phase of the PPP lifecycle. This stage is designed to ensure effective oversight of the PPP agreement's implementation—from the construction phase, through service delivery during the concession period, to the termination and handover of the project. This stage includes monitoring the performance of the Implementing Agency (or Special Purpose Vehicle—SPV), evaluating the achievement of Key Performance Indicators (KPIs), managing associated risks, and resolving any disputes that may arise during the collaboration period.

The SPV is responsible for constructing the project, a process that typically takes between 1.5 to 2 years, depending on the project's scale and prevailing site conditions. This construction must adhere strictly to the technical specifications and timelines stipulated in the PPP agreement. Upon completion of the construction and commissioning phase, and after securing a Certificate of Operational Feasibility, the hydropower or floating solar power plant is officially declared commercially operational on the Commercial Operation Date (COD).

During the 25-year cooperation period, the SPV must deliver electricity supply agreed in the PPA document and fulfill the required dam maintenance contribution. At the end of the cooperation period, project assets and associated facilities will be transferred to the Minister of Public Works as the Government Contracting Agency (GCA). The transferred assets must be in the condition specified in the agreement and fully operational, with routine and periodic maintenance, as well as equipment replacement carried out based on the agreed schedule. Before the handover process, SPV will conduct training for GCA staff or those appointed so that they can operate and maintain these assets with at least the minimum service standards.

The Development of Floating Solar Power Plants in Indonesia

Many countries have started developing floating solar power plants on reservoirs and other water bodies, including Indonesia, which has initiated such a project at the Cirata Reservoir. This initiative represents the first and largest floating solar power plant in the ASEAN region, marking a significant

milestone in Indonesia's renewable energy landscape. The project is a collaboration between Masdar, a company from the United Arab Emirates, and PT PLN (Persero) through its subsidiary, PT PLN Nusantara Power (formerly known as PT Pembangkitan Jawa Bali or PT PJB Indonesia).

The SPV for the Cirata Floating Solar PV project was established under PT Pembangkitan Jawa Bali Masdar Solar Energy (PSME), with a shareholding composition of 51% owned by PT PLN Nusantara Power and 49% by Masdar. The plant has an installed capacity of 192 MWp / 145 MWac and required a total investment of USD 129 million, equivalent to IDR 1.7 trillion. The electricity tariff agreed upon in the Power Purchase Agreement (PPA) is USD 0.0582 per kWh (Hidayat et al., 2022).

The PPA negotiation process has proven to be one of the most significant challenges in the development of renewable energy projects in Indonesia. A report by Mongabay Indonesia, using the Cirata Floating Solar Power Plant as a case study, revealed that reaching a PPA agreement was time-consuming. Although the auction process and selection of the winning consortium (Masdar and PT PJBI) were completed in 2017, the PPA was only finalized in 2020, resulting in a delay of approximately three years. This extended timeframe—primarily attributed to tariff negotiations and risk-sharing arrangement—has been cited as a major impediment to investment and a source of uncertainty for clean energy developers (Iqbal, 2023).

The current Cirata solar power plant uses around 4% of the reservoir's surface area. A regulatory modification that limits reservoir/dam inundation area utilization from 5% to 20% or higher (Minister of Public Works Regulation No. 7 of 2024) allows increasing Cirata Floating PV's potential capacity up to 1 GWp.

The Implementation of Floating Solar Power Plant PPP Projects Utilizing Dams Owned by the Ministry of Public Works: A Gap Analysis

Institutional challenges are often a major barrier to the success of green PPP projects (Owojori & Erasmus, 2025). Their study highlights that many developing countries still lack a comprehensive policy and regulatory framework to support green infrastructure initiatives. This inadequate or ambiguous policy direction then creates significant uncertainty for both private investors and public authorities. In addition, weak government institutional capacity to design, manage, and oversee complex PPP projects can lead to delays, cost overruns, and poor project outcomes. Case studies of PPP implementation in developing countries such as Ghana's solar energy sector, also show similar institutional challenges. Awuku et al. (2022) have identified that the main challenges faced in Ghana include the lack of adequate legislation, issues of accountability and transparency, and politicization of the PPP project procurement process.

The analysis of regulatory gaps in the implementation of PPP for Floating Solar Power Plants is based on several case studies of projects at various stages of development. To provide a realistic picture of the current development landscape and provide empirical evidence of existing challenges, the following Table 2 presents a list of projects that are being prepared by the government, including their locations and development status. In particular, the "Status" column in the table highlights the project that have stagnated at the transaction and tariff negotiation stages. This directly illustrates the effects of regulatory misalignment and the inefficiencies inherent in the two-stage procurement process, which will be further discussed in this section.

Table 2. List of Hydropower **and** Floating Solar PV PPP Projects in Indonesia

No	Project Name	Location	Phase	Status
1	Bintang Bano Mini Hydro Power Plant 6.3 MW	West Nusa Tenggara	Transaction	PPA: Tariff Negotiation with PT PLN
2	Tiga Dihaji Hydro Power Plant 40 MW	South Sumatera	Transaction	Establishment of Implementation Agency
3	Leuwikeris MHPP 7.4 MW	West Java	Preparation	Feasibility Study
4	Bener MHPP	Central Java	Preparation	Feasibility Study
5	Cipanas Floating Solar PV & MHPP	West Java	Preparation	Pre-Feasibility Study
6	Tapin MHPP	South Kalimantan	Preparation	Pre-Feasibility Study
7	Lau Simeme MHPP	North Sumatera	Preparation	Pre-Feasibility Study
8	Pamukkulu MHPP	South Sulawesi	Preparation	Pre-Feasibility Study
9	Keureto FSPV & MHPP	Aceh	Preparation	Pre-Feasibility Study
10	Bulango Ulu FSPV& MHPP	Gorontalo	Preparation	Pre-Feasibility Study
11	Way Apu FSPV & MHPP	Maluku	Preparation	Pre-Feasibility Study
12	Mbay FSPV	East Nusa Tenggara	Preparation	Pre-Feasibility Study
13	Karalloe MHPP	South Sulawesi	Preparation	Pre-Feasibility Study

Public-Private Partnership (PPP) projects inherently operate at the intersection of public and private law, often creating regulatory and contractual complexities. From a public law perspective, the government as the GCA is bound by regulations and laws regarding government procurement of goods/services, state finances, and administrative law. The main principles are transparency, accountability, fair competition, and achieving the best value for money. On the other hand, private law regulates commercial relations between the parties, where the business entity as an investor operates based on the principles of contract and corporate law, and aims to achieve profit and certainty of return on investment. The main challenge in every PPP project is to align these two different legal logics and objectives into a coherent and mutually beneficial project structure.

The difference in mandate between public procurement law and the private investment framework directly complicates project structuring. Public procurement law, as stipulated in the Presidential Regulation and LKPP regulations, requires the government to carry out a transparent and competitive auction process to select the best partner. In this case study, such a situation is reflected in the auction process at the MPW which aims to obtain the highest dam maintenance contribution from potential investors. In contrast, the private investment framework requires contractual certainty and financial viability (bankability) to obtain funding from financial institutions. Business entities will structure projects that can maximize profits and mitigate risks. Complexity arises when these two mandates are not well integrated, as in the two-stage procurement process in the Floating Solar Power Plant project in Indonesia. The first stage at the PUPR Ministry fulfills the public procurement objective, while the second stage at PT PLN (Persero) is a separate commercial negotiation. This fragmented structure, which arises from an attempt to fulfill two legal frameworks sequentially, actually creates inefficiencies, high transaction costs, and significant legal uncertainty for investors, making it very difficult to effectively structure projects.

Ambiguity in the tariff-setting mechanism and the responsibilities of the GCAs are the main sources of potential disputes. The current mechanism—where tariff negotiations with PT PLN (Persero) occur only after a business entity wins the auction conducted by the Ministry of Public Works—poses a significant risk. Business entities, having secured the auction based on preliminary tariff assumptions, may confront a situation where the tariff approved by PLN is lower than expected. This discrepancy can jeopardize the project's financial viability, leading to failed PPA negotiations, investor withdrawal, or legal disputes related to the fulfillment of initial commitments.

Currently, the GCA in PPP projects that provide electricity infrastructure utilizing dams is carried out by the Minister of Public Works. However, referring to the implementation of the previous two hydropower PPP projects, which have now entered the transaction stage, the ideal, expected condition is the implementation of joint GCA between the Ministry of Public Works and PT PLN (Persero). In line with Law Number 30 of 2009 on Electricity, this takes into account PLN's participation as a single off taker in electricity projects derived from water infrastructure, such as hydropower plants and floating solar power plants in Indonesia. According to Regulation Number 7 of 2023 of the Minister of National Development Planning/Head of the National Development Planning Agency, Joint GCA may be implemented.

A combination of two or more GCA for one kind of infrastructure or two or more GCA for two or more types of infrastructure is one of the statements. The definition mentions that GCA is the minister/head of institution/regional head, or State-Owned Enterprise/Region-Owned Enterprise as the provider or organizer of Infrastructure based on laws and regulations. According to Article 9 of the previous regulations, the directors of SOEs can act as GCA in PPP projects as long as the implementation is regulated in the relevant sectoral laws and regulations. This shows that the authority of SOE directors as GCA is not absolute, but must be within the regulatory framework that has been established for a particular sector. This provision provides flexibility for SOEs to take a strategic role in infrastructure projects or public services, while still ensuring compliance with applicable regulations (Rahardjo et al., 2025).

To formalize a Joint GCA arrangement, a Memorandum of Understanding (MoU) must be signed by the Minister, Head of Institution, or Regional Head who holds jurisdiction over the infrastructure sector involved. The MoU must, at a minimum, define the lead GCA coordinator, outline the division of roles, responsibilities, and budgets across the planning, transaction, and management phases, and establish the duration of the PPP cooperation. Joint PPP arrangements must also account for a variety of specific risks, including operational risks, infrastructure-specific risks, project integration risks, and institutional risks.

The Ministry of Public Works can be proposed as the lead agency or coordinator for the Joint GCA scheme for several key reasons. These include the Ministry's ownership of dam assets, its legal mandate and technical expertise in ensuring dam safety, and its current role as the GCA for dam utilization projects in hydropower. It is important to emphasize, however, that this coordinating role does not supersede or diminish the authority of PT PLN (Persero). Rather, PLN retains full responsibility over all electricity-related components, particularly those related to tariff negotiations and the PPA.

Under the proposed Joint GCA scheme formalized through a Memorandum of Understanding (MoU), the division of responsibilities between the Ministry of Public Works (MPW) and PT PLN (Persero) would be explicitly clarified. The MPW would focus on the management of physical infrastructure and water resource regulation, including ensuring dam safety, establishing inundation limits, and managing the procurement process, particularly regarding the bidding parameter related to dam maintenance contributions. Meanwhile, PT PLN (Persero), acting as the sole off-taker, would bear full responsibility for the commercial and technical aspects of electricity procurement, including conducting upfront tariff negotiations and signing the PPA, which is a critical element of the project's financial viability.

This clear division of responsibilities enables a more efficient allocation of risks, whereby each party bears the risks it is best equipped to manage. The MPW would assume risks inherent to its physical assets, primarily structural safety risks of the dam and hydrological risks related to water availability. On the other hand, PT PLN (Persero) would manage market and commercial risks, including tariff payment risk, the challenge of negotiating prices below the Highest Benchmark Price (*Harga Patokan Tertinggi* or HPT), and technical risks related to electricity grid stability.

Risks that stem from the inter-institutional cooperation itself, including project integration and institutional coordination risks, would be jointly managed through a governance framework outlined in the MoU. The main objective of this joint structure is to integrate two previously separate processes to enhance efficiency and provide legal certainty for all parties involved.

The concept of Joint GCA between the MPW and PT PLN (Persero) will have a positive impact on accelerating the implementation of the Floating Solar PV PPP project because both institutions have been actively involved since the early stages of project planning. PT PLN (Persero) as the off-taker is expected to evaluate the tariff from the beginning so that the tariff negotiation process runs smoothly. The proposed formation of a Joint GCA regulated in an MoU is a direct effort to mitigate the risk of this dispute by clearly defining the roles, responsibilities, and risk allocation of each party from the start.

Moreover, under such a coordination, private sector entities would benefit from greater certainty regarding applicable electricity tariffs, with which they can submit more accurate and confident bidding offers, particularly in calculating maintenance contribution values as auction parameters. However, challenges remain—especially those stemming from the current provisions of Presidential Regulation Number 112 of 2022 on the Acceleration of Renewable Energy Development for Electricity Supply. Although this regulation permits electricity procurement from Floating Solar PV through a direct selection mechanism, it still requires a post-selection tariff negotiation process and thus reintroduces potential uncertainty. Therefore, a regulatory harmonization process is highly suggested, particularly to align Presidential Regulation Number 112 of 2022 with the specific legal and operational requirements surrounding dam-based Floating Solar Power Plants.

Challenges encountered during the procurement or tendering stage constitute a critical issue in the PPP literature. A review by Khaderi et al. (2019) confirms that the tendering stage is frequently the main point of failure in PPP projects. This is attributed to the greater complexity, longer duration, and

higher transaction costs compared to traditional procurement mechanisms. This complexity, which includes extensive preparation of tender documents and lengthy negotiations, is the main reason for project delays and even the withdrawal of some potential investors from the tender process.

Furthermore, the two-stage procurement process, namely procurement at the Ministry of Public Works and PT PLN (Persero), has also become a major issue in the development of Floating Solar PV PPP projects that utilize dams. This occurs due to differences in regulations governing the procurement process in each agency. The MPW conducts procurement based on LKPP Regulation Number 1 of 2025 issued by the National Public Procurement Agency, while PT PLN (Persero) operates under Presidential Regulation Number 112 of 2022. These procedures prolong the project development timeline and undermine the core advantages of PPP schemes, which are designed to offer greater efficiency and effectiveness than conventional public procurement.

In addition to the tiered procurement sequence, additional regulatory challenges arise concerning the procurement method for Floating Solar PV PPP projects. According to Presidential Regulation Number 112 of 2022, the purchase of electricity generated from government-provided land (including reservoirs) must proceed through a direct selection mechanism. Thus, even after successfully completing the MPW's PPP auction process and being declared the winner, a business entity must re-enter the auction process at PT PLN (Persero) and compete again with other pre-qualified entities listed in PLN's Selected Providers List (*Daftar Penyedia Terseleksi* or DPT). Only after securing selection by PT PLN (Persero) can the entity enter into tariff negotiations and sign the PPA. This uncertainty can significantly reduce investor confidence and discouraging participation in Floating Solar PV PPP projects.

Another challenge is the use of different bidding parameters by the two institutions. The MPW uses the amount of contribution to dam maintenance activities as its primary bidding parameter. This contribution refers to a monetary value committed by the business entity to support the maintenance of dams used for power generation. Such maintenance activities may include annual routine operations or major maintenance conducted every five years, supervised by the relevant River Basin Center (*Balai Wilayah Sungai* or BWS). The entity offering the highest contribution value is typically declared the winner of the Ministry's auction.

In contrast, PT PLN (Persero) bases its procurement decisions on the electricity tariff offered by the business entity, which must not exceed the Highest Benchmark Price. In this case, the lower the proposed tariff, the higher the chance of winning the bid. This difference creates a paradox. On one hand, business entities are incentivized to maximize their financial contribution to the MPW. On the other hand, they are required to minimize the electricity tariff offered to PT PLN (Persero), which directly limits their revenue potential.

This inconsistency poses financial and operational risks for business entities. Winning the PPP auction at the Ministry of Public Works does not ensure selection by PT PLN (Persero), leading to possible financial and reputational losses. Furthermore, the timing of the tariff determination process introduces additional risk. PT PLN (Persero) typically sets the tariff after the PPP auction at the MPW is completed. Consequently, business entities must develop financial models based on estimated tariffs that may differ significantly from the final tariffs

approved by PT PLN (Persero). This gap can lead to revenue shortfalls and undermine the financial feasibility of the project. In this context, the government's infrastructure guarantee facility becomes a relevant risk mitigation instrument. The guarantee can reduce the risk of payment default by the off-taker (in this case, PT PLN), which is one of the main concerns for lenders and investors.

With a government guarantee in place, despite the uncertainty in the early stages, the revenue risk of the project becomes more manageable. This will increase lenders' confidence to provide financing and make the project more attractive to investors, although the inefficient two-stage procurement process remains a challenge.

Such regulatory misalignment and procedural inefficiencies may reduce the attractiveness of Floating Solar Power Plant PPP projects among investors, despite their alignment with Indonesia's renewable energy development goals. Therefore, it is essential to establish a harmonized regulatory framework, a unified procurement process, and an integrated tariff-setting mechanism to support the successful implementation of floating solar PV projects that utilize dams owned by the Ministry of Public Works.

Table 3. Gap Analysis

Current Condition	Expected Condition	Gap	Strategy
GCA by Ministry of Public Works (MPW)	A joint GCA structure involving both the MPW and PT PLN (Persero)	PT PLN (Persero) operates under its own regulatory framework for electricity procurement	Harmonize regulations on electricity purchases from FPV on MPW-owned dams by PT PLN (Persero)
The procurement process is accomplished in sequential stages (at the MPW and PT PLN (Persero)	The procurement process is conducted in a single integrated stage by combining the procedures of the MPW and PT PLN (Persero)	Business entities are required to undergo a two-stage procurement process, which extends the overall project timeline and create inefficiency	Regulatory adjustments to accommodate a single stage procurement process
Procurement methods at PT PLN (Persero) through Direct Selection	Procurement methods at PT PLN (Persero) through Direct Appointment	The MPW-selected tender winner must undergo a Direct Selection process at PT PLN (Persero)	An adjustment to PT PLN (Persero)'s procurement regulations is proposed to allow for Direct Appointment
Bidding parameters differ between the MPW and PT PLN (Persero)	Single bidding parameter agreed upon by the MPW and PT PLN (Persero)	Winning the MPW tender does not guarantee success in the PT PLN (Persero) tender	Create a unified bidding parameter agreed by MPW and PT PLN to ensure consistency, avoid redundancy, and streamline procurement
Determination of electricity tariffs by PT PLN (Persero) after the procurement process at the MPW is completed	Ensuring tariff clarity before final project selection	The lack of a tariff agreement between the MPW-selected entity and PT PLN creates uncertainty in project viability and financing	The tariff-setting process should be adjusted to set tariffs before MPW's procurement begins

Policy Recommendations

Based on the challenges discussed above, several key recommendations are proposed to improve the implementation of Floating Solar PV PPP projects on dams owned by the MPW. These recommendations are essential for supporting the Government of Indonesia's target of achieving a 21% share of NRE in the national energy mix by 2030.

1. Establishment of a Joint Government Contracting Agency (GCA)

   The government should enact enabling regulations to formally establish a joint GCA between the MPW and PT PLN (Persero). Although SOEs are allowed to act as GCAs under Regulation of the Minister of National Development Planning/Head of Bappenas Number 7 of 2023, further regulatory support is needed from the Ministry of SOEs and the Ministry of Energy and Mineral Resources. These ministries must issue sector-specific guidelines that clarify and authorize the joint implementation of PPP projects in the electricity sector.

2. Streamlining the procurement process

   Simplifying the procurement stages into an integrated process will eliminate the inefficiencies of the two-tiered approach. This could reduce transaction delays, enhance cost-efficiency, and lower the risk of procurement failure—especially during the crucial transaction phase of the PPP lifecycle.

3. Upfront tariff determination

   Determining electricity tariffs before the procurement process begins is vital for ensuring project bankability. Certainty regarding tariff levels at the feasibility study stage allows business entities to evaluate investment returns more accurately, reduce uncertainties, and strengthen investor confidence.

4. Regulatory harmonization

   The government should prioritize harmonizing the various regulations that govern PPP implementation in the renewable energy sector, particularly for Floating Solar PV projects that utilize government-owned dams. The harmonization would reduce overlapping regulations, simplify procedures, and increase legal certainty for all parties involved, including the government, business entities, and lenders. Regulatory reform and harmonization in this sector would also create a consistent and coordinated legal framework that can increase the effectiveness and efficiency of PPP project implementation, strengthen project institutions, strengthen the principle of accountability, and create a more conducive investment environment for business entities to participate in encouraging the achievement of the new renewable energy mix in Indonesia.

CONCLUSION

The development of Floating Solar Power Plant projects through the PPP scheme on dams owned by the MPW is currently hindered by insufficient regulatory support. These regulatory limitations could give significant risk to the timely acceleration of renewable energy development, particularly in optimizing the use of dam infrastructure. To overcome these constraints, it is crucial to enhance the legal framework governing the implementation of a Joint Government Contracting Agency (GCA) between the MPW and PT PLN (Persero). Such a joint arrangement will enable PT PLN's early and active engagement from project preparation through to the transaction stage.

Moreover, the current two-stage procurement process—separately conducted by the MPW and PT PLN (Persero)—must be streamlined into a unified procedure. This consolidation will reduce administrative burden, minimize delays, and improve efficiency. Furthermore, early determination of electricity tariffs is vital for ensuring project bankability and attracting private sector investment, as project viability is closely tied to the electricity tariff determined in the power purchase agreement.

The advancement of Floating Solar Power Plant projects through PPP schemes has the potential to serve as a role model for the development of sustainable energy infrastructure in Indonesia. Achieving this potential will require the integration of robust technical planning, coherent regulation, investment viability, and strong institutional coordination. These elements are essential to ensuring the success of Floating Solar Power Plant development on dam infrastructure, while contributing meaningfully to Indonesia's renewable energy mix target.

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Exploring Delphi Method Utilization Research Trends on Public-Private Partnership Infrastructure Studies

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ABSTRACT

This study seeks to explore the application of the Delphi method in Public-Private Partnership (PPP) infrastructure research over a ten-year span (2015-2024), with a focus on various characteristics such as the application of the Delphi method across different PPP infrastructure sectors, expert criteria for Delphi panels, the diverse use of consensus, and the execution of Delphi rounds. Employing a Systematic Literature Review (SLR) guided by the PRISMA framework, the study utilizes thematic categories alongside co-occurrence and co-authorship analyses to identify trends in the application of the Delphi method in PPP infrastructure studies. The review concentrates on literature indexed in two leading academic databases: Web of Science (WoS) and Scopus. The findings indicate that the use of the Delphi method has grown significantly in the past ten years within infrastructure PPP schemes, particularly in emerging countries driven by the increasing demand for infrastructure development. Research trends have highlighted a variety of characteristics of the Delphi method, including criteria for selecting experts, the number of expert participants, the number of Delphi rounds, and different approaches for achieving consensus or agreement. These findings offer valuable insights to inform and enhance the methodological rigor of future research utilizing the Delphi method in the context of PPP infrastructure.

Keywords: Delphi Method; Infrastructure; PPP; PRISMA; SLR

ABSTRAK

Kajian ini bertujuan untuk mengulas pemanfaatan metode Delphi dalam penelitian infrastruktur berskema *Public-Private Partnership* (PPP) pada rentang sepuluh tahun terakhir (2015–2024). Fokus kajian adalah pada berbagai karakteristik penggunaan Delphi, seperti penerapan metode Delphi di berbagai sektor infrastruktur PPP, kriteria ahli dalam panel Delphi, variasi penggunaan konsensus, serta pelaksanaan siklus Delphi. Metodologi yang digunakan adalah *Systematic Literature Review* (SLR) dengan pendekatan PRISMA yang mencakup kategori tematik, serta ditopang dengan analisis *co-occurrence* dan *co-authorship* untuk mengidentifikasi tren dalam penerapan metode Delphi. Kajian ini berpijak dua basis data utama, yaitu kepustakaan yang terindeks pada Web of Science (WoS) dan Scopus. Hasil analisis menunjukkan bahwa penggunaan metode Delphi dalam kajian infrastruktur berskema PPP mengalami peningkatan yang signifikan dalam sepuluh tahun terakhir, terutama di negara-negara berkembang, seiring dengan meningkatnya permintaan akan pembangunan infrastruktur. Tren penelitian mengungkap berbagai karakteristik metode Delphi, termasuk kriteria pemilihan ahli, jumlah peserta ahli, jumlah siklus/putaran Delphi, serta pendekatan yang berbeda dalam mencapai konsensus. Temuan ini dapat memberi panduan bagi penelitian di masa depan dalam bidang kajian infrastruktur PPP yang menggunakan metode Delphi.

Kata Kunci: Infrastruktur; Metode Delphi; PPP; PRISMA; SLR

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INTRODUCTION

As a framework for infrastructure investment involving long-term contractual arrangements, Public-Private Partnerships (PPPs) engage the private sector to address funding constraints in infrastructure development. This scheme has been widely implemented across various countries over the past decade (De Paula et al., 2023; Yescombe & Farquharson, 2018). Research on infrastructure PPP schemes has attracted scholarly attention due to the advantages that these schemes offer, such as achieving value for money (Almarri, 2023), bridging infrastructure gaps (Malik & Kaur, 2020), enhancing road safety (Albalate & Bel-Piñana, 2019), supporting financial sustainability (Mansilla & Vassallo, 2020), improving socio-economic conditions (AlKheder et al., 2022), promoting low-carbon economic transitions (Guo et al., 2022), strengthening governance (Tian et al., 2023), ensuring environmental security (Kaletnik & Lutkovska, 2021), increasing efficiency (Cheng et al., 2023), and enabling the integration of environmental, social, and governance ratings (Kharlamov, 2023).

Conversely, numerous researchers worldwide have applied the Delphi method in various studies. This approach is used to obtain a trustworthy agreement among a panel of specialists through a structured sequence of detailed surveys and monitored responses (Eyiah-Botwe et al., 2020). It is particularly useful when the subject matter can gain from group-based, panelist evaluations or judgments, especially in situations where effective communication within a group is impeded (Ramiani et al., 2024). Although participants do not interact directly, the Delphi method serves as a group decision-making approach (Kuru & Artan, 2024). The Delphi survey is characterized by several key features, including an expert panel, multiple iterative rounds with managed feedback, statistical overviews of group responses, anonymity, and the encouragement of consensus formation (Arijeloye et al., 2024).

Although alternative approaches such as Artificial Intelligence (AI) and Social Network Analysis (SNA) have gained popularity in PPP infrastructure research, the Delphi method offers distinct advantages—particularly when empirical data is limited, or expert judgment is essential. AI facilitates predictive modeling and data-driven decision-making (Kasaei et al., 2023), while SNA helps mapping complex stakeholder relationships (Wibowo & Alfen, 2015). However, these methods often require extensive datasets or predefined structures, which may not be suitable for early-stage or exploratory research. In contrast, the Delphi method is well-suited for identifying risks, setting priorities, and achieving consensus among experts in complex and context-

dependent PPP projects. Its structured, iterative process allows for the integration of diverse expert insights, making it especially effective in areas where informed judgment and stakeholder alignment are critical. This study focuses on the Delphi method to highlight its methodological strengths and its relevance for expert-driven analysis in PPP infrastructure research.

Scholars across various sectors, including those studying infrastructure PPP schemes, have adopted the Delphi method with its varied characteristics in terms of the selection of expert panels, the size of these panels, the number of iterative rounds, and the process for establishing consensus or agreement. Over the past decade, there has been a notable rise in academic interest in infrastructure PPP schemes. The trend is reflected in the increased attention and recognition of their benefits, as documented in indexed databases of Web of Science (WoS) and Scopus. While some studies have reviewed articles on the application of the Delphi method, many lack comprehensive analysis on its characteristics in PPP infrastructure research contexts. This gap may result in differing views on the practical application of the Delphi method within PPP infrastructure research.

The application of a Systematic Literature Review (SLR) serves as a critical first step in conducting an in-depth analysis of the Delphi method's use in Public-Private Partnership (PPP) infrastructure research. The objective of the SLR is to achieve a structured examination of relevant literature on a particular topic, guided by established protocols such as PRISMA (Hijriyah et al., 2023; Kumar, 2023). As noted by Gough et al. (2017), SLRs are particularly effective in obtaining high-quality, detailed insights and resolving ambiguities in existing data.

This study compiles research articles on the application of the Delphi method in PPP infrastructure studies published between 2015 and 2024. The data is drawn from two major global academic databases—Web of Science (WoS) and Scopus—to ensure the reliability of the findings. The SLR also seeks to identify research gaps and differing perspectives regarding the characteristics and implementation of the Delphi method in PPP-related studies.

The subsequent section presents the theoretical framework, outlines the article selection process, and summarizes the selected studies based on predefined criteria. The results and discussion section will then present findings related to the use of the Delphi method across PPP infrastructure sectors, research methodologies, geographic scopes, expert panel selection criteria, consensus measurement approaches, and the structure of Delphi rounds. The findings are expected to provide valuable insights for future research utilizing the Delphi method.

THEORETICAL FRAMEWORK

The Delphi Method is a structured technique that relies on a panel of experts to achieve consensus on a specific issue. This method is guided by several key principles, including participant anonymity, an iterative process, controlled feedback, and response aggregation (Alqahtani et al., 2024; Zarghani et al., 2024). Participant anonymity ensures that expert opinions remain uninfluenced by external factors, minimizing the risk of dominance by certain individuals (Fathi & Shrestha, 2023a; Ramiani et al., 2024). The iterative process enables the refinement of responses over multiple rounds which lead to a more comprehensive evaluation (Gharaee et al., 2023; Ojiako et al., 2023). Controlled feedback provides participants with summaries of previous responses that allow

them to reconsider and refine their perspectives (Tamošaitienė et al., 2021). Finally, response aggregation synthesizes diverse expert opinions into a collective consensus, making the Delphi Method a valuable tool for decision-making and policy development (Rarasati et al., 2014).

A PPP is a collaborative arrangement between the public and private sectors for the provision of public services (The World Bank Group, 2016). This framework is based on three core aspects: risk allocation, financing and investment, and institutional mechanisms involving key stakeholders (Yescombe & Farquharson, 2018). Effective risk allocation ensures that risks are optimally distributed among the parties involved to enhance efficiency and minimize costs (Kouton et al., 2023; Kristiana & Sunandar, 2020; Sunandar et al., 2024). Financing and investment mechanisms in PPPs facilitate the mobilization of private capital, thereby reducing the government's fiscal burden (Jafari Ramiani et al., 2024; Kukah et al., 2023; Sunandar & Indiyati, 2023). Moreover, institutional mechanisms play a crucial role in coordinating various stakeholders to align project objectives with public interests and the private sector's capacities (Fathi & Shrestha, 2023b; Jayasuriya et al., 2024). These aspects collectively contribute to the PPP project's sustainability and effectiveness.

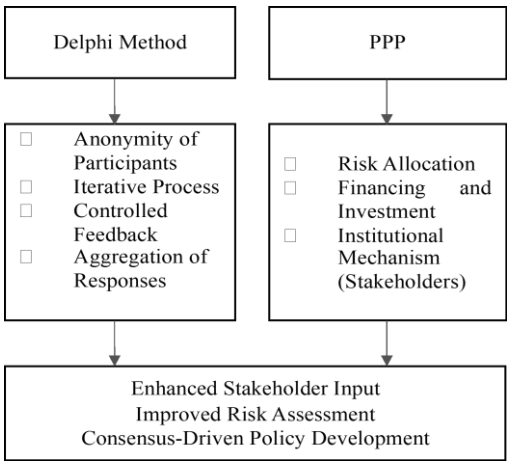

Figure 1. Theoretical Framework

The utilization of the Delphi Method in PPP research enhances stakeholder participation by incorporating expert opinions into the decision-making process (see Figure 1). Given the complexity and long-term nature of PPP projects, structured expert consultation helps identify potential challenges and opportunities early on (Alqahtani et al., 2024; Jafari Ramiani et al., 2024). The Delphi Method provides a systematic approach to gathering insights from various stakeholders, including policymakers, industry experts, and financial institutions. This ensures that PPP initiatives benefit from a comprehensive perspective leading to more well-informed and robust policy decisions (Chan et al., 2024).

METHODOLOGY

Systematic reviews have a number of advantages, such as providing a comprehensive examination of the topic or field under study, which is expected to yield targeted knowledge and assist in identifying focal points for future research (Page et al., 2021; Smith et al., 2011). A systematic search in this study was conducted to literatures published from 2015 to November 3, 2024,. This SLR was meticulously designed to ensure accuracy and alignment with research objectives, thereby opening opportunities for updates in the field of PPP infrastructure by exploring the use of the Delphi methodology in the future or combining it with other methodologies.

A detailed analysis based on inclusion criteria and defined steps or phases was conducted in using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, including identification, screening with specific criteria, eligibility assessment, and abstraction and synthesis review (Harie et al., 2023; Sahoo et al., 2022). The detailed PRISMA procedure is illustrated in Figure 2.

Identification

The PRISMA protocol in this SLR begins with the initial stage of identification (Hijriyah et al., 2023; Moher et al., 2009). Two globally recognized research index databases were employed to ensure the quality of the research, i.e., Scopus and Web of Science (WoS). The selection for these two databases represents a significant portion of high-quality scientific research worldwide valued by global researchers. A search using the keyword "Delphi Method PPP" was conducted to find articles related to the use of the Delphi Method in PPP schemes, which resulted in the finding of 50 articles indexed in WoS and 49 articles indexed in Scopus.

In conducting the identification stage, this study limited the search fields to the Title (T), Abstract (A), and Keywords (K) to maintain specificity and relevance. However, the chosen search string—"Delphi Method PPP"—introduces a methodological limitation, as it may exclude relevant studies that employed the Delphi method in PPP contexts without explicitly using these exact terms. This limitation highlights the potential underrepresentation of applicable studies and suggests that future reviews could benefit from broader or alternative keyword strategies, as well as supplementary methods such as snowballing or citation tracking to enhance comprehensiveness and reduce the bias of potential omission.

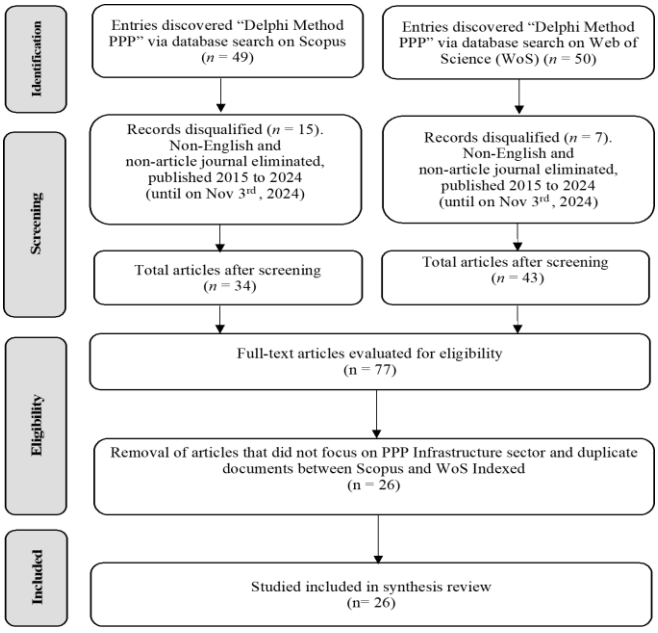

Figure 2. The PRISMA Protocol Adopted in the Research

Screening

From the two databases mentioned in the identification stage, a total of 99 aggregated articles were found, consisting of 50 articles from WoS and 49 articles from Scopus. This process was followed by the second stage, i.e., screening (see Figure 2). In this stage, exclusion criteria for published documents and the determination of criteria for the selected databases were applied (Ismail et al., 2021b). During this phase, several criteria were established to maintain the focus of this systematic review (Ismail et al., 2021a). *First,* regarding the publication period, the main criterion was set to a decade range from 2015 to November 3, 2024, as it was considered sufficient to represent the exploration of the Delphi method in PPP Infrastructure research. *Second,* only peer-

reviewed journal articles were retained, while other types of documents—such as conference proceedings, book reviews, and book chapters—were excluded. This step ensured consistency and academic rigor across the selected literature. *Third,* articles not published in English were excluded to minimize potential misinterpretations due to translation variability.

After applying these filters, 77 articles met the inclusion criteria, consisting of 43 articles from WoS and 34 from Scopus.

Eligibility

The next stage involved assessing the suitability of each article based on predefined inclusion criteria to ensure alignment with the research objectives. A manual assessment was conducted (Hijriyah et al., 2023; Ismail et al., 2021a) by focusing on studies that explicitly applied the Delphi method within the context of PPP infrastructure development. This evaluation considered the criteria established during the screening phase—namely relevance to PPP schemes, methodological rigor, and focus on Delphi-based research. As a result of this rigorous assessment, 26 articles were considered eligible for inclusion in the final analysis due to their direct relevance to the objectives of this systematic review.

Data Abstraction and Inclusion

The final phase consisted of the data abstraction and synthesis process conducted on the 26 eligible articles. A thorough review of each article was carried out to extract key information aligned with the research objectives. This process involved categorizing and thematically coding the content using a structured framework adapted from Thompson (2022). Each study was analyzed to identify relevant categories and subcategories, including sectoral application of the Delphi method, expert panel composition, consensus techniques, and the structure of Delphi rounds.

FINDINGS

SLR Category by Year, Publisher, and Rankings

This study analyzes a total of 26 articles obtained through the PRISMA protocol from reputable journals indexed in WoS and Scopus to ensure the quality of the research findings. The journals were mostly published in the United Kingdom (UK) and the United States of America (USA). The selected articles, which specifically apply the Delphi method to explore various aspects of PPP infrastructure schemes, are summarized in Table 1.

Table 1. SLR Outcomes Categories by Year, Publisher, and Rankings

No	Authors (Year)	Paper Code (P)	Journal's Name	Journal Impact Quartile	Country of the Publisher
1	Glumac et al. (2015)	P1	Land Use Policy	Q1	UK
2	Chan et al. (2015)	P2	Journal of Infrastructure Systems	Q2	USA
3	Ameyaw and Chan (2016)	P3	Journal of Infrastructure Systems	Q2	USA
4	Wu et al. (2018)	P4	Energy	Q1	UK
5	Sihombing et al. (2018)	P5	International Journal of Civil Engineering and Technology	-	India

No	Authors (Year)	Paper Code (P)	Journal's Name	Journal Impact Quartile	Country of the Publisher
6	Ameyaw and Chan (2018)	P6	Fuzzy Hybrid Computing in Construction Engineering and Management: Theory and Applications	-	UK
7	Li and Wang (2018)	P7	Journal of Risk Research	Q1	UK
8	Han et al. (2019)	P8	Land Use Policy	Q1	UK
9	Wang et al. (2019)	P9	Revista Internacional De Contaminacion Ambiental	Q4	Mexico
10	Eyiah-Botwe et al. (2020)	P10	Built Environment Project and Asset Management	Q2	UK
11	Giti et al. (2020)	P11	Journal of Financial Management of Property and Construction	Q3	UK
12	Surachman et al. (2020)	P12	Journal of Asian Finance Economics and Business	Q2	South Korea
13	Zhao et al. (2020)	P13	Advances in Civil Engineering	Q3	UK
14	Tamošaitienė et al. (2021)	P14	Sustainability	Q1	Switzerland
15	Moradi Shahdadi et al. (2023)	P15	Buildings	Q1	Switzerland
16	Zhao et al. (2023)	P16	Kybernetes	Q2	UK
17	Zhang et al. (2023)	P17	Land	Q2	Switzerland
18	Chan et al. (2023)	P18	Sustainability	Q1	Switzerland
19	Adu Gyamfi et al. (2024)	P19	Journal of Engineering, Design, and Technology	Q1	UK
20	Chan et al. (2024)	P20	Journal of Facilities Management	Q3	UK
21	Kukah et al. (2024)	P21	Journal of Financial Management of Property and Construction	Q3	UK
22	Kuru and Artan (2024)	P22	Journal of Design and Built Environment	Q2	Malaysia
23	Arijeloye et al. (2024)	P23	Journal of Engineering Design and Technology	Q1	UK
24	Nahdi et al. (2024)	P24	Buildings	Q1	Switzerland
25	Mahboubi Niazmandi et al. (2024)	P25	Decision Analytics Journal	Q2	USA
26	Ramiani et al. (2024)	P26	International Journal of Construction Management	Q1	UK

SLR Category by Research Approach, Data Collection, and Data Analysis

The analysis of the Delphi method's use in PPP infrastructure studies indicates that this method can be applied across all research approaches—quantitative (42%), mixed methods (31%), and qualitative (27%)—without dominance by any approach (see Figure 3). In terms of data collection, questionnaires are the most frequently employed method (69%) due to their efficiency in obtaining feedback from expert panels, while a combination of interviews

and questionnaires is utilized in 19% of studies, and interviews alone in 12% (Figure 4). Regarding data analysis, both modeling and statistical analysis are employed in 42% of studies, while thematic analysis accounts for 8%, with combinations of thematic analysis and modeling or statistical analysis, each comprising 4% (Figure 5).

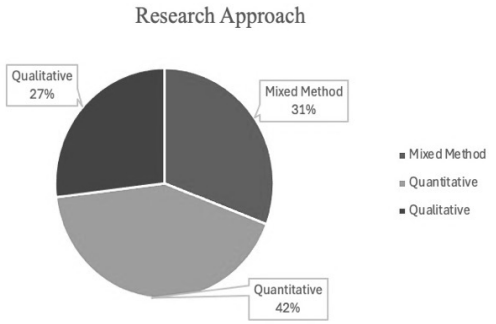

Figure 3. Proportion of the Research Approach in this SLR

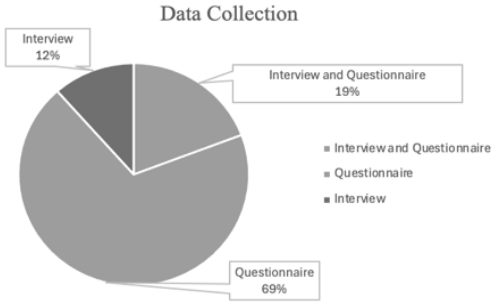

Figure 4. Proportion of Data Collection in this SLR

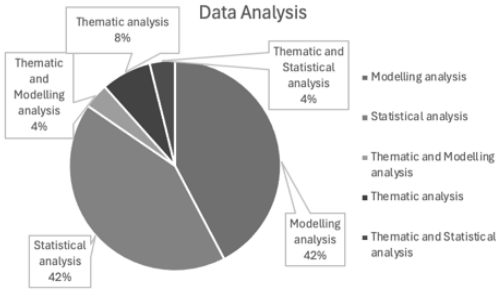

Figure 5. Proportion of Data Analysis in this SLR

SLR Category by Research Locations and Infrastructure Sector

PPP infrastructure schemes aim to promote sustainable development by involving the private sector amid budget constraints, with studies often focusing on emerging markets like China (31%), Iran (23%), Ghana (19%), and Indonesia (12%) (Figure 6).

Besides, the Delphi method is used across various countries, covering expert opinions for validation and consensus. In terms of sectors, it is applied to general infrastructure (35%), water and wastewater (23%), roads (15%), housing (8%), and other areas like power and smart cities (4% each). The data demonstrates the adaptability of PPP schemes to both broad and specific infrastructure categories (see Figure 7).

Figure 6. Mapping of Research Location Using Delphi Method in This Study

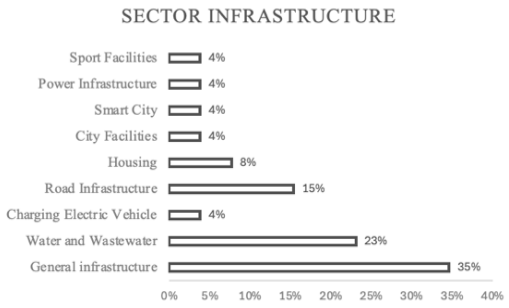

Figure 7: Mapping of Infrastructure Sector Using Delphi Method in This Study

SLR Category by Co-occurrence and Co-authorship Analysis

The co-occurrence analysis using VOSviewer highlights the evolving focus of PPP infrastructure studies employing the Delphi method, with themes shifting from privatization and risk management (2015–2020) to infrastructure projects (2020–2022) and risk factors, barriers, and project delivery (2022–2024) (see Figure 8).

The Co-authorship analysis reveals expanding researchers, from Tamosaitiene and Cristofaro (2015–2022) to broader networks involving Chan, Moradi, Lotfata, and others (2022–2024), reflecting growing academic engagement in this field (see Figure 9).

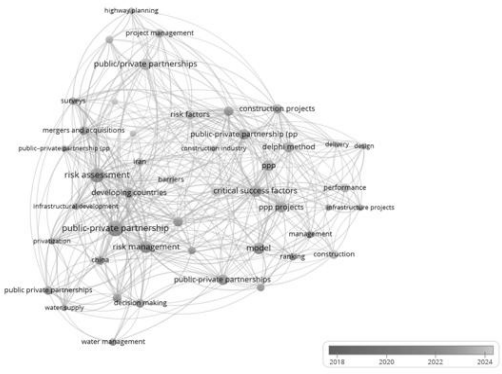

Figure 8: Mapping of the Co-occurrence

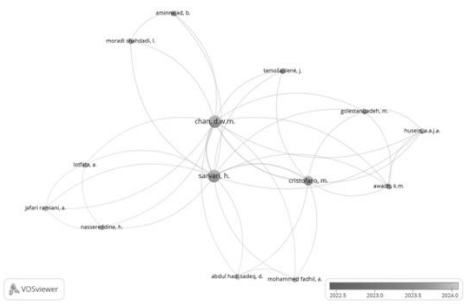

Figure 9. Mapping of the Co-authorship

SLR Category by Delphi Method (Round, Participant, Criteria)

Achieving consensus in the Delphi method typically requires multiple rounds, with most PPP infrastructure studies using three rounds (54%), while 27% use a single modified round, 15% require two rounds, and 4% extend to four rounds (see Figure 10). The number of rounds depends on research objectives, approach, expert homogeneity, and consensus criteria (see Table 2).

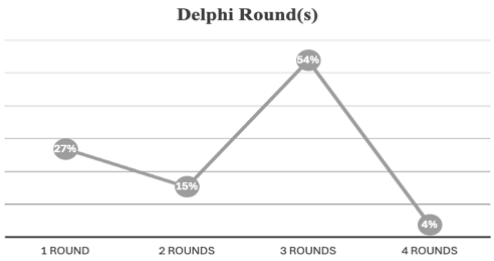

Figure 10. Delphi Round(s) used in this SLR

Table 2. SLR Outcomes Categories by Delphi Panel and Criteria

Paper Code (P)	Participants	Delphi Panel Criteria
P1	43	• Independent developers, contractors, asset creators, development agencies, and municipalities as experts
P2	105 and 93	• Involved in PPP projects in China, having extensive experience • Directly engaged in risk management for PPP projects in China, having recent or current involvement • Possessing a solid understanding and knowledge of PPP risk concepts, having gained through experience
P3	37, 37, and 10	• Water Company in Ghana, Public Utilities Regulatory Commission, Urban Water in Ghana, PPP Advisory Unit, Public Procurement Authority, along with private water developers and consulting firms, are all involved in the sector

Paper Code (P)	Participants	Delphi Panel Criteria
P4	5	• Government, private sector, and contractors
P5	16	• With 17 to 50 years of experience in the field, the respondents included academics, project management specialists, government officials, toll road investment experts, and infrastructure financing professionals
P6	37, 37, and 10	• Public and private organizations directly involved in PPP projects
P7	110	• In-depth expertise in the F-AHP risk assessment model • Author of books and reviewer of papers on the subject • Has participated in related projects
P8	16	• Officers (two), consultants (four), scholars (six), and managers (four) with relevant experience in the topic were invited to participate
P9	5	• Five experts in the field of water conservancy PPP project
P10	10	• Expertise and experience related to the issue under investigation • Ability and willingness to participate • Adequate time availability for participation in the Delphi process • Strong practical communication skills
P11	88	• Developing housing products from a policy perspective (housing practitioners/policymakers) with experience • Housing financing perspective (housing financiers) with experience • Housing development and the challenges associated with such strategies (housing developers) with experience
P12	Not mentioned	• Government contracting agencies (GCA) • Special Purpose Vehicle (SPV) • Ministries related to PPP in Indonesia • Other stakeholders: Multilateral agencies, IIGF, Lenders, and PPP consultants
P13	10	• Managers with extensive practical experience should be considered experts • Substantial theoretical knowledge of sponge city PPP projects should be possessed by experts • A minimum of 5 years of practical experience in sponge city PPP projects is required for experts
P14	60	• Involved in public-private partnership projects: experts, company managers, project managers, organizations, employers, and contractors
P15	14	• Academic staff in construction management or civil engineering • Professionals in construction or engineering management for water or sewage systems
P16	10	• Linear academic background with topic • Experts from different fields and industries
P17	9	• University professors (three) • Representatives from land reserve agencies (two) • Officials from land consolidation agencies (two) • Managers from land remediation companies (two)
P18	35	• Have knowledge and experience related to topic • Have time to participate and effective communication skills
P19	12	• Experts with between 5 and 30 years of experience in PPPs and risk management within construction industry in Ghana possess significant expertise.

Paper Code (P)	Participants	Delphi Panel Criteria
P20	103, 103, and 10	• A minimum of 20 years of professional experience in PPPs related to road transportation infrastructure in Iran
P21	48	• Have participated in at least one PPP power project • Possess work experience in the power sector and a solid understanding of its risks • Possess comprehensive and profound expertise in risk management within PPP procurement
P22	12	• Legal consultants is having experience and knowledge in project contract management and risk management processes
P23	11	• Knowledge and experience with the issues under investigation • Capacity and willingness to participate • Sufficient time to participate in the Delphi • Effective communication skills
P24	12	• Practitioners from contractors with a minimum of ten years of experience in PPP • Experts with an understanding of construction management in government projects • Experts knowledgeable about partnering and collaboration in government projects
P25	42	• Academic experts • Managers from contracting firms • Consulting service providers
P26	10	• Possess work experience in at least five distinct sports projects • Have participated in the implementation of PPP projects within the past one or two years

SLR Category by Delphi Method Consensus Utilization

The Delphi technique is used in PPP infrastructure studies for validation through expert judgment, with consensus achieved through repeated rounds. Criteria for consensus vary across research approaches, data analysis methods, and objectives, influencing the process. Table 3 outlines these criteria, offering a framework to guide future research and improve the quality of findings in PPP infrastructure studies.

Table 3: SLR Outcomes Categories by Delphi Consensus and Criteria

Paper Code (P)	Consensus in Round	Consensus or Agreement Criteria
P1	2	Collective opinions were gathered using the fuzzy Delphi method, offering a statistically valid experimental framework.
P2	2	In Round 2 of the Delphi process, risk factors with normalized values of 0.50 or higher were identified as Critical Risk Factors after the experts reviewed the overall responses. This threshold helped ensure that the most significant and pertinent risk factors were prioritized for further analysis in subsequent rounds.
P3	3	In Round 3, the risk factors used for modeling the risk-allocation decision-making were selected based on mean scores exceeding 5.05. This threshold was applied to ensure that only the most relevant and highly rated factors were considered. Besides, Kendall's coefficient of concordance (W) was employed to assess the level of consensus among the respondents.

Paper Code (P)	Consensus in Round	Consensus or Agreement Criteria
P4	Not reported	The significance of each index within the ANP system was determined based on experts' qualitative opinions.
P5	3	The Mean Score (MS) and Standard Deviation (SD) of the Critical Success Factor were calculated using relative importance indices.
P6	3	The risk allocation for a critical risk event related to PPP water supply projects was validated in Round 3 of the Delphi survey.
P7	Not reported	Experts' qualitative insights on risk levels and the likelihood of risk occurrence were gathered to obtain the necessary information.
P8	3	After 3 iterations of the questionnaire, with no further revisions from the experts, a consensus was reached, and the process was repeated until that point.
P9	Not reported	The expertise of a Delphi panel (qualitative) was used to establish a risk evaluation index system for water conservancy PPP projects.
P10	3	The Delphi technique was employed to identify the key factors and variables based on expert opinions, after which a field survey questionnaire was administered in Round 3.
P11	3	The mean and standard deviation were calculated to determine the level of consensus, after which Round 3 was conducted based on the responses from Round 2.
P12	Not reported	Delphi technique was used to get the importance levels of the factors from experts opinion (qualitative).
P13	Not reported	A risk evaluation index system for sponge city PPP projects was established based on qualitative expert opinions, using the Delphi method.
P14	3	Descriptive statistics were used to validate the indications, and the Kolmogorov–Smirnov test was applied to assess the normality of the data distribution and determine whether they are parametric or nonparametric.
P15	4	After determining the significance of the items, the degree of agreement among the participants was assessed using Kendall's coefficient of concordance. Items with an importance rating of ≥3.4 were selected based on the consensus achieved. This method ensured that only the most relevant items, as determined by expert judgment, were included in the final list.
P16	Not reported	Risk indicators were screened and identified based on qualitative expert opinions using the Delphi method.
P17	3	A consensus was reached in round 3 (qualitative), and in the round 4, the experts did not provide any additional significant changes.
P18	3	Consensus among participants on a particular topic indicates agreement. Additionally, the agreement among experts was assessed using Kendall's coefficient of concordance in each round of the Delphi process.
P19	3	It used questionnaire to obtain consensus or validate from experts qualitative opinion.
P20	3	In round 3, face validity was determined using Lawshe's equation to assess the validity of each factor.
P21	2	Consensus or validity was measured by using mean score ranking.
P22	3	The consensus criteria were defined as follows: Items were added to the final list if they met the following conditions: "IQR ≤ 1", "% of agree ratings (Ratings 4 and 5) ≥ 50%", "Median ≥ 4", and "Mode ≥ 4". Items were excluded if they did not meet these thresholds, such as when "% of agree ratings (Ratings 4 and 5) < 50%", or if the "Median < 4" or "Mode < 4". These criteria ensured that only those items with strong expert agreement were retained.

Paper Code (P)	Consensus in Round	Consensus or Agreement Criteria
P23	2	The level of agreement among the Delphi experts was assessed using Kendall's coefficient of concordance, which was found to be statistically significant at the 0.01 (1%) level. This result confirmed a high level of consensus among the experts, providing confidence in the reliability and validity of the findings.
P24	Not reported	It applied Focus Group Discussion (FGD) with Delphi panel to reach consensus among participants.
P25	3	The probability of occurrence, effect intensity, and detectability were measured using expert opinions (qualitative) through the Delphi method.
P26	3	The face validity of the questionnaire was assessed based on expert opinions, ensuring that the content was relevant and appropriate for the research objectives. A confirmatory analysis using SPSS was conducted, with Cronbach's Alpha values of 0.7 or higher supporting the retention of items. This analysis confirmed the content validity of the instrument, ensuring that the selected items accurately represented the intended constructs.

DISCUSSION

In general, the United Kingdom (UK) accounts for the majority of publications related to PPP infrastructure studies employing the Delphi method, representing 54% of the total, followed by Switzerland at 19%, and the United States at 12%. In terms of journal impact quartile, 42% of the selected articles are published in Q1 journals, followed by 31% in Q2, 15% in Q3, and only 4% in Q4. This distribution indicates that the application of the Delphi method in PPP infrastructure research is largely published in high-quality, Q1 and Q2 journals.

Various data collection techniques are employed in the reviewed studies. This variation demonstrates the versatility of the Delphi method in PPP infrastructure research. The techniques include questionnaires, interviews, or a combination of both. Quantitative and mixed-method studies often utilize modelling and statistical analyses to achieve consensus, while qualitative studies tend to rely on thematic analysis. In some qualitative studies, consensus is determined using simple statistical measures such as the mode, mean, or Inter-Quartile Range (IQR).

The use of the Delphi method in PPP infrastructure studies has been adopted in various countries, often involving local expert opinions. This ensures that the resulting insights are both practical and context-specific. While many studies focus on general infrastructure (macro-level), the Delphi method is also applied to sector-specific issues, depending on the research objectives.

A keyword co-occurrence analysis reveals significant trends. From 2015 to 2018, research centered around themes such as water supply, China, privatization, and decision-making. Between 2018 and 2020, the focus shifted to models, PPP, risk management, surveys, and mergers and acquisitions. From 2020 to 2022, emphasis was placed on PPP projects, infrastructure development, ranking, and construction projects, with a notable increase in studies based in Iran. Finally, from 2022 to 2024, the dominant themes included the Delphi method, construction, PPP, risk factors, barriers, delivery mechanisms, and design. These trends highlight a significant growth in the use of the Delphi method in PPP infrastructure studies, particularly from 2021 onward, as reflected in both the WoS and Scopus databases.

Achieving consensus in the Delphi method requires several rounds, or a single round if the consensus or agreement criteria are met. Thus, the decision regarding the number of Delphi rounds is influenced by several factors, including the research objectives, approach, the homogeneity of expert opinions, and the consensus requirements established for the study (Arijeloye et al., 2024; Eyiah-Botwe et al., 2020).

A fundamental aspect of the Delphi method involves determining the appropriate number of panelists or experts, as well as establishing the criteria for their selection. Numerous studies have not identified a direct link between the size of the expert panel and the effectiveness of the data gathered (Giti et al., 2020). In terms of expert criteria, it is crucial to ensure that experts possess both relevant academic qualifications and practical experience in their respective fields that enable them to offer valuable perspectives. Additionally, choosing experts from diverse sectors and industries is crucial to ensure the robustness and credibility of the research outcomes (Zhao et al., 2023). However, the expertise of the panelists is deemed more important than their quantity (Ramiani et al., 2024).

The Delphi technique is selected to validate requirements due to its reliance on expert judgment (Kuru & Artan, 2024). Consensus is defined as the agreement among participants on a particular topic (Chan et al., 2023), and the process is repeated until consensus is reached (Han et al., 2019). The variability in how consensus, agreement, or validation is determined in the application of the Delphi method in PPP infrastructure studies is evident across different research approaches, including mixed methods, qualitative, or quantitative methodologies. Furthermore, the choice of data analysis and the research objectives also influence the process of achieving consensus. This provides valuable insights for future research and offers a framework to determine consensus and present various options and criteria, which can assist researchers and enhance the quality of research findings, particularly in PPP infrastructure schemes.

While the Delphi method offers significant strengths in facilitating expert consensus and incorporating diverse stakeholder perspectives—making it particularly useful for complex and context-specific PPP infrastructure issues—it is not without limitations. A key drawback is the potential for the bandwagon effect, in which participants may align their views with perceived majority opinions and thus potentially compromise the objectivity of the results. Furthermore, the method's inherent emphasis on consensus may favor agreement over the accuracy or diversity of expert insights, which can lead to oversimplified conclusions. The iterative, multi-round nature of the Delphi process is also time-consuming and may result in participant fatigue or dropout, thereby affecting data quality and consistency.

The above challenges highlight the importance of careful panel selection, clear communication of objectives, and a robust design of consensus criteria. Critically addressing these limitations enables researchers—particularly those unfamiliar with the Delphi method—to apply it more effectively and avoid common pitfalls in PPP infrastructure research.

CONCLUSION

This study investigates the trends in the application of the Delphi method in PPP infrastructure scheme research over the past decade (2015–2024) by focusing on several key characteristics of the method, including criteria for selecting expert panels, the

number of experts involved, Delphi rounds, the approaches used to reach consensus or agreement, and additional aspects such as research methodologies, locations, publishers, co-occurrence and co-authors.

The findings reveal that the research mainly concentrates on the differences in opinions and decisions associated with the utilization of the Delphi method in PPP infrastructure research. The Delphi method is applicable to all types of research approaches, including mixed methods, qualitative, and quantitative research. The results show that no single approach is predominant; instead, the method is consistently applied across various research methodologies, depending on the goals of the study. Furthermore, Delphi method has been widely adopted in PPP infrastructure studies across different countries by incorporating the perspectives of local experts. The method can be effectively implemented using a range of data collection techniques, such as surveys, interviews, or a combination of both. Statistical approach is the most widely employed method; however, thematic or modelling techniques, or combinations of these methods, are also evident.

The results of this study offer an academic contribution as they highlight not only the bibliometric trends but also the thematic areas in which the Delphi method is applied within PPP infrastructure research—such as risk assessment, critical success factors, and stakeholder consensus. The study also reveals the method's frequent integration with tools like AHP and ANP in mixed methods approaches, so that it provides insights into why researchers adopt Delphi to address complex, multi-stakeholder issues in PPP studies.

Building upon the findings of this study, future research could explore the application of the Delphi method in relatively under-researched domains within Public-Private Partnership (PPP) infrastructure, such as digital infrastructure and urban resilience initiatives. These sectors present distinct challenges, including rapidly evolving technologies, complex interdependencies, and diverse stakeholder interests, which warrant further methodological innovation. Scholars are also encouraged to integrate the Delphi method with complementary participatory approaches—such as scenario planning or multi-criteria decision-making (MCDM)—to improve the analytical rigor and inclusivity of expert-based consensus-building processes.

Furthermore, comparative studies that investigate how cultural, institutional, or governance contexts influence consensus-building and expert judgment in PPP frameworks could provide valuable insights for both academic inquiry and policy development. Such investigations can help uncover context-specific factors that shape decision-making dynamics and offer both theoretical and practical contributions for policymakers and practitioners. These future research directions not only have the potential to enrich the methodological landscape of Delphi-based inquiry but also enhance its applicability to multidisciplinary challenges in infrastructure development across diverse socio-political environments.

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Digital Measurement of the Construction Workers' Performance through the Five-Minute Rating Method

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ABSTRACT

The Five-Minute Rating method is a simplified approach used to measure workers' performance based on time study principles, aimed to provide representative evaluations with minimal observation samples. However, its adoption in the construction industry remains low at only 6.4%, due to perceived impracticality and time-consuming implementation. A digital solution known as the Five-Minute Rating Solver (FMR-Solver), developed as an Android-based application, has been introduced. However, the practicality of its use and the efficiency of the measurement duration have yet to be studied. This study aims to measure the efficiency of the application tool in assessing worker effectiveness compared to using the conventional Five-Minute Rating method and to evaluate users' perceptions of using the application. A case study was conducted during the installation of foundation reinforcement. The results show that the application tool can increase measurement efficiency by 22.6%. Evaluations by five users—based on criteria of stability, accuracy, understandability, operability, usefulness, and attractiveness—indicate validity scores ranging from 76.0% to 96.0%, falling within the categories of valid to very valid. The results suggest that the method offers a practical and effective alternative for construction workers' performance and holds promise for wider industry adoption.

Keywords: Digitalization; Efficiency; Five-Minute Rating; Labor Performance

ABSTRAK

Five-Minute Rating merupakan salah satu metode pengukuran efektivitas kinerja berdasarkan prinsip *time study* dan bertujuan untuk memberikan penilaian yang representatif dengan sampel pengamatan yang relatif kecil. Namun, penggunaannya di industri konstruksi cukup rendah yaitu hanya 6,4% dengan alasan bahwa metode tersebut tidak praktis dan tidak singkat. Saat ini, pengukuran dengan alat bantu aplikasi Android berbasis *Five-Minute Rating Solver* (FMR-Solver) mulai diperkenalkan. Akan tetapi, tingkat kepraktisan dalam penggunaan dan efisiensi durasi pengukuran belum dikaji lebih lanjut. Penelitian ini bertujuan mengukur efisiensi alat bantu aplikasi dalam menilai efektivitas pekerja dibandingkan menggunakan metode *Five-Minute Rating* secara konvensional dan menilai persepsi pengguna dalam menerapkan aplikasi tersebut di lapangan. Studi kasus dilakukan pada pekerjaan instalasi tulangan sloof. Hasil studi menunjukkan bahwa alat bantu aplikasi mampu meningkatkan efisiensi durasi pengukuran sebesar 22,6%. Penilaian lima pengguna aplikasi berdasarkan kriteria *stability, accurateness, understandability, operability, usefulness,* dan *attractiveness* mencapai nilai pada rentang 76,0%-96,0% dengan kategori valid dan sangat valid. Hasil penelitian ini diharapkan memberikan gambaran bagi kontraktor atas penggunaan metode yang praktis dalam mengukur kinerja pekerja konstruksi, terlebih setelah adanya digitalisasi.

Kata Kunci: Digitalisasi; Efisiensi; *Five-Minute Rating*; *Labor Performance*

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INTRODUCTION

Technological advancements are playing an increasingly important role in the construction industry. Among the advancements, digitized performance measurement tools have emerged to enhance worker performance. Various forms of performance measurement technology at the digitized construction operation level include Method Productivity Delay Model (Januardi et al., 2025), Crew Balance Chart (Aziz et al., 2024), and Five-Minute Rating (Rochman, 2024). These tools aim to streamline the evaluation process of worker productivity and effectiveness, rendering it more time-efficient and practical (Aziz, 2023). Despite this progress, the implementation of such methods remains limited. A survey by Ulhaq (2023) found that only 6.4% and 8.8% of 125 construction practitioners had applied the Five-Minute Rating and Work Sampling methods in their projects. The Indonesian construction industry should further explore the development of digitalization and the application of more technology (Soemardi et al., 2020). At the same time, the rise of mobile technologies has opened new possibilities for enhancing workplace efficiency, including in construction productivity measurement (Oesterreich & Teuteberg, 2016).

Productivity and effectiveness assessments are not the same. Construction operation productivity assessments provide an overview of the ability of individuals or work groups to complete construction components in specific units. This aligns with definitions provided by Pramesti and Priyanto (2023) and Waney et al. (2023), who conceptualize productivity as the ratio between input—commonly expressed in man-hours (MH) or man-days (MD)—and output, defined by the quantity of completed work units or work capacity over a specific time interval. Effectiveness is the alignment between previously set goals and objectives and the results achieved (Rahmadini et al., 2023). In contrast, effectiveness pertains to the degree to which actual outcomes align with predefined goals and objectives (Rahmadini et al., 2023). When low productivity is suspected to stem from labor-related factors, effectiveness assessment can serve as a practical preliminary diagnostic tool that offers insights into worker performance before undertaking more comprehensive and time-intensive productivity analyses.

One way to measure worker effectiveness is through Five-Minute Ratings. This method involves observing workers for five minutes per sample, and their activities are classified as either active or inactive. A worker is considered to be actively working if the total duration of work exceeds 50% during the observation period (Dozzi & AbouRizk, 1993). However, the method is generally limited to small-scale observations and is less effective when applied to larger workgroups.

Digitalization refers to the process of transforming conventional systems into digital ones through the integration of information and communication technology. This process aims to improve efficiency and innovation in various fields, including construction. In this context, platforms such as MIT App Inventor offer pathways for the implementation of digitalization (Loukatos et al., 2024). One such initiative is the digitization of the Five-Minute Rating method through the development of the *Five-Minute Rating Solver* (FMR-Solver), an application created using the open-source MIT App Inventor by Rochman (2024). However, the efficiency of the application compared to conventional measurements has not been assessed, including its practicality for use by other parties.

This study aims to evaluate the efficiency of the FMR-Solver in terms of measurement duration when assessing construction worker effectiveness, as compared to the traditional Five-Minute Rating method. In addition, the study investigates user perceptions of the application, focusing on six indicators, i.e., stability, accuracy, understandability, operability, usefulness, and attractiveness.

THEORETICAL FRAMEWORK

Five-Minute Rating

Yates (2014) explains that the Five-Minute Rating method is useful for identifying whether workers are engaged in productive activities or are idle. According to Dozzi and AbouRizk (1993), this method offers a snapshot of crew effectiveness in performing their tasks. Similarly, Oglesby et al. (1989) emphasize that the primary objective of the Five-Minute Rating is to evaluate worker effectiveness.

When compared to other commonly used methods such as work sampling and time study, the Five-Minute Rating stands out for its simplicity and speed in gathering data on worker conditions. Although it is not as precise as these more comprehensive techniques, it offers a practical alternative for quick assessments in the field (Farooq & Moon, 2019; Abukhalaf & Abusal, 2021).

Measurement Stages

Measuring effectiveness using Five-Minute Ratings involves three main stages (Yates, 2014):

1. The first stage is preparing a standardized assessment sheet. This sheet is formatted as a table where the columns represent individual personnel or worker identifiers, and the rows indicate specific observation time intervals. This format ensures systematic data recording during the observation process.

2. The second stage is observing workers' activities. In this stage, observers monitor worker activities at fixed intervals, typically every five minutes. Each observation captures whether a worker is actively engaged in productive tasks. If the duration of active work exceeds 50% of the observed interval, a checkmark (✓) or symbol such as "x" is entered in the corresponding cell of the assessment sheet to denote productive status. Observers may also include brief qualitative notes for activities that do not clearly fall within the "working" category.

3. The final stage involves determining the effectiveness level of individual workers or teams. This is calculated by dividing the number of "working" observations by the total number of observations. The result is expressed as a percentage to represent the proportion of time workers were observed performing productive activities during the assessment period.

Table 1. Five-Minute Rating Observation and Analysis Form

5 Minutes Rating *Date: 8/1/2007*

Analysis Crew : Precast Panel Erection *Page: 1 of 1*

Job : University Dormitory Structure

Time Interval : 1 Minute ☐ *= Effective Work*

Weather : Sunny

Observ.	*Time of Observ*	*Man 1 Iron Worker*	*Man 2 Iron Worker*	*Man 3 Carpent.*	*Man 4 Carpent.*	*Man 5 Carpent.*	*Man 6 Welder*	*Operations*
1	10:13	☐						*Crew waiting for panel hosting*
2	:14	☐	☐	☐	☐	☐		*Landing panel/welder waiting to tack*
3	:15	☐	☐	☐	☐	☐		*Landing panel/welder waiting to tack*
4	:16		☐	☐	☐	☐		*Install upper brace bolt*
5	:17		☐		☐	☐		*Install bracket*
6	:18			☐	☐	☐		*Align panels*
7	:19			☐	☐	☐		*Align panels*
8	:20			☐	☐	☐		*Align panels*
9	:21	☐	☐	☐				*Unhook crane*
10	:22	☐	☐	☐				*Unhook crane*
11	:23						☐	*Welder tacks rebar, crew waits for*
12	:24						☐	*Next panel to be hoisted*
13	:25						☐	*" "*
								Total
	Maximum Total	***13***	***13***	***13***	***13***	***13***	***13***	***78***
	Effective Total	***5***	***6***	***8***	***7***	***7***	***3***	***36***
	Effectiveness Ratio	***38%***	***46%***	***62%***	***54%***	***54%***	***23%***	***46%***

Source: Yates (2014)

FMR-Solver Application

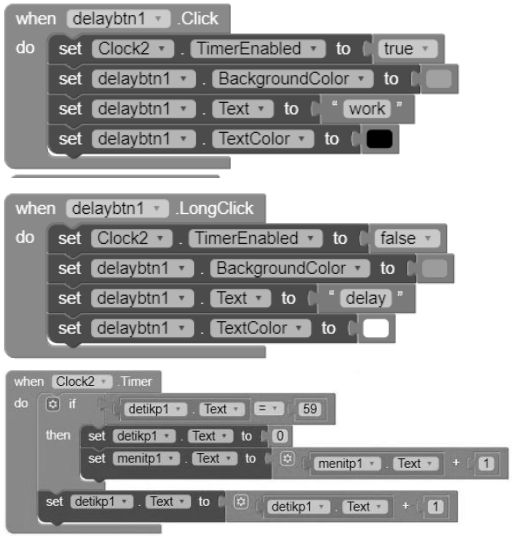

Figure 1. Coding Block Section of the Interface for Worker Condition Input

The FMR-Solver application is a product resulting from the digitization of the Five-Minute Rating measurement method developed by Rochman (2024) using the Android application development platform MIT (Massachusetts Institute of Technology) App Inventor. This platform is user-friendly for those without coding experience, as the application development process utilizes a drag-and-drop approach (Ulum & Badri, 2023) (Tombeng et al., 2023). Figure 1 illustrates the coding block design of the FMR-Solver.

The FMR-Solver facilitates the data collection and processing phases of worker effectiveness assessment by automating the classification of activities into "working" or "not working" categories. Unlike the manual method that requires observers to assess whether the duration of active work exceeds 50%, this application allows users to simply press a button to record whether a worker is engaged in productive activity. Based on these inputs, the application automatically calculates the effectiveness level. Figure 2 displays the initial user interface upon launching the application, where users are presented with a "Start" option to begin the assessment process.

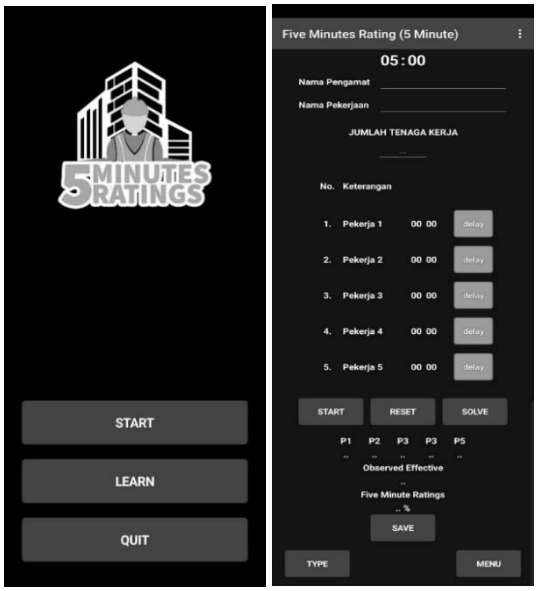

Figure 2. User Interface FMR-Solver

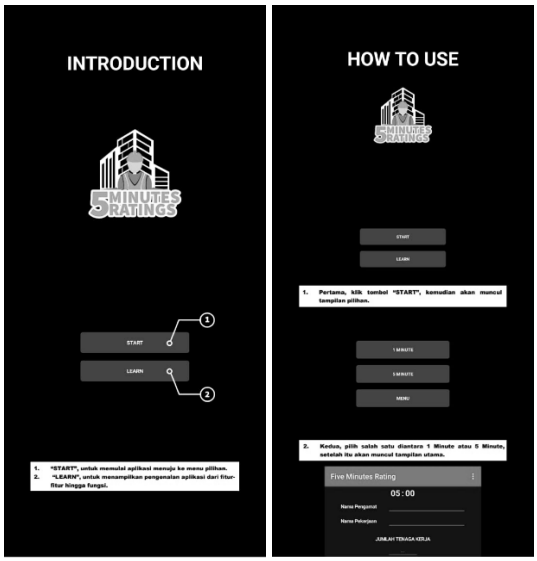

Figure 3. Interface of Introduction & Procedure to use FMR-Solver

The user interface of FMR-Solver is quite user-friendly because it provides a page to introduce and provide information on how to use this application. Figure 3 shows the interface when selecting the "learn" button.

METHODOLOGY

Research Design

This study was conducted by comparing the measurement of worker effectiveness using the FMR-Solver application with the conventional method, from the initial preparation of observations to obtaining the effectiveness results from the Five-Minute Rating method. A clearer description of each stage of the study is presented in Figure 4.

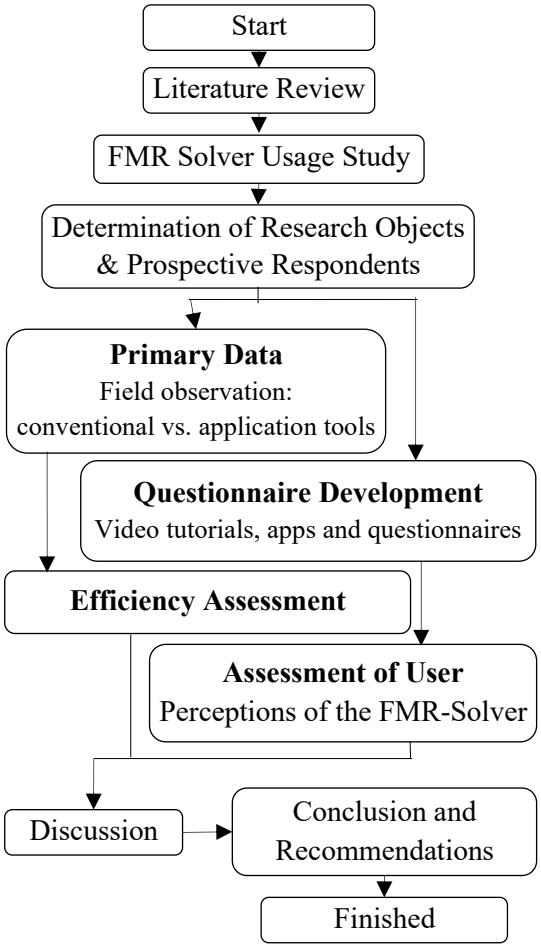

Figure 4. Research Flow

Effectiveness Measurement Techniques

The steps for using the FMR-Solver application are as follows (Rochman, 2024).

1. Click "Start" on the front screen.
2. Fill in the observer data and the work to be observed.
3. Click "Start" on the main screen when you are ready to observe the first sample work.
4. Observe the worker.

5. If the worker is not working, click "Delay," then if the worker starts working again, click and hold "Delay."
6. Once the first sample is complete, click "Solve" to view the results.
7. Then click "Save" to save the observation data to a spreadsheet.
8. For subsequent sample observations, repeat step two.

Figure 5 shows the process of measuring worker effectiveness using the FMR-Solver.

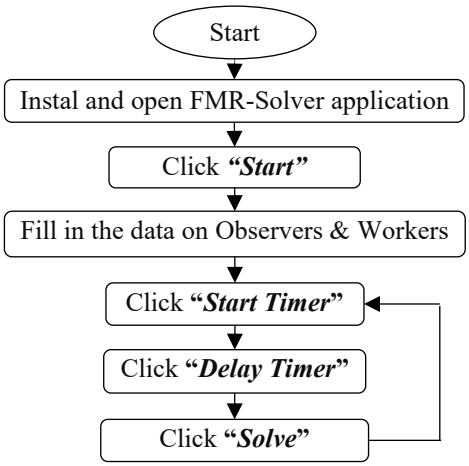

Figure 5. FMR-Solver Application Workflow

Efficiency Measurement Techniques

The efficiency assessment techniques are carried out as follows.

1. Record the activities of workers installing sloof reinforcement using video recordings.
2. Perform effectiveness measurement procedures using the conventional Five-Minute Rating method or using the FMR-Solver application tool.
3. Record and compare the duration of the effectiveness calculation for both methods.
4. Draw conclusions regarding the efficiency value of using the FMR-Solver application tool.

Application Assessment based on the Respondents' Perceptions

The FMR-Solver application was assessed based on several aspects to evaluate its usability and user comfort. Table 2 shows the assessment aspects and their explanations.

Table 2. Assessment Aspects

No.	Application Assessment Indicators	References
1	**Stability**	
	- The application does not crash or suddenly stop when in use.	Bevan et al. (2016)
	- No errors occur during use.	Pressman (2005)
	- The application remains responsive even when used for a long time.	Hoehle & Venkatesh (2015)
	- The application does not require repeated restarts to function properly.	Moumane et al. (2016)
2	**Accurateness**	
	- The application produces the same output as the conventional method.	Stoyanov et al. (2016)
3	**Understandability**	
	- The application is easy to understand and use with a PDF user manual and technical instructions in the application.	Hoehle & Venkatesh (2015)
	- The icons and symbols used in the application are clear and consistent with their functions.	Weichbroth (2020)
	- The application provides clear guides/tutorials.	Albert & Tullis (2013)
4	**Operability**	
	- The application has practical operating steps.	Kurniawan (2004)
	- The buttons and controls in the application work well.	Lewis (2018)
5	**Usefulness**	
	- This application helps users become more efficient.	Amin et al. (2014)
	- This application is useful for assessing worker effectiveness.	Brooke (1996)
6	**Attractiveness**	
	- The application design is simple and straightforward.	Hoehle & Venkatesh (2015)
	- The font and text size in the application are easy to read.	Silvennoinen et al. (2014)
	- The calculation results are clearly displayed.	Ngadiman et al. (2015)
	- The visual elements in the application are not excessive, making it comfortable to view.	Rubin & Chisnell (2008)

In terms of respondent assessment, the researcher established the following steps:

1. Providing the application and work videos to calculate effectiveness through the application that had been developed.

2. Providing a questionnaire form and requesting assessments from respondents regarding the application.

3. Analyzing the assessments from the data obtained from the respondents. The analysis was carried out using the Likert scale method obtained from the questionnaire with the help of Google Forms and Microsoft Excel.

Respondent Limitations and Case Study Determination

This study requires respondents to assess the practicality of the application. Respondents are limited by the following criteria:

1. Is a practitioner in the construction sector

2. Has conducted measurements of worker effectiveness or productivity using scientific methods (Januardi et al., 2024) such as work sampling, Five-Minute Rating, filed rating, dan time studies (e.g., crew balance chart, cycle chart, process chart and method productivity delay).

3. Are willing to measure worker effectiveness using FMR-Solver with a pre-determined case study before the application assessment.

4. The number of application evaluators is five. This is sufficient to assess usage, with findings nearly as numerous as when using a larger number of respondents (Nielsen, 2012, in Resdiyani et al., 2021).

This restriction was imposed considering that the tool used is intended for use in the construction sector, although it does not rule out the possibility of its use in other sectors for measuring performance effectiveness. In addition, it is difficult to find respondents who meet the criteria of having conducted scientific measurements of effectiveness or productivity. Therefore, the number of respondents in this study is only five.

The case study selected, which involved the reinforcement of a sloof, does not exclude the application of worker performance effectiveness measurement using this application in other types of work. This case study was randomly selected by the researcher from ongoing construction work at the building project at that time. Therefore, the application can be used for other types of work at all operational levels.

Questionnaire Analysis

In this study, the Relative Importance Index (RII) method was used to analyze data obtained through a questionnaire with a Likert scale of 1 to 5. RII serves to measure the relative importance of each item based on the respondents' answers. The RII calculation was performed using the following formula:

$$RII = \frac{\sum W}{A \; x \; N}$$

Where W is the sum of the weights of the respondents' responses, A is the maximum value of the Likert scale, and N is the number of respondents who answered the questionnaire (Qomusuddin & Romlah, 2022). This method is widely applied in quantitative research to identify respondents' priorities or satisfaction with various factors.

The RII approach allows researchers to rank items based on their level of importance according to respondents' perceptions (Boakye et al., 2023). RII results range from 0 to 1, with values closer to 1 indicating a

higher level of importance. This method is widely used in various fields, especially for evaluating factors in project management, service quality, and customer satisfaction (Qomusuddin & Romlah, 2022). The values obtained from the RII method are then converted using a conversion scale table to determine the resulting categories.

Table 3 below is the conversion scale table.

Table 3. Conversion Scale

Achievement Level (%)	Categories
81-100	Highly Valid
61-80	Valid
41-60	Sufficiently Valid
21-40	Less Valid
0-20	Not Valid

Source: Qomusuddin & Romlah (2022)

RESULTS

Data Collection Stage

The data were collected from the Toko Laris construction project located at Jl. Jend. Sudirman No. 115, Purbalingga Lor Village, Purbalingga District. Data collection was conducted on September 2, 2024, to record the activities of two workers installing the sloof reinforcement. The work was recorded at 9:00 a.m. and 1:00 p.m., with each video lasting 37 minutes and 38 minutes, respectively. The location for data collection is shown in Figure 6, and photo of the sloof work process is shown in Figure 7.

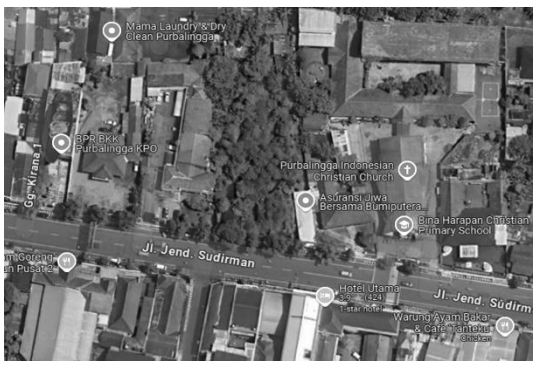

Figure 6. Data Collection Location

Figure 7. Sloof Reinforcement Installation Work

Data Processing Stage

Data processing was carried out after all the necessary data had been collected. The necessary data included the delay time data of every single worker at each observation interval. Data processing in this study was carried out using two different methods, namely the conventional method and the FMR-Solver application tool method. The purpose of the data processing is to compare the results and the length of the process (from preparation to completion of calculations) of each method.

The main distinction between these two methods lies in the data collection process. The conventional method involves a multi-step manual process, which requires the preparation of two forms prior to observation. Form 1 is used to log delay durations, while Form 2 is used to calculate worker effectiveness based on the data in Form 1. After the preparations are ready, observation and calculation can be carried out.

In contrast, the FMR-Solver application streamlines the entire process. Users only need to install the application on an Android device, after which they can directly observe and record worker activity using the application interface. The app automatically processes the input and provides real-time calculations of worker effectiveness (Rochman, 2024).

Conventional Method

Data processing using the conventional method is carried out by observing recorded videos, recording the duration of workers' delays in 1 sample, recording up to the last sample on form 1, then calculating the Five-Minute Rating effectiveness on form 2.

The following tables are forms 1 and 2. On form 1, the observer writes down the start and end times of the delay for each sample and notes the seconds, minutes, and hours.

Table 4. Form 1 for Observation

Form-1: Five-Minute Rating Form		
Observer's Name : Saeful Rochman		
Job Title	: Reinforcement Work on the Sloof	
No	**Worker 1**	**Worker 2**
1	-	-
2	06:32 - 06:57	-
3	12:33 - 13.02	-
4	-	-
5	-	23:41 - 24:21
6	-	-
7	-	-
8	-	-
9	44:15 - 45:00	42:11 - 42:58
10	-	-
11	-	-
12	-	-
13	-	-
14	01:07:21 - 01:08:05	-

In Form 2 below, the calculated Five-Minute Rating result is 100%, derived from the comparison between the number of Observed Effective instances and the Total Observed samples, which is 28 out of 28 (28/28). This outcome indicates that in each of the 28 observation intervals, the worker was considered effective. The 100% rating is justified by the fact that the duration of delays in each sample remained below 50% of the five-minute observation window.

Table 5. Form 2 for Effectiveness Analysis

Form-2: Five-Minute Rating Form				
Observer's Name : Saeful Rochman				
Job Title	: Reinforcement Work on the Sloof			
No	**Worker 1**	**Worker 2**	**Observed Effective**	**Five-Minute Ratings %**
1	✓	✓	2	100%
2	✓	✓	2	100%
3	✓	✓	2	100%
4	✓	✓	2	100%
5	✓	✓	2	100%
6	✓	✓	2	100%
7	✓	✓	2	100%
8	✓	✓	2	100%
9	✓	✓	2	100%
10	✓	✓	2	100%
11	✓	✓	2	100%
12	✓	✓	2	100%
13	✓	✓	2	100%
14	✓	✓	2	100%
Total Observed			28	
Observed Effective			28	
Effectiveness			100%	

Application Tool Method

Data processing using the FMR-Solver application tool was conducted by observing the recorded video of construction activities. During the observation, delay occurrences were directly input into the FMR-Solver application, which enables automatic calculation of worker effectiveness (Rochman, 2024). Unlike the conventional method, which requires manual entry and post-observation calculations, this digital tool streamlines the process by integrating real-time data entry and instant processing within the application interface. Table 6 presents the observation results obtained using the FMR-Solver. It records the calculated Five-Minute Rating effectiveness and the duration of delays for each observation sample.

Table 6. FMR-Solver Spreadsheet

Observer's Name : Saeful Rochman				
Job Title	: Reinforcement Work on the Sloof			
No	**Worker 1**	**Worker 2**	**Observed Effective**	**Five-Minute Rating %**
1	✓	✓	2	100%
2	✓	✓	2	100%
3	✓	✓	2	100%
4	✓	✓	2	100%
5	✓	✓	2	100%
6	✓	✓	2	100%
7	✓	✓	2	100%
8	✓	✓	2	100%
9	✓	✓	2	100%
10	✓	✓	2	100%
11	✓	✓	2	100%
12	✓	✓	2	100%
13	✓	✓	2	100%
14	✓	✓	2	100%
Total Observed			28	
Observed Effective			28	
Effectiveness			100%	

Comparison of the Results

There is no difference between the results calculated using the conventional method and the application tool method, which means that the application can be considered to provide accurate results.

Table 7. Comparison of Worker Effectiveness between Conventional Methods and FMR-Solver

Methods	Ratio Observed	Five-Minute Rating
Conventional	28/28	100%
FMR-Solver	28/28	100%

Efficiency of Application Tools

The efficiency of the application is assessed by comparing the conventional process of observation to obtain the Five-Minute Rating results with the application tool method. The data required for this calculation includes the duration of creating the draft table on the form, the duration of observation, and the duration of calculating the Five-Minute Rating results. The objective is to determine the efficiency value when using application tools compared to conventional methods. Table 8 provides information on the duration.

Table 8. Duration of Conventional Methods

No	Activities	Duration (second)
1	Preparation of draft tables for forms 1 and 2	449
2	Observation of workers (14 samples)	4,391
3	Data calculation	755
	Total	5,595

Based on conventional observation methods, there are three steps to obtain labor effectiveness. The time required to obtain the data using conventional observation methods to 14 samples is 5 minutes per sample, resulting in 5,595 seconds or 1 hour 33 minutes 15 seconds.

Table 9. Measurement Duration with Tools

No	Activities	Duration (second)
1	Observation of workers (14 samples)	4,328
	Total	4,328

Based on observations using the FMR-Solver application tool, there is one step to obtain labor effectiveness. The time required to obtain labor effectiveness using the conventional observation method of 14 samples is 5 minutes per sample, resulting in 4,328 seconds or 1 hour 12 minutes 8 seconds.

Table 10. Efficiency in Using Tools

No	Methods	Duration (second)
1	Conventional	5,595
2	FMR-Solver Application	4,328
	Difference	1,267
	Efficiency of application tools	22.6%

Based on the results of comparing the duration of observations of labor effectiveness measurements using conventional methods with the FMR-Solver application tool method, the FMR-Solver application tool method is 22.6% more efficient than conventional methods. Thus, FMR-Solver can make observations more efficient.

Application Assessment (User Perception)

The respondents in this study were practitioners who had used the Five-Minute Rating method and researched the performance/productivity of construction operations. The following is the profile of the respondents:

1. Respondent 1
   Agency/Company : PT Sarana Anugerah Perdana
   Qualification : Contractor
   Position : Site Manager
   Education : Bachelor's Degree in Civil Engineering

2. Respondent 2
   Agency/Company : KemenPUPR
   Qualification : Government
   Position : Technical Field Facilitator
   Education : Bachelor's Degree in Civil Engineering

3. Respondent 3
   Agency/Company : CV GCC
   Qualification : Design Consultant
   Position : Deputy Director
   Education : Bachelor's Degree in Civil Engineering

4. Respondent 4
   Agency/Company : KemenPUPR
   Qualification : Government
   Position : Technical Field Facilitator BSPS
   Education : Bachelor's Degree in Civil Engineering

5. Respondent 5
   Agency/Company : PT. Bangkit Manunggal Karya Teknik
   Qualification : Contractor
   Position : Quantity Surveyor
   Education : Bachelor's Degree in Civil Engineering

Respondents provided their perceptions of the application developed by the researchers by evaluating their experience using the FMR-Solver application through a Google Form questionnaire.

Based on the analysis of the respondents' questionnaires using the Likert scale and RII, the lowest RII value was 76.0%, and the highest was 96.0%, which means it is valid and highly valid according to Table 3 of the conversion scale. The rankings were sorted from highest to lowest percentage, but there were some ties. These were then sorted by highest score, but some remained tied even after sorting by highest score. These tied values are found in ranks 1, 2, and 3.

The results show that the application is suitable from several aspects of the indicators mentioned in Table 11. Based on the highest assessment, FMR-Solver was approved by respondents with maximum scores for producing the same effectiveness values as conventional methods, being easy to use, and providing measurement duration efficiency.

Table 11. Respondent Assessment Analysis

No	Application Assessment Indicators	Amount (W)					N	RII	Rank
	Score	1	2	3	4	5			
1	**Stability**								
	- The application does not crash or suddenly stop when in use.	-	-	1	1	3	5	88%	3
	- No errors occur during use.	-	1	1	-	3	5	80%	8
	- The application remains responsive even when used for a long time.	-	1	1	1	2	5	76%	9
	- The application does not require repeated restarts to function properly.	-	-	2	-	3	5	84%	6
2	**Accurateness**								
	- The application produces the same output as the conventional method.	-	-	-	1	4	5	96%	1
3	**Understandability**								
	- The application is easy to understand and use with a PDF user manual and technical instructions in the application.	-	-	-	1	4	5	96%	1
	- The icons and symbols used in the application are clear and consistent with their functions.	-	-	-	2	3	5	92%	2
	- The application provides clear guides/tutorials.	-	-	-	2	3	5	92%	2
4	**Operability**								
	- This application has practical operating steps.	-	-	1	1	3	5	88%	3
	- The buttons and controls in the application work well.	-	1	-	1	3	5	84%	5
5	**Usefulness**								
	- This application helps users become more efficient.	-	-	-	1	4	5	96%	1
	- This application is useful for assessing worker effectiveness.	-	-	-	3	2	5	88%	4
6	**Attractiveness**								
	- The application design is simple and straightforward.	-	1	-	1	3	5	84%	5
	- The font and text size in the application are easy to read.	-	1	-	3	1	5	76%	10
	- The calculation results are clearly displayed.	-	-	-	2	3	5	92%	2
	- The visual elements in the application are not excessive, making it comfortable to view.	1	-	-	1	3	5	80%	7

DISCUSSION

The FMR-Solver application offers a practical solution to measure worker performance effectiveness, particularly by improving time efficiency in the measurement process. This aligns with the digitalization trends in the construction sector and related fields (Sulartopo et al., 2023; Hermawan & Sudirman, 2023). The application is especially useful for contractors seeking to monitor worker performance effectiveness, either periodically to maintain performance rhyth or during instances where signs of performance decline are observed. If it is proven, it can be continued with productivity measurements such as the MPDM method, Crew Balance Chart, Process Chart, or Cycle Chart. This is to identify issues and recommend improvements based on the findings (Januardi et al., 2024).

According to Yates (2014), a worker is considered effective if delays account for less than 50%. Furthermore, an effectiveness rating between 80–90% indicates high efficiency, while ratings in the 50–60% range reflect lower efficiency. It is important to note that this method only provides a classification of worker status—productive or inactive—during the observation period.

The concept of effectiveness assessment in the Five-Minute Rating differs from the assessment in work sampling, which evaluates three conditions based on worker activities: effective work, essential work, and ineffective work (Yates, 2014) or productive, semi-productive (involved in supporting the main activity), and non-productive (Dozzi & AbouRizk, 1993). This is because the output values they produce are also different. The Five-Minute Rating focuses on the worker's effectiveness ratio, so what is compared is the duration of work without delays with the duration of

observation time. Work sampling, on the other hand, focuses on the labor utilization rate by conducting brief observations (events) without a specific duration like the Five-Minute Rating, and classifying those events into the three conditions mentioned above. Additionally, the Five-Minute Rating conducts continuous observation like the time study concept, albeit with a short observation duration (1 or 5 minutes), while work sampling uses a probability concept. Thus, the required sample size can reach 384 observations to achieve a 95% confidence level (Dozzi & AbouRizk, 1993).

Developing the FMR-Solver application using the MIT App Inventor has been reported not difficult (Rochman, 2024). Individuals without prior experience in software development or coding can complete this application in four months. The most important prerequisite for the development lies in the individual's understanding of the technical procedures of the measurement method to be developed.

Despite its practicality, the FMR-Solver application has several limitations

1. The application can only be used to measure the effectiveness of the Five-Minute Rating method.

2. The application is not yet available for public through the Play Store. However, those who need it for research and field use are welcome to contact the author.

3. Raw data will be automatically generated in the spreadsheet of the author's first email account as the application developer. The results of the effectiveness calculation can be directly obtained in the application.

4. The explanation of the application's usage is still in Indonesian language.

This study opens up opportunities for further research in the form of:

1. The FMR-Solver has the potential to be a model for the development of Adv-FMR, which is currently being developed by Kim et al. (2022), where IoT or ICT support is used to measure effectiveness and produce outputs with minimal error.

2. The FMR-Solver can be further developed by organizing the recorded time and duration database to make it open access for others by adding a user registration function (Hamzan et al., 2022). This includes adding a voice note function if something important is observed during observation that needs to be recorded without having to write it down (Aziz et al., 2024).

3. Further testing of the FMR-Solver application is recommended across construction tasks at the operational level to validate the application's availability for all types of work.

CONCLUSION

The use of the FMR-Solver application enhances the efficiency of the FMR method by 22.6% compared to the conventional approach. This improvement in efficiency is attributed to the application's ability to integrate observation, calculation, and result presentation within a single digital interface. In contrast, the conventional method requires a multi-step process involving the preparation of manual forms (Form 1 and Form 2), manual data recording, and subsequent calculations to obtain the result. In the Five-Minute Rating measurement using the conventional method and the FMR-Solver application tool for reinforcing bar installation work, the same effectiveness results were obtained, namely 100%. Both the conventional and digital methods yielded

identical effectiveness outcomes in the case study of reinforcing bar installation work, with each reporting a Five-Minute Rating of 100%, which indicated consistent measurement results of both approaches.

User perceptions of the FMR-Solver application were evaluated based on six key indicators—stability, accuracy, understandability, operability, usefulness, and attractiveness—resulting scores between 76.0% and 96.0%. These values are categorized as valid to highly valid. Such findings support the FMR-Solver as a reliable and efficient tool for measuring worker effectiveness.

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The Influence of Foreign Loan Lender Guidelines on the Project Consulting Services Tender in Indonesia

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ABSTRACT

This study investigates the influence of the Saudi Fund for Development (SFD) guidelines on the tender process of consultancy services in Indonesia, specifically for foreign loan-financed projects. It investigates the differences between Indonesia's national regulations, laid out in Presidential Decrees, and lender-specific guidelines, which are mandatory when external funding is used. This qualitative research applied interviews with actors holding decision-making authority within the procurement process. The data were examined through a thematic analysis using NVivo 12 software. Two significant differences between the SFD guidelines and Indonesia's national regulations were established. First, a manual process is stipulated by SFD guidelines, yet an electronic platform is preferred by Indonesia's regulations, which triggers extensive delays. Second, obtaining a No Objection Letter (NOL) from a lender for every phase of the tender process is a time-consuming demand that creates bottlenecks situation and prolongs the process. The research emphasizes that critical issues arise when balancing such differing sets of regulations, which are counterproductive for a smooth and timely process. Thus, harmonized national and lender-specific regulations are needed to minimize delays and accelerate a smooth process of service procurements.

Keywords: Consulting Services; No Objection Letter (NOL); Procurement; Tender Process

ABSTRAK

Artikel ini membahas dampak pedoman Saudi Fund for Development (SFD) terhadap proses pengadaan jasa konsultasi di Indonesia, khususnya untuk proyek yang didanai oleh pinjaman luar negeri. Penelitian ini mengkaji perbedaan antara peraturan nasional Indonesia yang ditetapkan dalam Keputusan Presiden dan pedoman khusus pemberi pinjaman yang wajib digunakan dalam proyek berbasis pendanaan eksternal. Data penelitian kualitatif ini diperoleh dari hasil wawancara dengan para pelaku yang memiliki kewenangan pengambilan keputusan dalam proses pengadaan. Data dianalisis secara tematik menggunakan perangkat lunak NVivo 12. Studi ini menemukan dua perbedaan signifikan antara pedoman SFD dan peraturan nasional Indonesia. Pertama, pedoman SFD menetapkan proses manual, tetapi peraturan Indonesia lebih memilih *platform* elektronik sehingga dimungkinkan adanya penundaan yang cukup lama. Kedua, proses pemerolehan Surat Tidak Keberatan (STK) dari pemberi pinjaman untuk setiap fase proses tender juga memakan waktu sehingga dapat menghambat dan memperpanjang proses pengadaan. Penulis melihat adanya persoalan yang muncul saat menyeimbangkan dua perangkat peraturan yang berbeda, yang terkesan kontraproduktif dan menghambat kelancaran proses pengadaan. Penelitian ini menyimpulkan bahwa harmonisasi peraturan nasional dan pemberi pinjaman sangat diperlukan untuk meminimalisasi keterlambatan dan mempercepat proses pengadaan layanan.

Kata Kunci: Layanan Konsultasi; Pengadaan; Proses Tender; Surat Tidak Keberatan (STK)

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INTRODUCTION

A good procurement system (sometimes referred to as the tender process) includes complex and interrelated elements, e.g., professional management, supportive human resources, and up-to-date regulations. The procurement system for goods/services is initially based on Presidential Regulation Number 54 of 2010. Subsequently, Presidential Regulation Number 16 of 2018 on the Procurement of Goods and Services was issued. Three years later, in 2021, the Government of the Republic of Indonesia reissued Presidential Regulation Number 12 of 2021, which is an amendment to the Presidential Regulation Number 16 of 2018 on Government Procurement of Goods/Services.

Procurement of goods/services, according to Presidential Regulation Number 12 of 2021, is an activity of procuring goods/services carried out by the Ministry/Institution/ Regional Apparatus and funded by the national or regional budgets. The procurement process begins with identifying the need for goods/services, to the completion stage of work activities (Tanesia, 2016).

In construction work, the most widely known procurement is the procurement of construction services and the procurement of consulting services, both with domestic and foreign funding support. One example of a consulting service procurement activity funded by foreign loan funds is the procurement of consulting services for the supervision of the XYZ University campus development project (pseudonym) with the Saudi Fund for Development (SFD) lender based in Jeddah, Kingdom of Saudi Arabia.

As with foreign loan-based projects, lenders must have guidelines that serve as a reference for the technical implementation of the loan (SFD Guidelines, 2001). The guidelines contain all matters regarding the process that the loan recipient will carry out. The processes in the guidelines include the procurement process, budget disbursement process, service provider's term, and construction and consulting. In the process, the procurement of consulting services requires a reasonably long time before the final results of the tender winner are announced. Many factors could be identified to cause the length of the tender implementation process.

In response to this tendency, the author tried to collect data from interviews with stakeholders related to the tender process and conducted a literature review for further analysis. This article seeks to examine the extent to which the presence of these lender guidelines has influenced the implementation of Project Consultancy Services Tender in Indonesia, which is still bound by the Presidential Regulation.

THEORETICAL FRAMEWORK

Procurement of Goods/Services Funded by the Government Budgets

Procurement of goods and services is a form of procurement through third parties to obtain goods and services within the governmental scope. Procurement whose financing is partly or entirely derived from the government (national or regional budgets, should aim to provide reliable public goods and services (Faisal et al., 2017).

In Indonesia, the procurement of goods/services is regulated in Presidential Regulation Number 54 of 2010 (Peraturan Presiden RI No. 54, 2010) which was later amended in Presidential Regulation Number 16 of 2018 (Peraturan Presiden RI No. 16, 2018) and Presidential Regulation Number 12 of 2021 (Peraturan Presiden RI No. 12, 2021). The purpose of formulating these regulations is to obtain prospective providers of goods/services of good quality to complete work by conducting selection through several stages. In addition, these regulations are enacted to avoid undesirable things that can cause state losses due to poor stages of obtaining goods/services providers, resulting in less than optimal utilization of the goods/services needed (Hamkah & Purwanto, 2018).

Basically, procurement regulations in Indonesia are not very strong and do not yet represent legal certainty because there are still frequent updates or changes to the procurement regulations for goods/services almost every year. The existence of a law on procurement of goods/services that is more reliable than a Presidential Regulation is expected to provide more legal certainty and can improve the procurement process and, in turn, support the achievement of good governance (Pane, 2017).

Figure 1 below outlines the procurement process according to Presidential Regulation Number 16 of 2018.

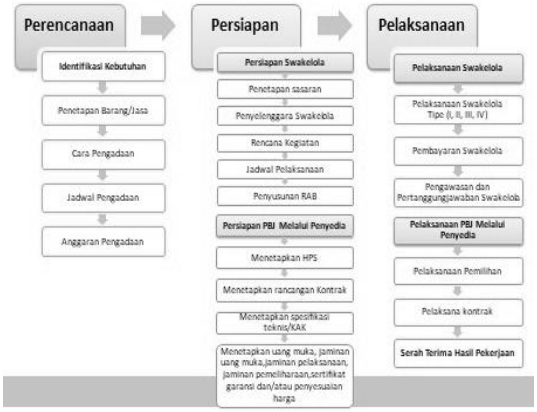

Figure 1. Outline of the Government Goods/Services Procurement Process
(Source: Peraturan Presiden No. 16 Tahun 2018)

In Indonesia, the procurement process of goods/services has been regulated in a guideline called *Standar Dokumen Pengadaan/SDP* (Procurement Document Standard). The document contains information on all activities required in the procurement process. The document was published by the Government Goods/Services Procurement Policy Agency (LKPP), which has the task and authority to develop policies regarding the government goods/services procurement process.

The implementation of this SDP is further supported and refined by the latest procurement regulations. Collectively, these regulations are expected to function as terms of reference (guidelines) for the working group or selection/tender committee when carrying out procurement process. It is in line with the research results of Kohler and Dimancesco (2020) and Relucio and Cruz (2020), which state that document standards are highly required to guarantee professional procurement process of goods/services, from initiation, planning, and implementation to handover of work.

The stages of government auctions for procurement of goods/services based on Presidential Regulation Number 16 of 2018 and LKPP Regulation Number 1 of 2015 can be described as follows.

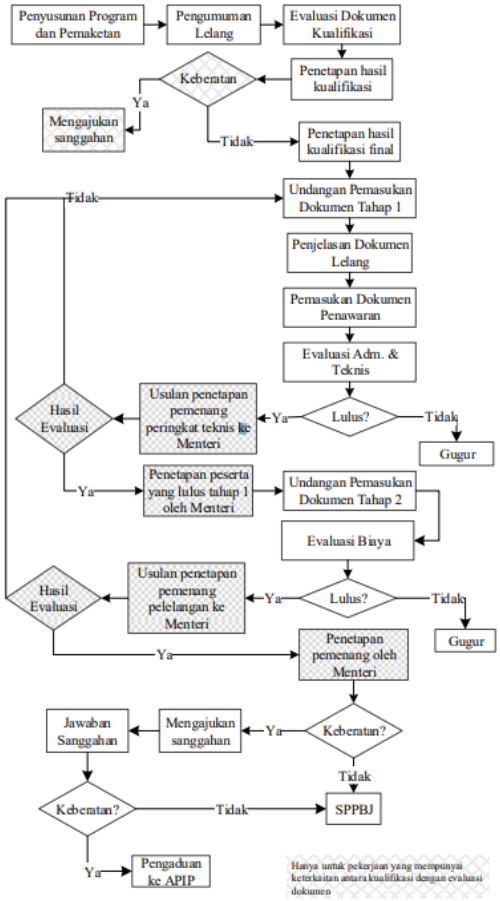

Figure 2. Stages of Government Auction (Source: Peraturan Presiden No. 16 Tahun 2018 dan Perka LKPP No.1 Tahun 2015)

Procurement of Goods/Services Funded by Foreign Loans

Foreign Loans and Grants (Pinjaman dan/atau Hibah Luar Negeri—PHLN), as defined in the Joint Decree (Surat Keputusan Bersama/SKB) No. 185/KMK.03/1995 and No. KEP.031/KET/5/1995 between the Minister of Finance and Bappenas, are state revenues received in the form of foreign exchange or goods and services that originate from external borrowing and must be repaid under specific terms. These loans are obtained from foreign countries (bilateral), multilateral institutions, and financial or non-financial institutions operating outside the jurisdiction of the Republic of Indonesia (Fithriyah, 2017).

Given the need to support national development, particularly in the post-COVID-19 recovery period, foreign loans continue to serve as an essential complement to the government budget. As noted by Suryani (2016) and Weerasekara et al. (2023), while foreign loans can have a positive impact, their effect on the budget deficit is generally insignificant. Nevertheless, the continued and cumulative use of foreign loans needs careful consideration to avoid adverse long-term fiscal implications.

The main distinction between procurement financed through government budgets (APBN/APBD) and that financed by foreign loans lies in the procedures. Procurement using APBN/APBD must adhere to national regulations, including Presidential Regulations and technical guidance issued by the LKPP. In contrast, procurement financed by foreign loans must comply with the procurement guidelines established by the respective lenders. These different regulatory frameworks lead to some notable procedural differences and sometimes contribute to project delays.

Studies by Setiawan et al. (2024) and Widjanarko (2021), for example, have identified several regulatory factors contributing to project delays in foreign-funded procurement, including the extended duration of the procurement process. These delays are often triggered by the procedural complexity and overly strict compliance requirements embedded within the lender-specific guidelines.

Procurement of Consulting Services Funded by Foreign Loans

The procurement of consulting services is typically classified into two main categories: construction consulting services and non-construction consulting services. Construction consulting services generally include the planning and supervision aspects of infrastructure projects, while non-construction consulting services often involve the production of scientific studies, legal documents, or other advisory outputs that are not directly related to physical construction activities.

Similar to the procurement of construction works, the procurement of consulting services include pre-qualification assessment mechanisms. The process usually begins with the submission of administrative bidding documents by prospective consultants. Upon successful administrative evaluation, candidates are required to submit technical proposals, which cover a work plan and a financial plan. This two-stage approach is commonly referred to as the two-envelope bidding method.

In foreign loan-funded procurement—such as those financed by the Saudi Fund for Development (SFD)—the procedures closely follow the procurement guidelines set by the respective lenders (SFD Guidelines, 2001), and are generally consistent with those applied by other multilateral and bilateral funding institutions. A distinctive feature of this foreign-funded procurement process is the requirement to obtain a No Objection Letter (NOL) from the lender at each stage of the tender process (Bekli et al., 2010; Leipold et al., 2017). This requirement can introduce additional administrative steps (or, burdens) and potential delays.

Another difference lies in the submission method. While procurement under Indonesia's national system utilizes the Electronic Procurement Service platform, procurement under foreign funding sources still relies on manual submission of documents, as stipulated by lender guidelines. Scholars such as Jumarni (2018) and Nicoletti (2018) emphasize that electronic procurement systems like SPSE are more efficient and transparent than manual processes. However, due to the binding nature of lender procurement frameworks, the application of Indonesia's e-procurement regulations must often be set aside in the context of foreign-funded projects.

All of the stages mentioned above should ideally be incorporated into a comprehensive procurement schedule prepared during the planning phase of consulting services procurement. When properly scheduled and executed based on lender timelines, the duration of tenders funded through foreign loans—such as those from the SFD—need not be protracted, assuming there are no administrative or procedural delays.

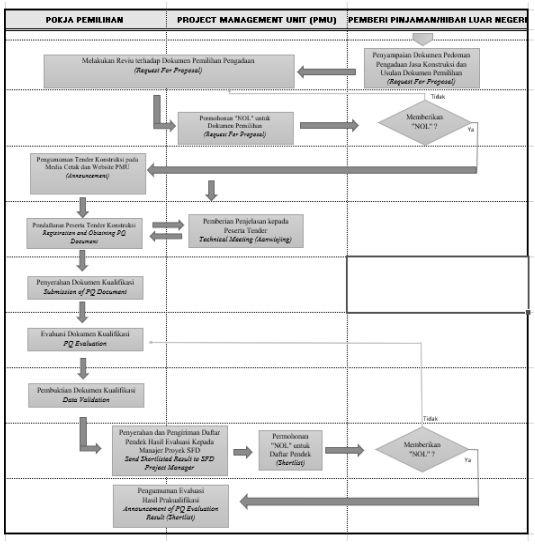

Figure 3. PHLN Tender Process, Pre-Qualification Stage
(Source: SFD Guidelines)

METHODOLOGY

This study applies a qualitative approach through the evaluation of human resource performance during the procurement process of consulting services. The evaluation outcomes serve as the primary basis for the assessment. According to Moha and Sudrajat (2019), a qualitative approach may start with secondary data collection, particularly through a comprehensive literature review. In this research, the data collection process is conducted concurrently with the procurement activities to ensure that the data is both valid and reliable.

The data analysis was performed using NVivo 12 Plus for Windows, a qualitative data analysis software widely used in qualitative and mixed-method research. The software facilitates efficient data management and enables researchers to categorize and code data systematically. It also supports the generation of thematic insights aligned with the study objectives.

The primary data source is field observation, which allows the researcher to directly examine the phenomena occurring throughout the consulting service tender process. Observation, as defined by Hasanah (2017), is a qualitative data collection method based on empirical evidence and theoretical grounding. The observation period spans from the initial planning of the tender process to the final announcement of the winning bidder. The researcher also collects primary data through semi-structured interviews with key stakeholders involved in the procurement process. They are representatives from the project owner, in this case, the leadership of the unit responsible for managing project implementation at XYZ University.

Additionally, secondary data is collected through a review of relevant literature and Indonesian government procurement regulations. The data is analyzed to identify regulatory frameworks and institutional practices that influence the procurement process and to assess their relevance to the research theme.

FINDINGS

The data processing workflow using NVivo 12 Plus software is illustrated in Figure 4 below.

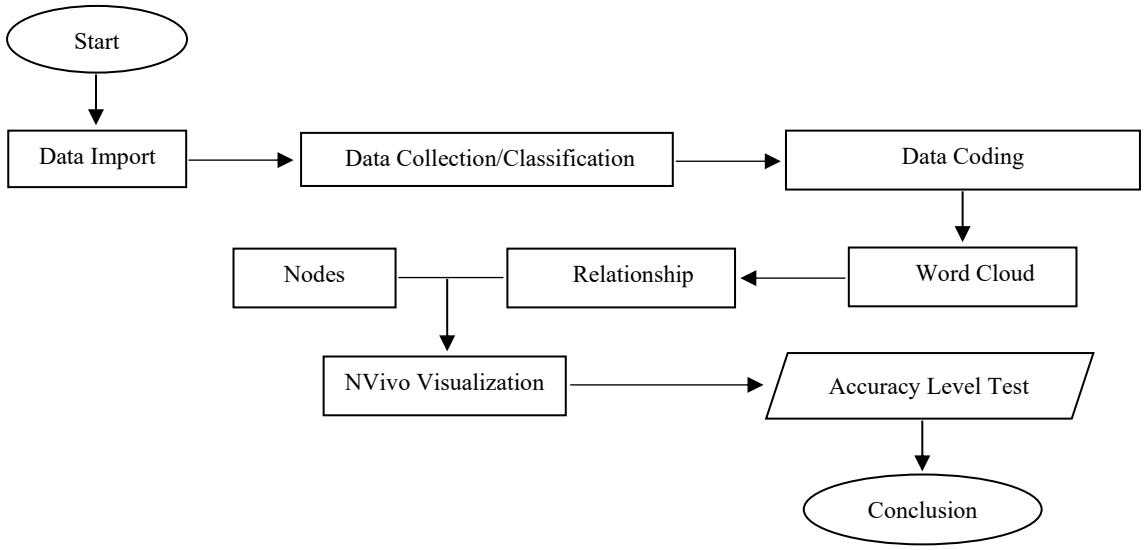

Figure 4. Data Processing Workflow Using Nvivo 12 Plus for Qualitative Analysis

Data Import

The data import process includes both primary and selected secondary data that have been documented in either .doc or .pdf file formats. Primary data consists of interview transcripts in .doc format, obtained from interviews with three different stakeholders directly involved in the tender process. Secondary data comprises relevant regulations and literature from prior studies, primarily in .pdf format, with some converted to .doc to facilitate processing.

Figure 5 below is a display of the data processing results when importing data.

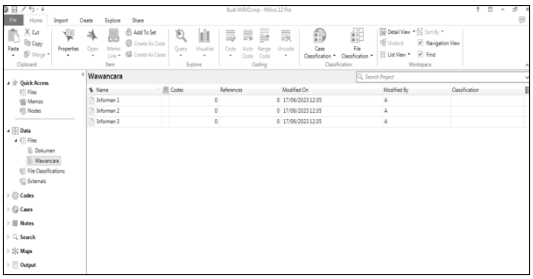

Figure 4. Data Import Display from Interviews in NVivo 12

Classification and Data Coding

Data classification is organized into two categories: interview data and documentation data (field observation records and literature review). The next step is coding, a process of assigning labels to relevant segments of the research data. Coding in NVivo 12 Plus can be performed using techniques provided by the software, such as highlighting important texts, thematic nodes-based classification, etc.

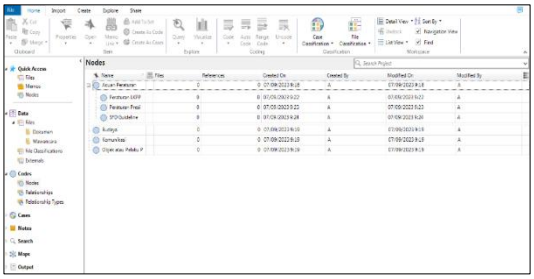

Figure 5. Display of Data Coding in NVivo 12

Based on the data processing results in NVivo 12 Plus, the most frequently occurring word is “procurement”, appearing 895 times, which accounts for 2.07% of the total word frequency count. This finding confirms “procurement” as a thematic focus in the analysis. The prominence of this term suggests its significance in understanding the challenges surrounding the procurement of consulting services, particularly within the context of foreign-funded tenders.

The high frequency of this keyword becomes a foundational entry point for identifying and exploring key variables and indicators that are potentially contributing to delays or inefficiencies in the tender process. To further support the analysis, the frequency query results are visualized in the word cloud, which highlights the dominant terminology and facilitates the recognition of recurring themes relevant to the research problem.

Figure 6. Word Cloud Processed by NVivo 12

Nodes and Relationship

The results of qualitative coding are systematically organized into *nodes* within the NVivo 12 Plus software. These nodes represent thematic categories derived from the research data, which are further broken down into subcategories or sub-variables to facilitate in-depth analysis and reveal interrelationships. This approach allows the identification of patterns and connections across the dataset.

In this study, the most prominent category emerging from the coding process is the regulations governing the consultancy tender process. This main category is further divided into two subcategories: (1) Government Regulations, which cover policies and procedures issued by national procurement frameworks; and (2) SFD Guidelines, which refer to the procurement directives set by foreign lending institutions. All of these processes—node creation, classification, and relationship mapping—are conducted within the NVivo 12 Plus environment.

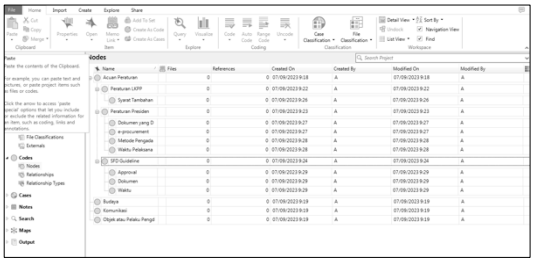

Figure 6. Display of Nodes and Relationships between Categories in NVivo 12

Visualization

The data processing stage in NVivo 12 Plus resulted in the classification of regulatory influences into three subcategories: SFD Guidelines, Presidential Regulations, and LKPP Regulations. Given that the consultancy tender process examined in this study is conducted in Indonesia, the Presidential Regulation serves as the primary legal framework governing procurement activities. Complementing this are the LKPP Regulations, which offer technical and procedural guidelines specific to the procurement of consultancy services.

Furthermore, the SFD Guidelines function as a comparative framework. These guidelines are critical in assessing the extent to which international lending rules align or diverge from Indonesia's national regulatory provisions.

The following figure is the visualization results from the NVivo 12 application.

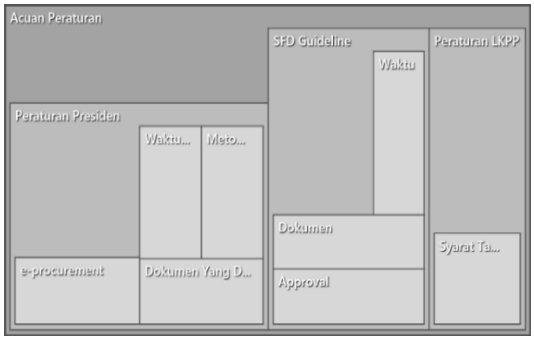

Figure 7. Hierarchy Chart Visualization Using NVivo 12 Application

DISCUSSION

Data processing results show that the most fundamental thing for procuring these consulting services is the regulatory aspect. From the implementation aspect, the manual method required in the lender's guidelines significantly impacts the time difference compared to the tender implementation method with the system stipulated by the Presidential Regulation and LKPP Regulation. It is in line with the study of Guruminda (2019) that the average time required for a pre-qualification tender according to regulations in Indonesia is 61 (sixty-one) days and uses an electronic system. However, the observations indicate that the implementation of this consulting service tender takes more than four months and is also carried out manually.

A fundamental factor contributing to tender delays for foreign-financed projects is the requirement to obtain a No Objection Letter (NOL) at each stage. Typically, a consultancy tender process may involve four to five procedural stages, each necessitating prior approval through NOL. This sequential mechanism introduces a challenge, as the time required to await formal responses from the lender can cause the process to become temporarily stagnant at multiple points.

Faisal et al. (2017) emphasize the importance of synchronizing local and international procurement guidelines to reduce ambiguity and avoid procedural delays. To mitigate the issues, several scholars—Abduh et al. (2022), Firmansyah et al. (2024), Ratnawati et al. (2020), and Relucio and Cruz (2020)—recommend a combination of strategies such as digitalizing procurement stages, providing targeted training on both domestic and lender-specific regulations for procurement officials, and enhancing institutional capacity, particularly in terms of communication skills with international lenders.

Leipold et al. (2017) and Sarlina (2016) further note that international lenders such as the World Bank and the Islamic Development Bank frequently impose rigid procedural standards that often conflict with local practices and lead to inefficiencies and delays. These observations are supported by the findings of this study, which identify manual processes—including paper-based document submission and the requirement for No Objection Letters (NOL) at multiple stages—as significant contributors to procurement delays in Indonesia.

Pane (2017) critiques Indonesia's reliance on Presidential Regulations rather than statutory law for procurement governance. This results in regulatory inconsistency and frequent amendments that hinder legal certainty and enforcement. Thus, there is need for a more stable and unified legal framework, especially to enhance the efficiency of foreign-funded procurement initiatives.

Moreover, Endah and Farista (2018) as well as Kohler and Dimancesco (2020) advocate for the adoption of e-procurement systems, which can streamline procedures, reduce administrative delays, and minimize corruption risks. Nevertheless, as previously discussed, the implementation of such systems is often constrained by lender requirements that mandate manual procedures and cause tensions between local and international requirements. Guruminda (2019) highlights that although Indonesian law increasingly favors electronic tendering through the SPSE platform, foreign loan-based projects frequently circumvent its use due to restrictive lender's guidelines.

CONCLUSION

The procurement tender process for consulting services studied in this article operates under two regulatory frameworks: the guidelines issued by the foreign lender and the Government regulations. When these two sets of rules intersect, several inconsistencies arise that hinder the effectiveness and timeliness of the tender process. Two issues emerge here:

1. On one hand, national procurement regulations mandate the use of electronic procurement systems, particularly the SPSE *(Sistem Pengadaan Secara Elektronik)*. On the other hand, lender guidelines often require the application of manual or face-to-face procedures. This duality leads to procedural inefficiencies, as each tender stage necessitates in-person meetings between the project owner and prospective service providers, which result in a prolonged timeline.

2. In accordance with lender guidelines, each stage of the procurement process must secure a No Objection Letter (NOL) before proceeding. The timeline for completing the tender thus becomes heavily dependent on the lender's responsiveness. The issuance of NOLs can facilitate a more timely process; conversely, delayed responses contribute to the extended duration of the overall tender process.

The procurement of consulting services funded by foreign loans can be optimized through careful preparation. The planning is crucial, particularly for the procurement schedules and the potential challenges of differences between national regulations and lender-specific guidelines. Moreover, procurement stakeholders must possess a comprehensive understanding of both regulatory frameworks. Harmonizing these regulations is vital to fostering a transparent, efficient, and equitable procurement system.

Based on the results of this study, the following recommendations are proposed:

1. Policy Coordination: Establish a dedicated task force or governing body to coordinate efforts between national regulatory institutions (e.g., LKPP) and foreign lenders. This body should work toward integrating key elements of lender guidelines into Indonesia's procurement legal framework to reduce regulatory conflicts and procedural delays.

2. Standardized Documentation: Develop unified documentation templates that comply with both domestic and foreign regulations, including the provision for No Objection Letters (NOL). This approach can help streamline the approval process and minimize redundancy.

3. Digitalization of Procurement Processes: Advocate for the broader application of electronic procurement systems (such as SPSE) even in foreign-funded projects. Where manual submission is mandated by lenders, negotiate for the acceptance of secure digital alternatives to improve efficiency and transparency.

4. Automated NOL System: Collaborate with financing agencies to implement an automated NOL tracking and approval system. This system should facilitate faster responses, reduce administrative downtime, and increase accountability.

5. Specialized Training: Provide training programs for procurement officers and stakeholders that focus on both national and international (lender) guidelines. The programs should emphasize dual compliance and strategies to handle procedural discrepancies effectively.

6. Guidelines Mapping Document: Develop a comparative mapping guide that outlines the intersections and divergences between Indonesia's procurement regulations and those of major international lenders. This resource may ensure procedural alignment at each stage of the tender process.

7. Review and Reform of the NOL Process: Work with international lenders to review the necessity and frequency of NOLs. One potential reform is the adoption of a consolidated NOL that covers multiple stages of the procurement process.

8. Conditional NOLs: Promote the implementation of conditional NOLs, in which lenders issue pre-approvals based on the fulfillment of predefined criteria. This can help maintain procedural integrity while accelerating project timelines.

9. National Procurement Manual for Foreign Loan Projects: Draft a comprehensive national guideline manual specifically for managing procurement processes with foreign loans. This manual should reconcile domestic legal provisions with lender-specific requirements

10. Clear Role Definition: Clearly define the roles and responsibilities of each stakeholder involved in foreign loan-funded procurement projects. Clear duties can foster accountability, reduce role ambiguity, and enhance coordination.

11. Stakeholder Engagement: Institutionalize regular consultative forums between Indonesian procurement authorities (e.g., LKPP) and international lenders. These platforms will facilitate dialogue on policy updates, regulatory interpretations, and operational challenges.

12. Feedback Loops: Develop feedback mechanisms that allow stakeholders of foreign loan-financed projects to share insights and recommendations. This continuous feedback process can help regulatory improvements and ensure that policy revisions are responsive to the existing realities and expectations.

By focusing on these strategic areas, stakeholders can reduce procedural inefficiencies in foreign-funded procurement projects. The recommendations will improve coordination, enhance process predictability, and foster a more transparent and efficient procurement system.

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Tata Kelola Pembangunan Berkelanjutan dalam Upaya Menghadapi Konflik Agraria di Kawasan Transmigrasi Provinsi Lampung

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ABSTRACT

Indonesia's transmigration program, despite its scale and strategic intent, has generated persistent structural issues, including agrarian disputes and social tensions. This study investigates the ineffectiveness of sustainable development governance in transmigration areas and proposes evidence-based policy solutions, with a focus on Lampung Province. Employing a mixed-methods approach, the research integrates in-depth interviews, focus group discussions, field observations, and literature review. The study was conducted in four transmigration sites: Rawa Pitu, Mesuji, Way Tuba, and Ngambur. Data were collected from 35 key informants and secondary sources, and analyzed thematically and spatially using ArcMap 10.8.2 software, alongside a descriptive-narrative method. The findings reveal that, by 2023, a total of 6,397 land plots across 24 locations remained uncertified due to overlapping claims. Besides, approximately 40% of issued land certificates did not match the actual physical boundaries. As of 2024, 65% of land disputes have not been resolved, primarily due to institutional fragmentation and overlapping mandates between the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency (ATR/BPN) and the Ministry of Environment and Forestry (KLHK). Social conflicts, such as those observed in Papan Rejo Village, reflect the limitations of top-down policy approaches and the neglect of local communities' historical land rights. The study recommends structural reforms in integrating land governance systems, accelerating spatially-based land certification, and adopting inclusive and participatory conflict resolution mechanisms.

Keywords: Agrarian Conflict; Land Certification; Transmigration Policy

ABSTRAK

Program transmigrasi di Indonesia telah berlangsung secara masif namun masih menyisakan persoalan struktural seperti konflik agraria dan ketegangan sosial. Penelitian ini bertujuan mengkaji ketidakefektifan tata kelola pembangunan berkelanjutan di kawasan transmigrasi Provinsi Lampung serta merumuskan solusi kebijakan. Penelitian menggunakan metode campuran *(mixed method)*, di mana data dikumpulkan melalui wawancara mendalam, FGD, observasi, kajian pustaka. Lokasi penelitian mencakup empat kawasan transmigrasi: Rawa Pitu, Mesuji, Way Tuba, dan Ngambur. Data dikumpulkan dari 35 narasumber kunci dan sumber sekunder, serta dianalisis secara tematik dan spasial melalui pendekatan deskriptif-naratif dengan bantuan perangkat lunak ArcMap 10.8.2. Hasil penelitian menunjukkan bahwa hingga 2023, sebanyak 6.397 bidang tanah di 24 lokasi belum bersertipikat akibat tumpang tindih klaim. Sekitar 40% sertipikat yang terbit tidak sesuai batas fisik. Hingga 2024, 65% konflik lahan belum terselesaikan karena fragmentasi kelembagaan, seperti tumpang tindih wewenang antara ATR/BPN dan KLHK. Konflik sosial, seperti yang terjadi di Desa Papan Rejo, mencerminkan kegagalan pendekatan *top-down* dan pengabaian hak historis masyarakat lokal. Peneliti merekomendasikan reformasi struktural berupa integrasi tata kelola lahan, percepatan sertipikasi berbasis spasial, serta penyelesaian konflik yang inklusif dan partisipatif.

Kata Kunci: Kebijakan Transmigrasi; Konflik Agraria; Sertipikasi Tanah

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PENDAHULUAN

Transmigrasi merupakan salah satu strategi utama pembangunan di Indonesia. Menurut para pendiri negara, transmigrasi mendistribusikan penduduk untuk menyeimbangkan kemajuan dan kesejahteraan antarwilayah (Kebschull, 2020). Inisiatif ini melibatkan 2,2 juta keluarga, atau 9,1 juta orang, di 3.606 unit pemukiman di 619 zona transmigrasi pada tahun 2024. Wilayah-wilayah tersebut saat ini memiliki 1.567 desa, 466 ibu kota kecamatan, 116 ibu kota kabupaten, dan 3 ibu kota provinsi (Suryanagara, 2024). Transmigrasi telah berubah dari alat kontrol politik dan ekonomi menjadi alat pembangunan nasional sejak kolonialisme (Armawi, 2020; Breman, 2014; Levang, 2003).

Kendati demikian, selain keberhasilan dalam hal jumlah dan pemekaran wilayah, program transmigrasi juga meninggalkan berbagai permasalahan. Konflik agraria yang berkepanjangan, tumpang tindih klaim lahan dan kawasan hutan, serta ketidakharmonisan antara transmigran dan masyarakat setempat muncul di beberapa daerah yang menjadi episentrum transmigrasi, seperti Provinsi Lampung (Balitbangda, 2018; Budianto et al., 2022; Kusworo, 2014; Sinaga et al., 2022; Wijaya & Ardianta, 2020; Wulandari & Kurniasih, 2019). Fenomena tersebut mengindikasikan bahwa tata kelola pembangunan yang berkelanjutan dan inklusif masih belum sepenuhnya berhasil (Alfit & Koeswahyono, 2022; Amrin et al., 2021; Asri, 2022; Sukmawati, 2016).

Penelitian ini dilandasi oleh adanya tata kelola pembangunan berkelanjutan yang masih belum memadai dalam konteks konflik agraria di wilayah transmigrasi (Budianto et al., 2022; Pratiwi et al., 2022; Salim, Utami, et al., 2021; Sinaga et al., 2022). Hal ini tidak hanya menunjukkan tidak adanya pendekatan kebijakan yang komprehensif berdasarkan keadilan sosial tetapi juga menunjukkan buruknya koordinasi antarlembaga pemerintah (Mutolib & Nuraini, 2022). Provinsi Lampung, wilayah transmigrasi tertua di Indonesia, menawarkan konteks empiris yang kuat untuk menilai kembali kerangka kebijakan, khususnya yang berkaitan dengan integrasi dimensi hukum, sosial, dan spasial.

Secara historis, transmigrasi telah menjadi subjek analisis historis, konsekuensi sosial-ekonomi, dan analisis lingkungan (Hardjono, 1988; Junaidi et al., 2012; McCarthy, 2010). Di sisi lain, mayoritas penelitian belum sepenuhnya merangkul pendekatan yang mengintegrasikan analisis spasial, hukum, dan kebijakan multivariat untuk mengatasi isu-isu kontemporer. Otten (1986) dan Breman (1997), misalnya, menekankan motivasi kolonial dari program transmigrasi, sedangkan Stanley (1994) dan Li (2021) mengkritik kekerasan struktural tanpa adanya

solusi kebijakan yang komprehensif. Meskipun relevan, penelitian Borras (2007) tentang hak atas tanah dan kewarganegaraan belum diverifikasi secara empiris dalam konteks transmigrasi di Indonesia.

Penelitian ini bertujuan untuk menganalisis akar permasalahan transmigrasi di kawasan transmigrasi Provinsi Lampung dengan fokus pada tiga aspek utama: (1) mengidentifikasi persoalan dominan terkait lahan, administrasi, dan konflik sosial; (2) mengeksplorasi faktor penyebab dari perspektif spasial dan kebijakan publik; serta (3) merumuskan solusi berbasis *evidence-based policy* yang melibatkan empat aktor kunci: Kementerian ATR/BPN, Kementerian Transmigrasi, Kementerian Kehutanan, dan pemerintah daerah.

KERANGKA TEORI

Transmigrasi, sebagai kebijakan rekayasa demografis dan pembangunan wilayah, telah menjadi objek kajian multidisipliner yang melibatkan perspektif sejarah, sosiologi, hukum, dan kebijakan publik (Wong, 1996). Berdasarkan literatur, setidaknya terdapat tiga kerangka utama yang mendasari analisis transmigrasi, yaitu:

Transmigrasi sebagai Alat Kolonial dan Pasca kolonial

Konsep transmigrasi berakar pada kebijakan kolonial Belanda (1905) yang hendak melakukan ekspansi ekonomi melalui penguasaan lahan dan tenaga kerja di luar Jawa (Breman, 2014; Levang, 2003). Motif ini dilanjutkan oleh Orde Baru dengan dalih "pembangunan nasional" tetapi tetap mempertahankan paradigma eksploitatif, seperti pengalihan lahan untuk perkebunan sawit dan Hutan Tanaman Industri (HTI) (Dhiaulhaq & McCarthy, 2020; Li, 2011). Teori *internal colonialism* (Hechter, 2017) menjadi relevan karena Jawa, sebagai episentrum kekuasaan, dihuni oleh penduduk yang menjadi target transmigrasi ke wilayah "pinggiran" (Sumatera, Kalimantan, Sulawesi). Hal ini bertujuan untuk mengontrol sumber daya alam dan sumber daya manusia di luar wilayah Jawa dan mengurangi ketimpangan pembangunan. Meskipun studi yang dilakukan Hardjono (1988) dan Otten (1986) telah membahas topik ini, mereka cenderung fokus pada motif historis tanpa mengaitkannya dengan konflik agraria kontemporer.

Lalu, apakah transmigrasi pascakolonial memang bertujuan mendorong pemerataan, atau sekadar melanggengkan praktik eksploitasi sumber daya alam dan manusia dengan wajah baru? Temuan Breman (2014) tentang perluasan perkebunan sawit di masa Orde Baru mendukung argumen ini.

Ketimpangan Agraria dan Hak atas Tanah

Kajian Borras (2007) menekankan bahwa akses terhadap sumber daya agraria-tanah merupakan hak dasar yang melekat pada kewarganegaraan. Namun, dalam konteks transmigrasi, hak mendasar ini sering terabaikan akibat tumpang tindih klaim lahan antara transmigran, masyarakat lokal, dan negara (Salim, Wulan, et al., 2021). Teori ini diperkuat oleh analisis *structural violence* oleh Li (2021) dan Stanley (1994) yang menyoroti kebijakan transmigrasi Orde Baru sebagai bentuk pemaksaan yang mengorbankan hak-hak petani Jawa dan komunitas lokal. Selain itu, Alfit dan Koeswahyono (2022), Wirawan dan Amrifo (2020), serta Junaidi et al. (2012) juga telah mengidentifikasi dampak transmigrasi pada deforestasi hutan dan kemiskinan namun kajian-kajian tersebut belum menyentuh aspek hukum-administratif terkait hak atas tanah, seperti ketidaksesuaian sertipikat atau status bidang tanah/lahan pada kawasan transmigrasi terhadap kawasan hutan.

Kajian ini menguji teori Borras (2007) dalam konteks spesifik di kawasan transmigrasi Provinsi Lampung, di mana klaim negara atas kawasan hutan sering berbenturan dengan kebutuhan hidup para transmigran.

Kegagalan Koordinasi Kebijakan Multisektoral

Kebijakan transmigrasi yang telah berlangsung setidaknya melibatkan empat pemangku kepentingan utama, yaitu Kementerian ATR/BPN, Kementerian Transmigrasi, Kementerian Kehutanan, dan Kementerian Dalam Negeri. Teori *fragmented authoritarianism* oleh Wu et al. (2015) menjelaskan bahwa ego sektoral dan kurangnya sinkronisasi regulasi yang menjadi dasar pelaksanaan program antar kementerian (misalnya UU Ketransmigrasian *vs.* UU Kehutanan) menciptakan celah kebijakan yang memicu masalah hingga konflik agraria pada kawasan transmigrasi.

Studi de Wee (2022) tentang *stakeholder responsiveness* menyebutkan bahwa ketidakmampuan negara dalam merespons masalah transmigrasi secara holistik (misalnya masalah lahan restan-lahan cadangan, praktik jual beli lahan di bawah tangan, peningkatan status desa tertinggal, dan pembangunan infrastruktur) mencerminkan kegagalan institusi dalam menjalankan mandat perlindungan hak para transmigran.

Kajian ini menggunakan tiga kerangka teoritis di atas. Pertama, teori *structural violence* untuk mengungkap ketidakadilan agraria dan kegagalan adaptasi sosial (Wilson, 2008). Kedua, teori *fragmented authoritarianism* untuk menjelaskan tumpang tindih regulasi antarkementerian di Indonesia (Barter & Côté, 2015). Ketiga, teori *integrated land governance* perspektif Borras (2007) dan de Wee (2022) untuk merumuskan rekomendasi kebijakan.

Penelitian ini diharapkan dapat memberikan peta jalan *(roadmap)* yang konkret bagi penyelesaian masalah transmigrasi di kawasan transmigrasi Provinsi Lampung pada khususnya dan Indonesia pada umumnya.

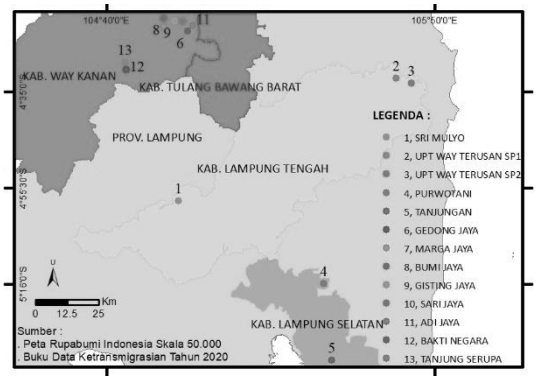
METODE PENELITIAN

Desain Penelitian

Penelitian ini menggunakan metode campuran *(mixed-methods)* yang mengintegrasikan pendekatan kualitatif dan kuantitatif (Creswell, 2016) untuk memberikan pemahaman yang komprehensif mengenai persoalan agraria di kawasan transmigrasi Provinsi Lampung, terutama terkait Surat Keputusan Menteri Transmigrasi No. 220/2007, No. 293/2009, No. 9/2016, dan No. 132/2019. Penggunaan nomenklatur terkini mengacu pada perubahan kelembagaan kementerian yang semula bernama Kementerian Tenaga Kerja dan Transmigrasi (2009) dan menjadi Kementerian Desa, Pembangunan Daerah Tertinggal, dan Transmigrasi (2014).

Terdapat empat kawasan transmigrasi yang diteliti, yaitu: (1) Kawasan Rawa Pitu (9 desa, luas 12.993,30 ha) dengan usaha utama sawit dan karet; (2) Kawasan Mesuji (25 desa, luas 58.845,03 ha) dengan usaha utama sawit, karet, padi, dan jagung; (3) Kawasan Way Tuba (37 desa, luas 48.821,02 ha) dengan sektor pertanian, peternakan, dan perkebunan seperti padi sawah, jagung, sapi, kerbau, karet, kopi, cengkeh, kakao, dan sawit; serta (4) Kawasan Ngambur (22 desa, luas 25.000 ha) dengan dominasi usaha kelapa dan sawit.

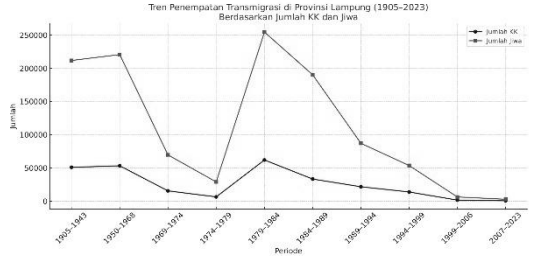
Berdasarkan survei pendahuluan, terdapat permasalahan-konflik agraria di 13 desa pada empat kawasan tersebut, meliputi permasalahan lahan transmigrasi, adaptasi sosial, dan dinamika kebijakan transmigrasi (lihat Gambar 1).



Gambar 1. Lokasi Transmigrasi "Bermasalah" di Provinsi Lampung
(Sumber: Analisis Data Sekunder Peneliti, 2025)

Penelitian ini diawali dengan pendekatan kualitatif untuk menggali pemahaman para 35 orang responden kunci melalui wawancara berdurasi sekitar 1,5 jam per narasumber. Kegiatan dilanjutkan dengan *Focus Group Discussion* (FGD) bersama akademisi dan mahasiswa Fakultas Hukum Universitas Lampung, serta telaah literatur berupa laporan kinerja, tesis, disertasi, dan artikel ilmiah terkait tema penelitian transmigrasi.

Tahap selanjutnya, peneliti menggunakan pendekatan kuantitatif untuk mengukur tren data statistik transmigran dan data geospasial terkait lahan transmigrasi, seperti jumlah penempatan transmigran, jumlah bidang tanah, dan sebaran lokasi bermasalah (lihat Gambar 2).



Gambar 2. Tren Penempatan Transmigran sejak 1905-2023 di Provinsi Lampung
(Sumber: Analisis Data Sekunder Peneliti, 2025)

Kegiatan lapangan dilakukan di beberapa kabupaten, khususnya Tulang Bawang sebagai sampel, yang telah dimekarkan menjadi tiga wilayah: Tulang Bawang Barat, Tulang Bawang, dan Mesuji. Lokasi ini dipilih karena merupakan lokasi awal transmigrasi di Indonesia yang menyimpan kompleksitas permasalahan seperti tumpang tindih sertipikat tanah, jual beli di bawah tangan, kesejahteraan sosial dan keragaman etnis (Lampung asli-penduduk lokal dan pendatang-Jawa). Penelitian berlangsung selama hampir enam bulan, dari 26 Mei hingga 20 November 2023, mencakup studi pustaka, pengumpulan dan analisis data, serta penyusunan laporan.

Data dan Sumber Data

Data primer penelitian ini diperoleh melalui observasi, wawancara, dan FGD pada 19–26 Juni 2023. Wawancara dilakukan dengan 10 pejabat aktif dan mantan pejabat transmigrasi dari dinas provinsi dan kabupaten, 3 tokoh pemuka desa transmigrasi, dan 5 transmigran untuk memberikan informasi tata kelola transmigrasi secara valid dan terpercaya. FGD dilakukan dengan 10 akademisi dan mahasiswa, serta pemangku kepentingan dari BPN, Dinas Transmigrasi. Alat bantu seperti citra satelit resolusi tinggi dari *google maps* dan GPS *handheld* digunakan untuk pemetaan dan verifikasi posisi. Pendekatan *oral history* juga digunakan untuk merekonstruksi sejarah transmigrasi.

Data sekunder penelitian ini berasal dari peraturan perundang-undangan, artikel ilmiah, dan laporan statistik, yang dikumpulkan dari Kanwil BPN Provinsi Lampung, kantor pertanahan kabupaten, Dinas Transmigrasi, kantor desa, LSM, serta Arsip Nasional.

Adapun tahap-tahap pengumpulan data meliputi identifikasi informan dan lokasi, pengumpulan dokumen, wawancara mendalan, FGD, serta pemetaan berbasis citra satelit dan teknologi SIG (Sistem Informasi Geografis).

Pada tahap analisis data, data kuantitatif yang telah terkumpul dianalisis menggunakan pendekatan tematik-analisis spasial. Teknisnya, data geospasial diproses menggunakan ArcMap Versi 10.8.2 melalui *tools* seperti *overlay*, *buffer*, *intersect*, serta simbolisasi untuk visualisasi peta. Data kualitatif dianalisis mengikuti pendekatan deskriptif sebagaimana dikemukakan oleh Ridder et al. (2014), dengan langkah-langkah koreksi narasi, pengelompokan berdasarkan isu (misalnya konflik lahan, disharmoni sosial), dan penyusunan narasi kronologis untuk merekonstruksi tata kelola transmigrasi. Gabungan analisis kualitatif dan kuantitatif ini menghasilkan rekomendasi kebijakan transmigrasi berbasis bukti empiris.

Penelitian ini memiliki tantangan tersendiri, seperti keterbatasan waktu, dana, akses pada data privat (HPL, HGU, kawasan hutan), dan resistensi dari beberapa informan. Untuk mengatasinnya, peneliti melakukan penyamaran data yang bersifat sensitif, triangulasi data, pendekatan partisipatif, dan jaminan anonimitas untuk menjaga validitas dan reliabilitas (Sugiyono, 2016).

HASIL

Program transmigrasi di Indonesia, khususnya di Provinsi Lampung, merupakan kebijakan yang berakar sejak era kolonial Belanda (1905) dan Jepang, kemudian dilanjutkan pascakemerdekaan. Pada masa Orde Baru, program ini menjadi instrumen strategis dalam Repelita I-VI (1969-1998) sebagai alternatif dari kegagalan *landreform* di era Orde Lama. Tujuannya adalah pemerataan penduduk, pengembangan ekonomi, dan kedaulatan pangan melalui relokasi penduduk dari Jawa ke luar Jawa. Namun, implementasinya menghadapi beberapa tantangan struktural seperti koordinasi antarlembaga yang lemah, ketiadaan payung hukum sebelum UU No. 3/1972 tentang Undang-Undang Pokok Transmigrasi, partisipasi masyarakat lokal yang minim, serta persiapan infrastruktur dan SDM yang tidak memadai.

Terdapat empat tipe utama transmigrasi, yaitu: *Spontaneous Transmigration Model*, *Settlement Transmigration Model*, *Intensive Transmigration Model*, dan *Planned Resettlement Model* (Kebschull, 2020). Di Provinsi Lampung, model-model ini telah diterapkan sejak 1905 hingga saat ini, yaitu:

a. *Spontaneous Transmigration Model*, termasuk transmigrasi spontan dan swakarsa yang dicirikan oleh inisiatif mandiri dari masyarakat untuk pindah ke daerah baru, dengan dukungan minimal dari pemerintah. Transmigrasi spontan di Provinsi Lampung berlangsung pada 1905-1978 dan transmigrasi swakarsa pada 1979-2009;

b. *Settlemant Transmigration Model,* termasuk transmigrasi umum yang melibatkan relokasi komunitas secara terorganisir dengan dukungan penuh pemerintah, seperti penyediaan lahan, rumah, dan infrastruktur dasar. Jenis transmigrasi umum di Provinsi Lampung berlangsung pada 1905-1978;

c. *Intensive Transmigration Model*, termasuk transmigrasi keluarga yang dilakukan dalam skala besar dengan tujuan strategis seperti pembukaan lahan pertanian atau pengembangan industri. Jenis transmigrasi famili di Provinsi Lampung berlangsung 1905-1978;

d. *Planned Resettlement Model*, termasuk transmigrasi lokal yang terjadi akibat relokasi masyarakat terdampak proyek pembangunan, seperti bendungan atau pertambangan. Jenis transmigrasi lokal di Provinsi Lampung berlangsung pada 1979-2006.

Model-model transmigrasi ini menunjukkan bahwa kebijakan relokasi penduduk di kawasan transmigrasi Provinsi Lampung tidak bersifat tunggal, namun kontekstual dan multidimensi. Pemahaman masing-masing model sangat penting untuk merancang kebijakan transmigrasi yang berkelanjutan.

Menilik fakta jenis transmigrasi tersebut terdapat tumpang tindih kewenangan antarinstansi (seperti Dirjen Agraria, Kementerian Transmigrasi, dan pemerintah daerah) yang menyebabkan inefisiensi. Misalnya, Dirjen Agraria bertanggung jawab atas penyediaan lahan tanpa mandat khusus transmigrasi, sehingga proses sertipikasi kerap tertunda. Data 2024 menunjukkan 24 dari 88 lokasi transmigrasi di Lampung masih bermasalah, dengan 6.397 bidang tanah belum bersertipikat (Tabel 1).

Tabel 1. Beban Sertipikat Hak Atas Tanah Transmigrasi di Provinsi Lampung

Kabupaten	2020		2024	
	∑lokasi	Bidang	∑lokasi	Bidang
Tulang Bawang	44	4.368	5	175
Mesuji	22	2.545	6	431
Tubaba	0	0	0	0
Lampung Selatan	3	200	1	200
Lampung Tengah	19	8.644	12	5.591
Total	88	15.757	24	6.397

Sumber: Kantor Wilayah BPN Provinsi Lampung (2024)

Mengurai Simpul-simpul Konflik Transmigrasi

Transmigrasi di Provinsi Lampung meninggalkan warisan konflik agraria yang kompleks. Berdasarkan 12 masalah utama (Tabel 2) di 13 desa, tiga isu utama yang paling menonjol yaitu tumpang tindih kawasan hutan, konflik dengan masyarakat lokal dan korporasi, dan ketidaksesuaian subjek dan objek sertipikat tanah.

Tabel 2. Identifikasi dan Pemetaan Masalah serta Penyelesaian Lahan Transmigrasi

No	Identifikasi Masalah	Alternatif Penyelesaian	Pihak Terkait
1	Lahan transmigrasi di kawasan hutan (Desa Sukapura, Way Terusan, Tanjung Serupa, dll.)	Mengusulkan pelepasan kawasan hutan melalui PP No. 23/2021 dan skema PS (Perhutanan Sosial) Permen LHK 7/2021	BPKH, GTRA, Kementrans, Kemen Kehutanan
2	Sengketa dengan masyarakat (okupasi, klaim tanah)	Penelitian penguasaan lahan; Mediasi; Litigasi	Kementrans, Pemda, BPN
3	*Overlaping* lahan dengan HGU/HTI perusahaan (PT KAP, PT PAL)	Konfirmasi ke BPN; Pelepasan Sebagian HGU (*enclave*)	Dinas Trans, BPN, pemegang HGU
4	Konflik dengan masyarakat lokal (klaim tanah)	Mediasi/ tindakan tegas Bupati; Penyelesaian klaim	Dinas Trans. Lampung, Pemda, masyarakat
5	Pemanfaatan lahan restan transmigrasi oleh masyarakat	Pelepasan tanah restan oleh Pemda untuk masyarakat	Pemda, masyarakat
6	Belum ada HPL lahan transmigrasi	Penerbitan sertipikat langsung	Dinas Trans., BPN
7	HPL tidak sesuai	Penataan ulang HPL	BPN, Pemda
8	Batas fisik bidang tanah sertipikat salah	Pengukuran ulang untuk sertipikat baru	BPN, masyarakat
9	Perbedaan subjek (nama di sertipikat)	Penetapan pengadilan (opsional)	Dinas Trans, BPN, pengadilan
10	Kesalahan nama desa karena pemekaran	Penyelesaian administratif	Kementrans, Pemda, ATR/BPN
11	Sertipikat transmigrasi tidak lengkap	Pengusulan PTSL/Redist. oleh Pemda	Pemda, BPN, masyarakat
12	Transaksi jual beli tanah tanpa bukti	Penetapan pengadilan	BPN, Dinas Trans. pengadilan

Sumber: Analisis Data Primer Peneliti (2025)

Kasus Desa Sukapura di Lampung Barat menjadi contoh nyata adanya tumpang tindih dengan kawasan hutan. Lahan transmigrasi yang telah dihuni masyarakat sejak 1980-an tiba-tiba diklaim sebagai bagian dari Hutan Lindung Bukit Rigis (dalam rangka pemenuhan kecukupan tutupan hutan dalam provinsi sebesar 30%). Padahal, saat ini, UU Cipta Kerja (UUCK) telah mencabut ketentuan 30% tutupan hutan tersebut. Hal ini sejatinya membuka peluang penyelesaian sertipikasi. Namun, ketiadaan HPL (Hak Pengelolaan Lahan) dan data fisik-yuridis yang tidak akurat menghambat proses ini.

Kasus lain, sebanyak 70% lahan transmigrasi di Kabupaten Tulang Bawang Barat (Tubaba) tumpang tindih dengan kawasan hutan (Register 45B, 47, dan 5 Way Ketibung). Contoh kasus ketiga adalah terdapat lahan transmigrasi di Desa Sukapura (Lampung Barat) seluas 350 ha tumpang tindih dengan kawasan Hutan Lindung Bukit Rigis.

Konflik dengan masyarakat lokal dan korporasi terjadi di Kabupaten Tulang Bawang Barat. Lahan transmigrasi yang telah dikuasai masyarakat pendatang terjadi tumpang tindih dengan klaim masyarakat lokal dan HGU perusahaan seperti PT KAP. Masyarakat lokal menganggap tanah tersebut sebagai warisan turun-temurun, sementara korporasi mengacu pada izin resmi yang dari BPN. Konflik seperti ini umumnya belum terselesaikan karena ketiadaan sertipikat transmigrasi dan dokumen riwayat tanah masyarakat lokal yang tidak tertulis jelas.

Di kawasan transmigrasi Provinsi Lampung juga terjadi ketidaksesuaian objek dan subjek Hak Atas Tanah (HAT). Ketidaksesuaian objek HAT adalah batas fisik penguasaan tidak sama dengan batas di sertipikat. Hal ini berdampak pada letak, bentuk, dan luas dari sertipikat tanah transmigrasi yang berbeda dengan kondisi fisik penguasaan tanah masyarakat. Maksud dari ketidaksesuaian subjek adalah nama yang tertera di sertipikat berbeda dengan nama yang menguasai tanah. Terdapat juga sertipikat HAT transmigrasi yang tumpang tindih dengan batas kawasan hutan, termasuk Hutan Produksi Terbatas (HPT). Misalnya, sebanyak 500 KK di Desa Tanjungan menguasai lahan seluas 600 ha di desa tersebut dan tumpang tindih dengan kawasan HPT Register 5 Way Ketibung 1.

Analisis Akar Masalah Transmigrasi dari Perspektif Spasial dan Kebijakan

Penelitian ini mengungkap akar masalah transmigrasi di kawasan transmigrasi Provinsi Lampung melalui pendekatan spasial dan kebijakan. Berdasarkan perspektif spasial, tiga masalah utama teridentifikasi: Pertama, tumpang tindih lahan antara kawasan transmigrasi dengan konsesi perusahaan (HGU/HTI) dan kawasan hutan. Contoh nyata terjadi di Desa Sukapura, Kecamatan Sumber Jaya (Lampung Barat), di mana 350 ha lahan transmigrasi masuk ke dalam Hutan Lindung Bukit Rigis Register 45B. Di Mesuji, 150 ha lahan transmigrasi di enam kampung (Gisting Jaya, Marga Jaya, dll.) bertabrakan dengan konsesi PT (KAP). Konflik serupa terjadi di Desa Purwotani (Jati Agung), di mana 74 KK transmigran menggarap lahan di kawasan Hutan Produksi Tetap Register 40. Data lapangan menunjukkan bahwa 40% lahan transmigrasi di Lampung belum memiliki batas spasial yang jelas sehingga memicu klaim ganda dari korporasi dan masyarakat adat.

Kedua, ketidakpastian batas administrasi desa/tiyuh akibat pemekaran wilayah dan fenomena desa "*ngantong*". Desa ngantong adalah desa yang memiliki batas wilayah terpisah dengan jarak bervariasi. Temuan lapangan di Kabupaten Tulang Bawang Barat, terdapat 9 dari 93 desa merupakan desa *ngantong*—wilayah adat yang terpisah dari

induknya—seperti Desa Bandar Dewa dan Gunung Agung. Batas desa *ngantong* ini belum difiksasi secara hukum sehingga memicu konflik penguasaan lahan antara transmigran dan masyarakat adat. Misalnya, di Kecamatan Abung Timur, sengketa antara Desa Papan Rejo (transmigran) dan Desa Gedong Nyapah (masyarakat adat) melibatkan 500 KK dengan luasan 600 ha.

Pemekaran wilayah juga menyebabkan inkonsistensi data NIB (Nomor Identifikasi Bidang) yang memengaruhi proses pelayanan di BPN. NIB adalah nomor unik yang dimiliki sebuah bidang tanah (seperti nomor objek pajak pada perpajakan atau nomor induk kependudukan pada data kependudukan). Karenanya, terdapat 30% sertipikat di wilayah pemekaran desa transmigrasi yang tidak sesuai dengan peta dasar.

Ketiga, kualitas data spasial yang rendah menjadi penghambat penyelesaian konflik agraria. Studi di Kantor Pertanahan Tulang Bawang Barat menemukan bahwa 60% peta transmigrasi lama (era 1980–1990) tidak ter digitalisasi sehingga sulit diintegrasikan dengan Sistem Informasi Geografis (SIG) modern melalui Geospasial Komputerisasi Kantor Pertanahan (GeoKKP). Selain itu, 45% lahan transmigrasi di Lampung tidak tercatat dalam Peta Rencana Tata Ruang Wilayah (RTRW) sehingga alokasi lahan tidak sesuai dengan daya dukung ekologis. Misalnya, di Kecamatan Pakuan Ratu, lahan gambut seluas 4.666 ha dialokasikan untuk transmigrasi, padahal secara ekologis tidak layak untuk pertanian intensif.

Berdasarkan perspektif kebijakan, empat masalah utama adalah dualisme hukum, inkonsistensi regulasi, lemahnya koordinasi lintas sektor, dan perencanaan program transmigrasi yang dilakukan secara *top-down* tanpa pelibatan tokoh pemerintahan desa-kecamatan hingga tokoh masyarakat lokal.

Pertama, dualisme hukum terjadi antara ketentuan UU Kehutanan No. 41/1999 dan UU Cipta Kerja. UU Kehutanan mewajibkan setidaknya seluas 30% dari wilayah provinsi ditetapkan sebagai kawasan hutan, sementara UU Cipta Kerja menghapus ketentuan ini melalui UU No. 6/2023. Akibatnya, lahan transmigrasi yang sebelumnya dilarang dikeluarkan dari kawasan hutan (seperti di Register 45B Sumberjaya) kini bisa dialihstatuskan, tetapi prosedurnya belum terintegrasi dengan Permen LHK No. 7/2021. Hal ini menimbulkan kebingungan di lapangan. Status hukum dari 12 lokasi transmigrasi di Lampung Barat dan Tulang Bawang masih terkatung-katung.

Kedua, ketidakjelasan status HPL (Hak Pengelolaan). Meskipun Kantor Wilayah BPN Provinsi Lampung pada akhir tahun 2023 telah mengeluarkan sebanyak 27 sertipikat HPL, namun setidaknya terdapat 7 SK pencadangan yang belum ditindaklanjuti dengan penerbitan sertipikat HPL. Rekapitulasi pencadangan dan pemanfaatan lahan transmigrasi tersebut tersebar di 6 kabupaten sebagaimana tersaji pada Tabel 3.

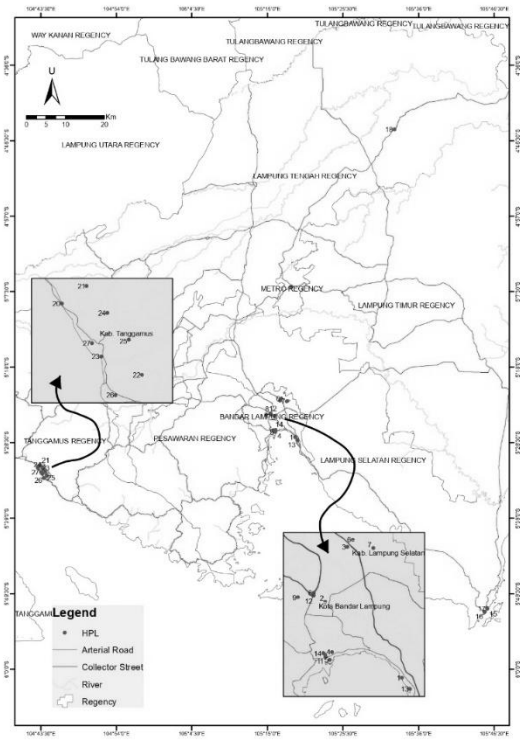
Tabel 3. Pencadangan dan Pemanfaatan Lahan Transmigrasi di Provinsi Lampung

Kabupaten	SK Pencadangan	Pemanfaatan Area
Lampung Selatan	SK Bupati No. 173/Distrans/HK-LS/2002 (12 Mei 2002)	Total: 1.178 ha Dimanfaatkan: 200 ha Sisa: 978 ha
Lampung Utara/Tulang Bawang Barat	G/086/Bappeda/HK/ 1981 (4 Mei 1981)	Total: 12.000 ha Dimanfaatkan: 4.260 ha Sisa: 7.740 ha
Lampung Tengah	G/176/DA/HK/1984 (6 Agustus 1984)	Belum dimanfaatkan (4.666,61 ha)
Tulang Bawang	G/198/BPN/HK/1992 (21 Mei 1992) G/176/DA/HK/1984 (4 lokasi)	Rencana Teknis Satuan Permukiman Transmigrasi (RTSP) 96/97 luas belum diketahui

Sumber: Dinas Transmigrasi Provinsi Lampung (2024)

Tabel 3 menunjukkan bahwa dari tujuh SK Pencadangan Lahan Transmigrasi di Provinsi Lampung, hanya dua lokasi yang disertai dengan SK HPL (Hak Pengelolaan). Kedua lokasi tersebut masih menyisakan lahan yang belum dimanfaatkan secara optimal (7.740 ha di Tulang Bawang Barat dan 4.666,61 ha di Lampung Tengah). Sementara itu, lima SK Pencadangan lainnya tidak dilengkapi SK HPL, sehingga status hukum lahan tidak jelas dan rentan konflik.

Menurut Kepala Bidang Dinas Transmigrasi Provinsi Lampung, salah satu permasalahan lahan transmigrasi adalah masih terdapat sebagian lahan yang tumpang tindih dengan kawasan hutan atau klaim pihak lain. Selain itu, terdapat lahan transmigran yang sudah dikuasai oleh kelompok tertentu sebelum proses alokasi. Hal inipun terklarifikasi dengan *database* HPL dari Kantor Wilayah BPN Provinsi Lampung bahwa lokasi yang telah disebutkan sebelumnya belum terbit sertipikat HPL per Oktober 2023 (Gambar 3).



Gambar 3. Lokasi HPL di Provinsi Lampung
(Sumber: Analisis Data Primer Peneliti, 2025)

Ketiga, terdapat fragmentasi kewenangan antarlembaga pada penyelenggaraan program transmigrasi. Selama ini, meskipun program transmigrasi telah melibatkan kementerian (ATR/BPN, Transmigrasi, Kehutanan, PUPR, dll.) dan pemerintah daerah, namun tidak ada mekanisme *single authority* yang mengikat. Di Provinsi Lampung, koordinasi antarkementerian dan instansi tersebut belum berhasil menciptakan permukiman terpadu, tidak seperti di Kecamatan Sitiung Provinsi Sumatera Barat yang berhasil.

Pemangku kepentingan transmigrasi seharusnya tidak hanya fokus pada sertipikasi lahan yang *clean and clear*, sementara Kementerian Kehutanan (sebelumnya KLHK) menolak revisi batas kawasan hutan tanpa kajian komprehensif. Akibatnya, 65% konflik transmigrasi di Lampung tidak terselesaikan secara struktural (FGD, 2023). Lahan yang *clean and clear* (bersih dan jelas) merujuk pada tanah yang status hukumnya sah, tidak bermasalah, dan memenuhi syarat administrasi fisik untuk dimanfaatkan atau dialihkan kepada pihak lain (Kumalatina et al., 2022).

Keempat, transmigrasi masa lalu dirancang secara *top-down* tanpa melibatkan tokoh pemerintah desa, kecamatan, hingga tokoh masyarakat adat/lokal. Alokasi lahan di Desa Gunung Agung pada tahun 1981, misalnya, dilakukan tanpa konsultasi dengan masyarakat adat sehingga berdampak adanya konflik agraria yang berkepanjangan.

Formulasi Penyelesaian Persoalan Lahan Transmigrasi di Provinsi Lampung

Penelitian ini merumuskan solusi dengan melibatkan empat pemangku kepentingan (Kementerian ATR/BPN; Kementerian Kehutanan; Kementerian Transmigrasi; Kementerian Dalam Negeri), yaitu (1) percepatan sertipikasi dan penyelesaian HPL; (2) resolusi konflik lahan dengan pendekatan partisipatif; (3) penguatan koordinasi lintas

sektor, dan (4) penguatan kelembagaan dan kapasitas aparat.

Solusi *pertama*, yaitu percepatan sertipikasi dan penyelesaian HPL, perlu melibatkan Kementerian ATR/BPN. Kementerian ATR/BPN dapat melakukan percepatan sertipikasi dan penyelesaian HPL lahan transmigrasi. Berdasarkan PP No. 23/2021, Kementerian ATR/BPN bersama Kementerian Kehutanan yang tergabung dalam Gugus Tugas Reforma Agraria (GTRA) dapat mengalihstatuskan lahan transmigrasi dari kawasan hutan melalui mekanisme Penyelesaian Penguasaan Tanah dalam Rangka Penataan Kawasan Hutan (PPTPKH).

Contohnya, lahan 500 KK di Desa Tanjungan yang masuk HPT Register 5 Way Ketibung dapat dikeluarkan melalui mekanisme di atas. Kementerian ATR/BPN juga dapat melakukan penyederhanaan administrasi legalisasi aset dengan mekanisme Pendaftaran Tanah Sistematis Lengkap (PTSL) terhadap lahan transmigrasi yang belum bersertipikat dengan mendasarkan atas penguasaan lahan >5 tahun. Dengan ini, tunggakan sertipikaasi lahan transmigrasi sebagaimana data Kantor Wilayah BPN Lampung (2023) yang menunjukkan 6.397 bidang tanah di Lampung belum bersertipikat dapat terselesaikan. Dengan PTSL, sertipikat lahan bisa diterbitkan langsung dengan Hak Milik tanpa menunggu HPL bila ada rekomendasi dari Dinas Transmigrasi dan bukti penguasaan fisik.

Pada level kabupaten, Kantor pertanahan kabupaten/kota yang berada di bawah Kementerian ATR/BPN dapat merevisi NIB (Nomor Identifikasi Bidang) atas sertipikat tanah transmigrasi yang mengalami pemekaran atau pemecahan wilayah desa transmigrasi. Hal ini untuk menyelesaikan permasalahan data sertipikat tanah yang berada di 93 desa yang belum selesai pengadnimistrasian wilayah desanya.

Solusi *kedua* adalah melakukan pendekatan partisipatif untuk meresolusi konflik lahan transmigrasi melalui mediasi. Rizaldi et al. (2023) menyatakan bahwa kesuksesan mediasi memerlukan sejumlah bahan, seperti kajian mengenai riwayat penguasaan lahan masyarakat antara pihak lokal (masyarakat adat) dan pihak pendatang (transmigran). Mediasi dapat memprioritaskan lahan transmigrasi seluas 600 ha di Desa Papan Rejo (Lampung Utara). Pelibatan pihak akademisi (seperti Universitas Lampung) sangat relevan untuk meneliti sejarah tanah adat Mataram Udik yang mengklaim lahan transmigrasi. Atas kajian tersebut, Bupati menjadi panglima untuk mediasi permasalahan lahan karena berada pada wilayah kerjanya.

Penyelesaian permasalahan tanah adat terkait dengan desa *ngantong* dapat menerapkan mekanisme pemetaan partisipatif. Pemetaan partisipatif tersebut dapat diprioritaskan di 9 desa kantong (seperti Bandar Dewa dan Tirta Kencana) dengan pelibatan bersama warga adat dan transmigran menggunakan teknologi citra satelit/mosaik foto udara/*drone*. Penarikan batas wilayah administrasi desa *ngantong* dimulai dengan mendelineasi *general boundary* (batas alam) yang tampak dari citra atau foto udara menggunakan spidol berwarna. Setelahnya, pihak yang berbatasan melakukan pelacakan batas di lapangan untuk menjadikan batas desa tersebut menjadi *fixed*. Hasil peta batas wilayah desa *ngantong* yang telah disepakati kemudian diintegrasikan ke dalam peta desa Nasional.

Permasalahan selanjutnya, yaitu tumpang tindih HGU, dapat diselesaikan dengan menggunakan mekanisme *enclave*. Di Mesuji, 150 ha lahan PT KAP yang tumpang tindih dengan transmigran bisa dialokasikan sebagai *enclave* korporasi, dengan syarat perusahaan dapat memberikan kompensasi berupa akses infrastruktur atau fasilitas publik lainnya kepada para transmigran.

Solusi *ketiga* adalah penguatan koordinasi lintas sektor. Pemerintah Daerah dan Kementerian Transmigrasi perlu membentuk Satuan tugas (Satgas) transmigrasi terpadu. Di antara tugas Satgas adalah melakukan sinkronisasi kebijakan dan integrasi peta kawasan transmigrasi ke RTRW Lampung. Hal ini perlu dilakukan untuk menghindari alokasi lahan dalam rangka proyek strategis nasional di kawasan rawan konflik agraria pada masa depan. Selain itu, satgas perlu meningkatkan kualitas data, utamanya dengan melakukan digitalisasi peta transmigrasi lama (1905–2000) hingga 100%.

Solusi *keempat* adalah penguatan kelembagaan dan kapasitas aparat, misalnya dengan memberikan pelatihan penyelesaian sengketa lahan transmigrasi pada pegawai di setiap kementerian. Pembentukan kelompok masyarakat tertib transmigrasi yang menampung dan menindaklanjuti laporan masyarakat terkait sertipikasi dan konflik agraria juga perlu dilakukan.

Seiring dengan pesatnya perkembangan teknologi informasi, pemanfaatan aplikasi berbasis web juga dapat dikembangkan untuk memantau progres sertipikasi dan konflik secara *real-time*. Selain itu, pelibatan sektor perbankan dapat mendorong kredit khusus untuk koperasi transmigran, seperti yang sudah berjalan di Kecamatan Sitiung Sumatera Barat, dengan jaminan sertipikat tanah.

Empat solusi di atas merupakan jawaban atas konflik agraria pada program transmigrasi di Provinsi Lampung. Namun, lemahnya komitmen politik bisa berimbas pada gagalnya penyelesaian konflik agraria pada program transmigrasi tersebut. Penerapan solusi ini tidak hanya mengatasi ketimpangan spasial dan administratif, tetapi juga memperkuat hak agraria para transmigran sebagai bagian dari *agrarian citizenship* (Borras, 2007). Adanya sinergi antarkementerian, lembaga, dan instansi pusat hingga daerah diharapkan dapat mengantarkan Provinsi Lampung sebagai salah satu model penyelesaian konflik agraria pada kawasan transmigrasi.

PEMBAHASAN

Temuan tentang tumpang tindih antara lahan transmigrasi dengan kawasan hutan serta klaim masyarakat adat di Provinsi Lampung memperkuat argumen Breman (2014) bahwa transmigrasi sejak awal merupakan instrumen eksploitasi kolonial yang dilanjutkan oleh Orde Baru. Alih-alih berfokus pada pemerataan pembangunan, motif utama program transmigrasi justru berkaitan dengan penguasaan sumber daya alam di luar Jawa. Hal ini tercermin dari fakta bahwa sekitar 70% lokasi transmigrasi di Lampung berada pada kawasan strategis seperti hutan lindung dan area konsesi perkebunan yang berpotensi menimbulkan konflik struktural. Kajian ini juga terkait dengan kritik Li (2021), bahwa kegagalan integrasi sosial para transmigran bukan semata-mata akibat tekanan ekonomi, tetapi juga karena warisan kebijakan yang mengabaikan hak-hak masyarakat lokal.

Lebih lanjut, temuan mengenai lemahnya koordinasi antarlembaga—seperti ATR/BPN, Kementerian Kehutanan, Kementerian Transmigrasi, dan Kemendagri—menunjukkan belum optimalnya sinergi kelembagaan dalam implementasi program transmigrasi. Situasi ini mengafirmasi teori *fragmented authoritarianism* (Wu et al., 2015), yang menggambarkan bahwa proses pengambilan kebijakan sering kali diwarnai oleh tawar-menawar antarbirokrasi dan dominasi sektoral. Contoh nyata dapat dilihat di Tulang Bawang Barat, di mana lahan transmigrasi tidak memiliki status HPL karena adanya tumpang tindih klaim: Kementerian Kehutanan menetapkan lahan tersebut sebagai kawasan hutan, sementara ATR/BPN tidak memiliki data detail bidang tanah untuk

proses sertipikasi. Fenomena ini menunjukkan bagaimana ego sektoral dapat menghambat penerapan kebijakan secara menyeluruh. Kajian ini juga memperkaya analisis McCarthy (2010) dengan menambahkan dimensi administrasi sebagai penyebab konflik agraria, di samping aspek ekonomi dan lingkungan.

Di sisi lain, ketidaksesuaian antara data sertipikat dan penguasaan fisik lahan yang terjadi pada 40% kasus mengindikasikan kegagalan negara dalam menjamin hak dasar para transmigran. Hal ini menunjukkan bahwa pemerintah belum mampu memenuhi hak atas tanah dan kewarganegaraan agraria sebagaimana dikemukakan dalam konsep *land citizenship* (Borras, 2007). Negara belum sepenuhnya memberikan kepastian hukum sebagai imbal balik atas partisipasi transmigran dalam program pembangunan nasional. Temuan lapangan juga menyingkap suatu paradoks: meskipun sekitar 60% transmigran telah menguasai lahan selama lebih dari 20 tahun, hanya 24% di antaranya yang berhasil memperoleh sertipikat tanah. Ini menunjukkan bahwa pengakuan terhadap *land citizenship* tidak hanya ditentukan oleh lamanya penguasaan, melainkan juga sejauh mana akses terhadap birokrasi tersedia.

Akhirnya, keberadaan restan lahan transmigrasi seluas 7.740 hektare di Tulang Bawang Barat serta konflik yang melibatkan masyarakat adat menuntut kebijakan berbasis *integrated land governance*. Terdapat tiga langkah strategis yang direkomendasikan: pertama, penerapan PP No. 23/2021 untuk mengeluarkan lahan transmigrasi dari kawasan hutan secara legal dan sistematis; kedua, sinkronisasi data spasial melalui penguatan geoportal (integrasi Peta Desa, RTRW, HPL, dan HGU) dengan melibatkan Badan Informasi Geospasial dan Kemendagri; dan ketiga, penyelesaian konflik adat melalui pengakuan hak komunal berdasarkan Peraturan Menteri ATR/BPN No. 14 Tahun 2024. Rekomendasi ini sejalan dengan pandangan de Wee (2022) serta Usadolo dan Caldwell (2016) yang menekankan pentingnya peran negara sebagai fasilitator dialog multipihak, bukan sekadar menunggu inisiatif dari masyarakat akar rumput.

SIMPULAN

Penelitian ini menunjukkan bahwa konflik agraria pada program transmigrasi di Provinsi Lampung merupakan warisan struktural dari kebijakan kolonial dan Orde Baru yang belum sepenuhnya terselesaikan. Secara spasial, akar utama konflik agraria terletak pada tumpang tindih kawasan transmigrasi dengan kawasan hutan serta klaim masyarakat lokal. Ketidakjelasan batas spasial, ditambah fenomena desa *ngantong* dan pemekaran wilayah yang tidak terencana, menyebabkan ketidaksesuaian data fisik (letak, batas, luas, dan bentuk) dan data yuridis (nama pemilik) bidang tanah *existing* terhadap *database* bidang tanah pada GeoKKP. Selain itu, keberadaan peta transmigrasi yang belum terdigitalisasi dari era 1980–1990 ikut menghambat integrasi kebijakan pertanahan dan tata ruang.

Pada sisi regulasi, konflik agraria ditandai dengan adanya inkonsistensi peraturan dan fragmentasi kelembagaan. Dualisme hukum antara UU Kehutanan No. 41/1999 dan UU Cipta Kerja menciptakan ketidakjelasan alih status kawasan transmigrasi dari kawasan hutan. Hal ini menjadikan kawasan transmigrasi belum memiliki kepastian hukum akibat prosedur yang tidak sinkron dengan Permen LHK No. 7/2021. Di sisi lain, absennya HPL (Hak Pengelolaan) di kawasan transmigrasi mencerminkan lemahnya koordinasi antara ATR/BPN, Kementerian Kehutanan, dan Kementerian Transmigrasi. Ego sektoral inilah yang menyebabkan konflik agraria transmigrasi belum terselesaikan secara struktural.

Untuk mengatasi persoalan di atas, peneliti menyarankan empat langkah strategis: (1) melakukan percepatan sertipikasi tanah dan penyelesaian HPL; (2) menyelesaikan konflik lahan secara partisipatif; (3) melakukan penguatan koordinasi lintas sektor; dan (4) melakukan penguatan kelembagaan dan kapasitas aparat di lapangan.

Temuan ini menyiratkan bahwa penyelesaian permasalahan transmigrasi membutuhkan komitmen politik yang tinggi dan pengakuan hak agraria transmigran sebagai bagian integral dari hak kewarganegaraan. Implikasi kebijakan yang ditarik mencakup reformasi regulasi lintas sektor, penyelarasan data spasial antarinstansi, dan perumusan mekanisme resolusi konflik agraria yang adil dan inklusif. Secara praktis, diperlukan pembentukan satuan tugas lintas kementerian untuk legalisasi lahan transmigrasi dan harmonisasi kebijakan sektoral.

Transmigran dan masyarakat lokal seharusnya diposisikan sebagai subjek pembangunan, bukan sekadar objek kebijakan *top-down*. Dengan sinergi lintas lembaga, Provinsi Lampung berpeluang menjadi model nasional dalam penyelesaian konflik agraria berbasis data dan partisipasi. Namun tanpa reformasi struktural terhadap warisan kebijakan lama, persoalan agraria di kawasan transmigrasi akan terus menjadi lingkaran setan yang menghambat keadilan sosial dan keberlanjutan pembangunan.

Negara perlu mengakui bahwa konflik agraria ini merupakan imbas dari ketidaktertiban kebijakan masa lalu. Dengan kemajuan infrastruktur hukum, SDM, dan teknologi saat ini, penyelesaian konflik seharusnya lebih mudah. Pemerintah daerah bersama para pemangku kepentingan perlu menyusun peta jalan (*roadmap*) berbasis karakteristik lokal agar solusi yang diambil dapat lebih progresif dan kontekstual.

Transmigran, sebagai warga negara yang sah, berhak atas kepastian hukum atas lahan dan permukiman mereka. Negara wajib menjamin keadilan ini, bukan justru mewariskan beban kepada generasi mendatang. Pada akhirnya, penyelesaian konflik agraria pada kawasan transmigrasi bukan sekadar soal redistribusi tanah, melainkan juga pengakuan terhadap kontribusi historis transmigran dalam membangun bangsa.

TENTANG PENULIS

Rohmat Junarto, M. Nazir Salim, dan Dian Aries Mujiburohman adalah dosen pada Program Studi Diploma IV Pertanahan, Sekolah Tinggi Pertanahan Nasional (STPN) Yogyakarta.

Rohmat Junarto menyelesaikan pendidikan Magister Teknik Geomatika di Universitas Gadjah Mada (UGM) dengan spesialisasi rekayasa-rekayasa geomatika, teknologi geospasial, dan manajemen lahan.

M. Nazir Salim menyelesaikan pendidikan Magister Sejarah di Universitas Gadjah Mada (UGM) dengan spesialiasi kebijakan pembangunan inklusif dan keadilan agraria.

Dian Aries Mujiburohman menyelesaikan pendidikan Magister Ilmu Hukum di Universitas Indonesia (UI) dengan fokus kajian pada bidang hukum kenegaraan.

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Analisis Risiko Kebencanaan Indonesia untuk Mendukung Kebijakan Publik

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ABSTRACT

Indonesia is situated within an active tectonic zone, rendering it highly susceptible to earthquakes. Earthquake disasters not only result in physical damages and loss of life but also pose significant challenges in formulating adaptive and risk-based public policies. This study aims to analyze earthquake disaster risk in Indonesia and evaluate the extent to which public policy has addressed this potential hazard. The methodology employed is a literature review using a mixed-methods approach: qualitative analysis to examine geological and social aspects, and quantitative analysis through spatial assessments utilizing Geographic Information Systems (GIS). The analysis is grounded in a conceptual disaster risk framework encompassing three main components: hazard, exposure, and capacity. The findings reveal that the presence of active faults traversing densely populated areas, limited public awareness, and weak enforcement of technical regulations such as the Indonesian National Standard (*Standar Nasional Indonesia/*SNI) for earthquake-resistant buildings contribute to the high disaster risk. This study recommends the integration of disaster education into the school curriculum, the strengthening of technical regulations such as the earthquake-resistant SNI, and the incorporation of local wisdom in building practices as strategies to enhance community resilience to earthquake disasters.

Keywords: Earthquake; Fault; Regulation; Risk; Tectonic.

ABSTRAK

Indonesia merupakan negara yang terletak di kawasan tektonik aktif sehingga memiliki potensi tinggi terhadap gempa bumi. Bencana gempa bumi tidak hanya menyebabkan kerugian fisik dan korban jiwa, tetapi juga menimbulkan tantangan dalam perumusan kebijakan publik yang adaptif dan berbasis risiko. Penelitian ini bertujuan untuk menganalisis risiko kebencanaan gempa bumi di Indonesia serta mengevaluasi sejauh mana kebijakan publik telah merespons potensi tersebut. Metode yang digunakan adalah studi literatur dengan pendekatan campuran, yaitu kualitatif dalam menelaah aspek geologi dan sosial, serta kuantitatif dalam analisis spasial berbasis Sistem Informasi Geografis (SIG). Analisis didasarkan pada diagram konseptual risiko kebencanaan yang mencakup tiga komponen utama: *disaster* (bahaya), *exposure* (paparan), dan *capacity* (kapasitas). Hasil kajian menunjukkan bahwa keberadaan patahan aktif yang melintasi wilayah padat penduduk, rendahnya edukasi masyarakat, serta lemahnya pengawasan terhadap penerapan regulasi teknis seperti SNI bangunan tahan gempa, berkontribusi terhadap tingginya risiko bencana. Penelitian ini merekomendasikan integrasi edukasi bencana dalam kurikulum pendidikan, penguatan regulasi teknis seperti SNI tahan gempa, serta pemanfaatan kearifan lokal dalam konstruksi bangunan sebagai strategi membangun ketangguhan masyarakat terhadap bencana gempa bumi.

Kata Kunci: Gempa Bumi, Patahan, Regulasi, Risiko, Tektonik

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PENDAHULUAN

Indonesia merupakan salah satu negara yang memiliki potensi bencana yang cukup tinggi (Irsyam et al., 2020). Kondisi tersebut erat kaitannya dengan aktivitas tektonik di mana Indonesia berada di antara empat lempeng, yaitu Indo-Australia, Eurasia, Pasifik, dan Filipina (Pratiwi et al., 2019). Interaksi di antara lempeng tersebut menjadi sebab Indonesia memiliki potensi bencana, dan salah satunya adalah gempa bumi.

Kajian ini berfokus pada bencana gempa tektonik yang diakibatkan oleh patahan aktif berdasarkan data dari Pusat Studi Gempa Nasional (PusGEN) tahun 2017. Berdasarkan data yang diperoleh, sejak tahun 1815 hingga tahun 2018, telah terjadi setidaknya 24 kejadian gempa yang cukup besar di Indonesia dan memakan sejumlah 38.399 kornam jiwa serta merusak 169.240 rumah dan infrastruktur lain (Tabel 1). Data tersebut hanya sebagian kecil dari total kejadian gempa yang terjadi di Indonesia sehingga dapat disimpulkan bahwa Indonesia memiliki tingkat kerawanan bencana yang tinggi.

Secara umum, penelitian ini menjelaskan risiko bencana di Indonesia dengan mengulas tiga komponen utama: paparan, bencana, dan kapasitas. Hasil dari penelitian ini diharapkan bisa menjadi salah satu pertimbangan dalam kebijakan publik terkait kebencanaan. Oleh karena itu, penelitian ini menitikberatkan pada analisis risiko gempa bumi berbasis spasial dan mengevaluasi respons kebijakan publik terhadap risiko tersebut.

Tabel 1. Catatan Gempa Besar di Indonesia (National Centers for Environmental Information, 2024)

No	Daerah	Tahun	Total Korban Jiwa	Kehancuran Bangunan	Skala Magnitudo Momen (Mw)
1	BALI	1815	10253		
2	IRIAN JAYA	1976	6000		
3	JAWA: BANTUL, YOGYAKARTA	2006	5749	127000	6.3
4	SULAWESI	2018	4340	3673	7.5
5	LAUT BANDA	1899	2460		
6	BALI	1917	1500		
7	SUMATERA: BARAT DAYA	2005	1303	300	8.6
8	SUMATRA: PADANG	2009	1117		7.5
9	SUMATRA: ACEH - LEPAS PANTAI BARAT	2004	1001		9.1
10	WILAYAH FLORES, MAUMERE, BABI	1992	1000	31785	7.8
11	JAWA: WONOSOBO	1924	727		
12	BALI	1976	573		
13	PULAU LOMBOK	2018	560		6.9
14	IRIAN JAYA: PEGUNUNGAN JAYAWIJAYA	1981	305		
15	TIMOR: PULAU ALOR	1896	750		
16	JAWA: JOGYAKARTA	1943	213		
17	SUMATERA SELATAN, LIWA, LAMPUNG	1994	207	6000	6.9
18	PULAU SANGIHE	1913	138		7.8
19	IRIAN JAYA: JAYAWIJAYA	1976	133		
20	TIMOR: PANTAR, MOUNT SIRUNG	1987	125	237	
21	DISTRIK KURIMA, BALIEM RIVER	1989	120		
22	SULAWESI UTARA: MENADO, TIKALA, TOMOHON	1845	118		
23	SUMATRA: ACEH - PIDIE JAYA	2016	104	245	6.5
24	SUMATRA: BENGKULU, ENGGANO	2000	103		7.9

DATA DAN METODE PENELITIAN

Penelitian ini menggunakan metode campuran (kualitatif dan kuantitatif) untuk menganalisis potensi bahaya gempa bumi di Indonesia. Metode kualitatif digunakan dalam proses interpretasi geologi dan geodinamika, khususnya dalam menganalisis keterkaitan antara keberadaan patahan aktif dengan kepadatan penduduk dan aktivitas tektonik. Sementara itu, metode kuantitatif diterapkan melalui kompilasi dan analisis spasial data numerik, termasuk data demografi.

Penulis memanfaatkan data sekunder yang diperoleh dari berbagai sumber terpercaya, antara lain:

1. Titik sumber gempa (Supendi et al., 2020) digunakan dalam pemetaan distribusi aktivitas seismik dan identifikasi konsentrasi energi tektonik yang dapat menimbulkan gempa (Gambar 2).

2. Batas interaksi lempeng tektonik (Hasterok et al., 2022) digunakan untuk meninjau zona subduksi, konvergen, divergen, dan transform yang berperan penting dalam pembentukan patahan dan pemicu gempa.

3. Data patahan aktif dari Pusat Studi Gempa Nasional (Pusgen, 2017) digunakan untuk menentukan lokasi patahan yang masih menunjukkan aktivitas geologis dan memiliki potensi tinggi terhadap kejadian gempa bumi.

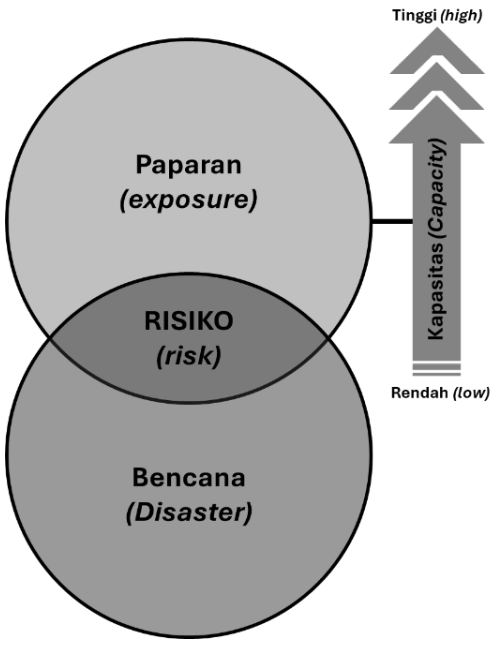
4. Data kepadatan penduduk Kementerian Dalam Negeri Republik Indonesia (2023) digunakan untuk menilai tingkat kerentanan suatu wilayah, di mana semakin tinggi jumlah penduduk di wilayah yang dilalui patahan aktif, maka semakin besar pula risiko kerugian sosial ekonomi yang dapat ditimbulkan apabila terjadi gempa bumi.

Seluruh data dikompilasi dan dianalisis menggunakan perangkat lunak pemetaan berbasis Sistem Informasi Geografis (SIG). Hasil pemetaan ini berupa visualisasi spasial yang menunjukkan lokasi-lokasi dengan tingkat potensi bahaya gempa bumi yang tinggi. Analisis ini juga memungkinkan identifikasi wilayah-wilayah prioritas untuk mitigasi bencana serta perencanaan tata ruang berbasis risiko (Farhan et al., 2024).

Dengan menggabungkan pendekatan geologi dan geografi kependudukan sebagaimana diaplikasikan dalam kajian gempa lainnya (seperti Jena et al. (2020) dan Kusniyah et al. 2025), penelitian ini diharapkan dapat memberikan gambaran komprehensif mengenai keterkaitan dinamika geotektonik dan risiko terhadap masyarakat yang tinggal di daerah rawan gempa.

HASIL

Dalam analisis risiko kebencanaan, terdapat tiga komponen utama yang saling berkaitan, yaitu *hazard* (bencana), *exposure* (paparan), dan *capacity* (kapasitas), sebagaimana terlihat pada diagram konseptual Gambar 1.

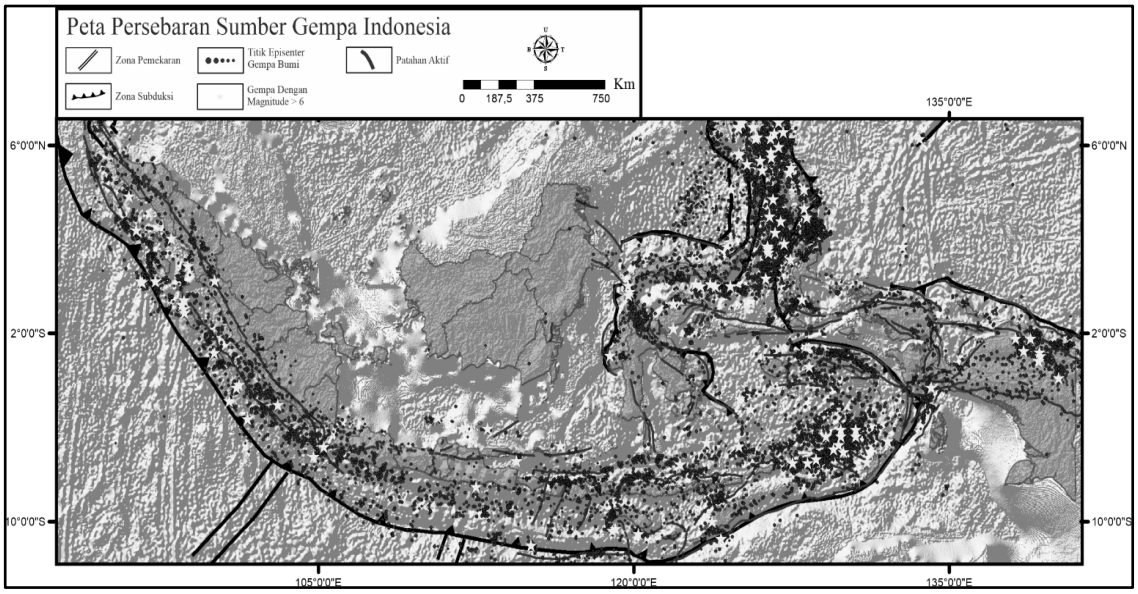


Gambar 1. Komponen Analisis Risiko Bencana

Diagram di atas menunjukkan bahwa *hazard* merupakan elemen yang bersifat statis dan tidak dapat dikendalikan. Bencana alam merupakan fenomena yang erat kaitannya dengan kondisi geologi, tektonik, dan klimatologi suatu wilayah. Di sisi lain, *exposure* merupakan elemen yang menggambarkan sejauh mana manusia, aset, dan infrastruktur terpapar oleh potensi bahaya. Dampak dari suatu bencana akan bergantung pada seberapa besar objek-objek kehidupan di permukaan bumi, seperti populasi manusia dan fasilitas/infrastruktur, berada dalam wilayah paparan tersebut.

Interaksi antara *hazard* dan *exposure* ini membentuk potensi risiko (*risk*). Namun, besarnya risiko tidak semata-mata ditentukan oleh dua faktor tersebut, melainkan juga dipengaruhi oleh tingkat *capacity* yang dimiliki. Kapasitas dalam konteks ini merujuk pada kemampuan suatu sistem, baik infrastruktur maupun masyarakat, dalam menghadapi, merespons, dan memulihkan diri dari kejadian bencana. Berbeda dengan *hazard*, kapasitas merupakan komponen yang dapat dikendalikan dan ditingkatkan. Oleh sebab itu, peningkatan kapasitas menjadi strategi penting dalam upaya mitigasi risiko bencana. Penguatan kapasitas infrastruktur, sistem peringatan dini, serta edukasi pada masyarakat dalam merespons bencana adalah langkah strategis untuk mengurangi dampak bencana yang mungkin terjadi.

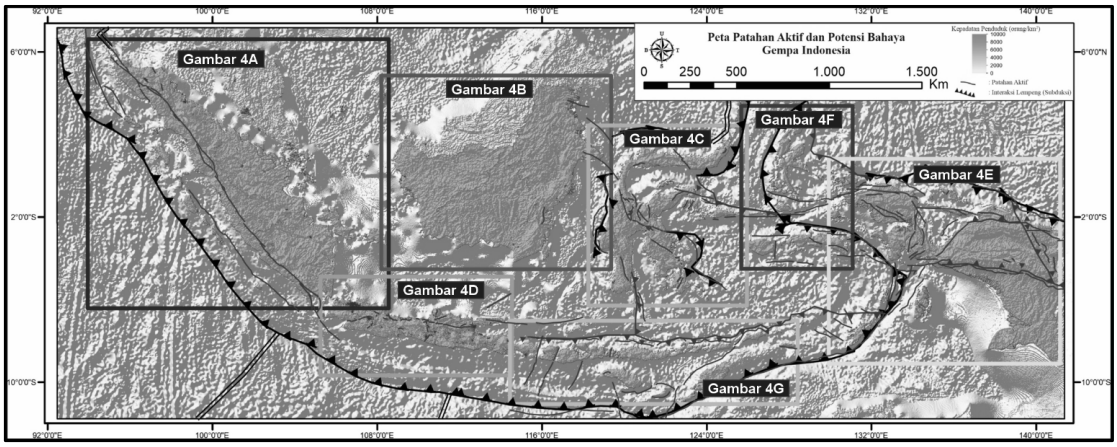
Indonesia merupakan daerah dengan keterdapatan patahan aktif yang menyebar di seluruh daerah (Watkinson & Hall, 2017; Makrup et al., 2018). Salah satu contoh patahan aktif yang ada di indonesia adalah Patahan Semangko di sumatera. Patahan Semangko merupakan salah satu patahan aktif yang ada di indonesia, yang mana patahan tersebut melewati banyak kota besar di Sumatera dari utara yaitu Banda Aceh hingga di selatan seperti Lampung .



Gambar 2. Peta Persebaran Sumber Gempa
(Sumber: Diadaptasi dari PusGEN (2017), Supendi et al. (2020), dan Hasterok et al. (2022))

Gambar 2 menunjukkan bahwa aktivitas seismik di Indonesia sangat intens dan tersebar luas. Ribuan titik yang merepresentasikan episenter gempa bumi menggambarkan bahwa Indonesia berada di wilayah yang sangat aktif secara tektonik. Konsentrasi terbesar episenter tampak di sepanjang zona subduksi yang membentang

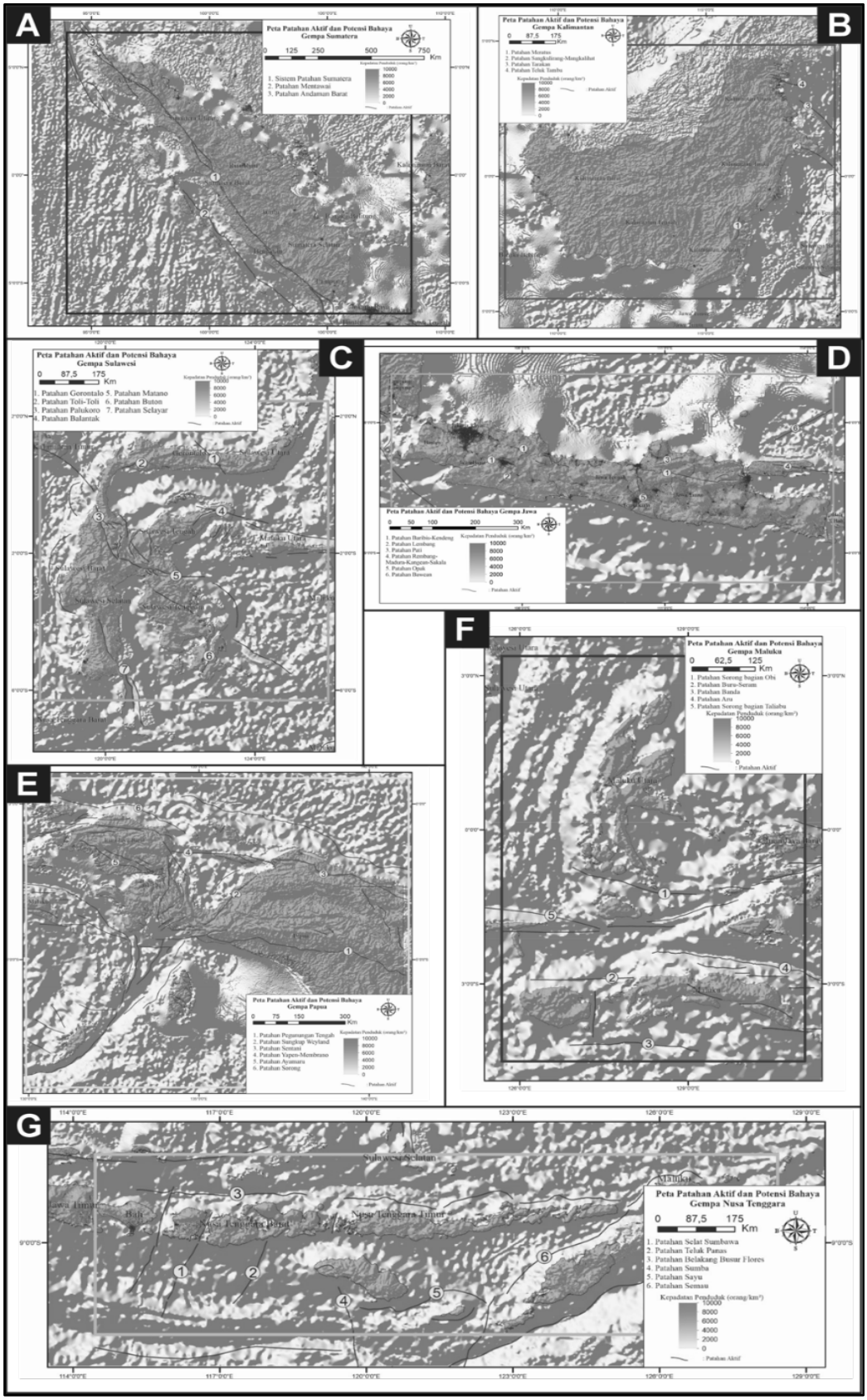
dari barat Sumatera, selatan Jawa, hingga Nusa Tenggara, Maluku, dan Papua. Simbol bintang yang menggambarkan gempa dengan magnitudo >6 menjadi indikasi bahwa Indonesia tidak hanya rawan gempa dengan frekuensi tinggi, tetapi juga berpotensi mengalami gempa besar yang berdampak destruktif. Selain itu, garis-garis pada peta menandai keberadaan patahan aktif yang tersebar di hampir seluruh wilayah daratan Indonesia. Keberadaan patahan aktif di wilayah padat penduduk merupakan indikator utama dalam pembentukan risiko gempa bumi. Peta ini dengan jelas memperlihatkan keterkaitan spasial antara *hazard* (sumber gempa) dan *exposure* (kepadatan penduduk), yang bila tidak diimbangi oleh kapasitas mitigasi yang memadai akan menghasilkan risiko gempa bumi dan destruksi yang sangat tinggi.



Gambar 3. Peta Tektonik Indonesia dan Persebaran Patahan Aktif. Ilustrasi Detail pada Gambar 4a-g.

Gambar 3 di atas (dan Gambar 4A-4G di bawah) menampilkan peta tektonik Indonesia yang terbagi dalam beberapa wilayah berdasarkan sistem patahan aktif. Peta ini sangat penting dalam menyoroti hubungan spasial antara patahan aktif dan kota-kota padat penduduk yang menjadi komponen kunci dalam peningkatan risiko kebencanaan.

Gambar 4A memperlihatkan Patahan Semangko melintasi kota-kota besar di Pulau Sumatera, seperti Padang dan Bukittinggi. Gambar 4B menunjukkan bahwa sebagian Kalimantan, meskipun tidak seaktif wilayah lain, memiliki beberapa patahan lokal yang mendekati kawasan permukiman. Di Gambar 4C, terlihat jelas Patahan Palu-Koro, yang melintasi Kota Palu dan menjadi penyebab utama bencana besar pada tahun 2018. Sementara itu, Gambar 4D memperlihatkan pulau Jawa dengan Patahan Lembang dekat dengan kawasan urban di Bandung, serta Patahan Opak di sekitar Yogyakarta, dua kota dengan kepadatan sangat tinggi. Pada Gambar 4E, terlihat bahwa wilayah utara Papua dilalui Patahan Yapen dan Patahan Mamberamo yang berada dekat dengan kota-kota seperti Jayapura dan Nabire, yang memiliki konsentrasi penduduk cukup tinggi. Gambar 4F menunjukkan wilayah Maluku, di mana Patahan Sorong dan patahan lokal lainnya melintasi kota-kota seperti Ambon dan Ternate—dua wilayah dengan kerentanan tinggi terhadap gempa karena posisi tektonik yang kompleks. Sementara itu, Gambar 4G memperlihatkan wilayah Nusa Tenggara, di mana Patahan Flores dan patahan lainnya berada sangat dekat dengan kota-kota seperti Mataram di Lombok dan Bima di Sumbawa, yang keduanya menunjukkan paparan tinggi terhadap bahaya seismik akibat jalur patahan aktif yang melewatinya.



Gambar 4. Peta Kepadatan Penduduk dan Kehadiran Patahan Aktif pada Beberapa Pulau dan Kepulauan Besar di Indonesia

Tabel 2. Catatan Gempa Besar di Indonesia (National Centers for Environmental Information, 2024)

NO	KOTA	SESAR AKTIF	JUMLAH PENDUDUK/km2
1	Banda Aceh	Sumatran *Fault*	4006.7156127771
2	Padang	Tanimbar *Fault*	1310.8213966497
3	Bandung	Sesar Cimandiri, Sesar Lembang	14886.70833
4	DIY	Sesar Opak	17771.80279
5	Semarang	Sesar Baribis Kendeng	4516.381294
6	Surabaya	Sesar Baribis Kendeng,	8480.632738
7	Lombok	Lombok Strait Strikeslip *Fault*	2115.895233
8	Denpasar	Lombok Strait Strikeslip *Fault*	5111.410236
9	Balikpapan	Sesar Meratus	1363.231499
10	Palu	Sesar Palu-Koro	942.0582278
11	Gorontalo	Sesar Gorontalo	2726.582975
12	Ambon	South Buru *Fault*	1180.43602
13	Raja Ampat	Sesar Sorong	7442.306
14	Jayapura	Sesar Sorong	14082.212
15	Jayawijaya	Warnena	38.82577158
16	Mimika	Papua *Fold Thurst Belt*	14.43419775

DISKUSI

Hasil analisis menunjukkan bahwa risiko kebencanaan gempa bumi di Indonesia dipengaruhi oleh sejumlah faktor yang saling berkaitan, mulai dari kondisi geologi dan tektonik hingga aspek sosial kelembagaan. Keberadaan patahan aktif yang melintasi kawasan padat penduduk, lemahnya kapasitas mitigasi masyarakat, serta kurang optimalnya implementasi kebijakan teknis menjadi faktor dominan yang memperparah kerentanan. Oleh sebab itu, upaya untuk membangun ketangguhan terhadap bencana gempa bumi membutuhkan intervensi lintas sektor yang terintegrasi dan berbasis data risiko. Tiga sektor utama yang perlu mendapat perhatian khusus dalam konteks mitigasi gempa adalah sektor pendidikan, pembangunan, dan perencanaan wilayah (Rahayu et al., 2020).

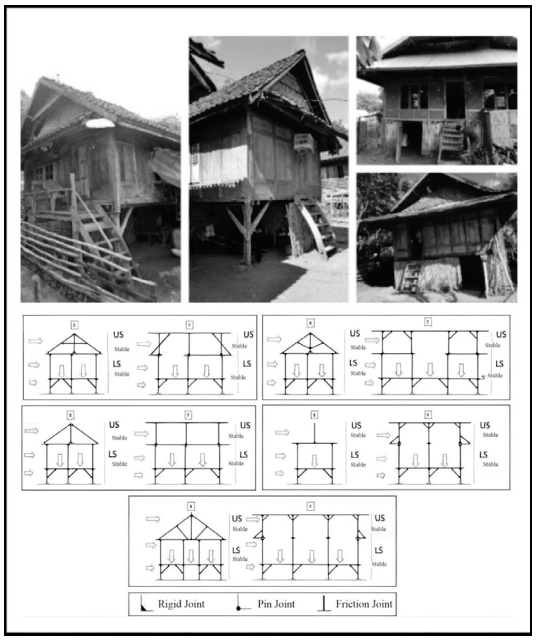
Pendidikan merupakan fondasi awal dalam membangun kesadaran dan budaya tanggap bencana (Muslim et al., 2019). Sayangnya, saat ini edukasi kebencanaan di Indonesia masih belum terintegrasi secara menyeluruh dalam kurikulum nasional, terutama di tingkat sekolah dasar dan menengah. Sebagian besar aktivitas pendidikan bencana bersifat insidental, bergantung pada program lembaga non-pemerintah atau inisiatif lokal. Padahal, pemahaman dasar mengenai gempa bumi, evakuasi darurat, dan tindakan penyelamatan diri sangat penting diajarkan sejak dini untuk membentuk generasi yang sadar risiko (Irsyam et al., 2018). Oleh sebab itu, penelitian ini merekomendasikan agar pendidikan kebencanaan diintegrasikan secara formal ke dalam kurikulum nasional, disertai dengan pelatihan rutin bagi guru dan simulasi berkala di sekolah-sekolah yang berada di zona rawan gempa.

Rekomendasi ini sejalan dengan berbagai penelitian yang menunjukkan efektivitas sosialisasi dan edukasi dalam meningkatkan pemahaman serta kemampuan masyarakat dalam menghadapi bencana. Hasil penelitian Muhlisah (2021) menunjukkan bahwa sosialisasi kepada masyarakat sangat bermanfaat karena dapat meningkatkan pemahaman dan kemampuan mereka untuk tanggap ketika bencana terjadi. Meski demikian, edukasi mengenai mitigasi gempa bumi terhadap anak-anak masih dirasa kurang, seperti yang ditunjukkan oleh penelitian Maharani (2024) di Banjar Mandala, di mana anak-anak masih kesulitan menjawab pertanyaan mengenai tindakan yang harus diambil saat gempa bumi.

Peningkatan pemahaman gempa bumi dapat dilakukan dengan beberapa cara, seperti memberikan sosialisasi melalui simulasi tanggap bencana secara langsung maupun melalui media seperti video edukasi. Sosialisasi tanggap bencana yang dilakukan oleh Arisona (2020) di Ponorogo terbukti efektif meningkatkan pemahaman publik terhadap bencana gempa bumi. Pemberian video edukasi kepada masyarakat juga terbukti dapat meningkatkan pemahaman mengenai bencana gempa bumi dan cara menanggapi ketika bencana tersebut terjadi. Lebih lanjut, Antari dan Setyaningrum (2023) melakukan percobaan kepada siswa SD di Bantul dan menghasilkan peningkatan signifikan terhadap pemahaman siswa dalam menanggapi bencana gempa bumi. Berbagai studi ini memperkuat argumen bahwa edukasi terhadap masyarakat sangat perlu dilakukan dan terbukti meningkatkan pengetahuan masyarakat terhadap gempa bumi, sebagaimana ditunjukkan oleh studi Lukvianti (2023) yang menunjukkan adanya peningkatan pemahaman para lansia setelah mereka menerima materi sosialisasi.

Di sektor pembangunan, Indonesia sebenarnya memiliki kerangka regulasi teknis, seperti SNI 1726:2019 tentang ketahanan gempa bangunan (Badan Standardisasi Nasional. (2019). Namun, implementasi standar ini masih belum merata. Bangunan perumahan, fasilitas umum, dan infrastruktur di daerah rawan gempa banyak yang tidak dibangun sesuai standar tersebut, terutama karena keterbatasan pengawasan, rendahnya kapasitas teknis di tingkat daerah, dan kurangnya sosialisasi pada pelaku konstruksi nonformal. Selain itu, program bantuan rekonstruksi pascabencana sering kali tidak mengedepankan prinsip bangunan tahan gempa secara ketat.

Oleh karena itu, dibutuhkan penguatan sistem pengawasan dan insentif bagi penerapan SNI, termasuk pelatihan kepada tukang bangunan, penyuluh lapangan, serta pemberian sertifikasi teknis untuk pekerjaan konstruksi di wilayah rawan gempa (Sengara & Aldiamar, 2021; Rais & Somantri, 2021). Di sektor pembangunan, penguatan kebijakan tidak seharusnya berfokus pada implementasi standar teknis modern saja, tetapi juga perlu menggali dan mengadopsi kembali kearifan lokal dalam arsitektur vernakular Indonesia. Struktur rumah adat berbentuk panggung, yang umum dijumpai di berbagai wilayah rawan gempa, secara empiris telah terbukti memiliki ketahanan gempa yang unggul.



Gambar 5. Rumah Adat Umu Panggu dan Bagian-bagiannya (Sumber: Hariyanto et al., 2023)

Salah satu contoh konstruksi tahan gempa adalah rumah panggung di Kabupaten Bima yang disebut Umu Panggu. Rumah ini memiliki struktur rangka dengan konstruksi yang tebuat dari kayu lokal. Sambungan kayu, pasak, dan gesek pada komponen struktur bawah dan atas disusun dalam tata letak struktur vertikal. Struktur Umu Panggu mampu memenuhi kriteria stabilitas dan kekakuan struktur, serta memberikan peluang terjadinya pergerakan yang elastis saat terjadi gempa bumi (Hariyanto et al., 2023).

Perencanaan wilayah dan tata ruang juga merupakan aspek kunci dalam mitigasi bencana, namun proses perencanaan masih sering mengabaikan data kebencanaan sebagai dasar pertimbangan utama. Contoh nyata dari lemahnya integrasi risiko gempa dalam perencanaan adalah kasus Jalan Tol Cisumdawu di Jawa Barat, yang mengalami pergeseran struktural tidak lama setelah diresmikan pada tahun 2023. Jalan tol tersebut melintasi zona patahan aktif, dan fakta bahwa dampak gempa dapat langsung dirasakan menunjukkan perlunya integrasi data geologi dan seismotektonik dalam tahap perencanaan proyek infrastruktur strategis. Ketidak-cermatan ini tidak hanya berisiko menimbulkan kerugian ekonomi tetapi juga memperbesar potensi korban jika terjadi bencana. Oleh sebab itu, seluruh proses perencanaan pembangunan, baik skala nasional maupun daerah, harus mewajibkan penggunaan data risiko sebagai prasyarat, bukan sekadar pelengkap.

Mengingat pentingnya mempertimbangkan aspek risiko kebencanaan gempa bumi pada sektor pendidikan, pembangunan, dan perencanaan wilayah, maka pemerintah perlu menerapkan pendekatan kebijakan yang lebih menyeluruh, berbasis bukti, dan berorientasi jangka panjang. Tanpa integrasi yang kuat antarsektor, upaya mitigasi bencana hanya akan bersifat simbolis dan reaktif. Penelitian ini menunjukkan bahwa analisis spasial risiko gempa, meskipun masih sederhana, dapat menjadi alat awal yang penting dalam mengidentifikasi zona rawan dan menyusun prioritas intervensi kebijakan. Ke depan, penguatan kapasitas analisis, pemanfaatan data spasial secara lebih mendalam, serta koordinasi lintas sektor perlu menjadi fokus utama dalam membangun masyarakat Indonesia yang tangguh dan antisipatif terhadap bencana.

Untuk memastikan bahwa rekomendasi kebijakan di sektor pendidikan, pembangunan, dan perencanaan tata ruang dapat diimplementasikan secara efektif dan berbasis pada data ilmiah yang akurat, keterlibatan para ahli menjadi prasyarat mutlak. Dalam konteks ini, pemerintah tidak perlu berjalan sendiri. Indonesia memiliki organisasi profesional yaitu Ikatan Ahli Geologi Indonesia (IAGI), yang di dalamnya terdapat kelompok kerja atau anak organisasi bernama Masyarakat Geologi Teknik Indonesia (MGTI) yang secara spesifik memiliki fokus dan keahlian dalam kajian geologi teknik untuk mitigasi bencana.

Oleh sebab itu, pemerintah – baik di tingkat pusat maupun daerah – perlu membangun mekanisme koordinasi yang formal dan berkelanjutan dengan IAGI dan MGTI. Kolaborasi ini dapat diwujudkan dalam penyusunan standar teknis bangunan yang lebih aplikatif, validasi data risiko untuk perencanaan tata ruang yang akurat, pengembangan materi edukasi kebencanaan yang tepat sasaran, serta pengawasan independen terhadap proyek-proyek infrastruktur strategis. Kemitraan ini akan menjembatani kesenjangan antara pengetahuan ilmiah dan praktik kebijakan, sehingga setiap regulasi dan program yang dihasilkan menjadi lebih kokoh, dapat dipertanggungjawabkan, dan benar-benar mampu meningkatkan ketangguhan bangsa terhadap bencana gempa bumi.

SIMPULAN

Meskipun kejadian bencana alam, khususnya gempa bumi, tidak dapat dicegah karena merupakan bagian dari *hazard* yang bersifat alamiah dan tidak dapat dikendalikan, dampak bencana alam dapat ditekan melalui pengurangan *exposure* dan peningkatan kapasitas. Penelitian ini menunjukkan bahwa risiko kebencanaan di Indonesia sangat

dipengaruhi oleh keberadaan patahan aktif yang melintasi wilayah padat penduduk serta lemahnya kapasitas mitigasi di tingkat masyarakat dan infrastruktur.

Penguatan kapasitas masyarakat melalui edukasi mitigasi bencana terbukti efektif dalam meningkatkan kesiapsiagaan, terutama jika diintegrasikan dalam kurikulum pendidikan formal dan pelatihan berbasis komunitas. Selain itu, penerapan dan pengawasan terhadap Standar Nasional Indonesia (SNI) bangunan tahan gempa perlu diperkuat agar pembangunan di wilayah rawan gempa benar-benar memperhitungkan aspek keselamatan.

Pemanfaatan kearifan lokal seperti rumah panggung, yang telah terbukti adaptif terhadap guncangan gempa, dapat dijadikan sebagai inspirasi desain bangunan tahan gempa yang kontekstual namun tetap relevan dengan teknologi masa kini. Dengan integrasi kebijakan lintas sektor berbasis data risiko serta kolaborasi aktif antara pemerintah dan komunitas keilmuan seperti IAGI dan MGTI, Indonesia dapat membangun sistem yang lebih tangguh dalam menghadapi risiko bencana di masa depan.

TENTANG PENULIS

Muhammad Gazali Rachman adalah peneliti doktoral bidang Geoscience di Universiti Brunei Darussalam. Ia adalah dosen Jurusan Teknik Geologi Universitas Pembangunan Nasional "Veteran" Yogyakarta. Ia memperoleh gelar sarjana dan magister di bidang Teknik Geologi dari UPN "Veteran" Yogyakarta, masing-masing tahun 2014 dan 2018. Ia merupakan Ketua Pusat Studi Geoheritage dan Geopark UPN "Veteran" Yogyakarta serta aktif di bidang mitigasi bencana. Pada tahun 2023, Rachman mewakili Brunei Darussalam dan Indonesia sebagai *panel speaker* pada event Regional Workshop on Youth Innovation in Disaster Prevention and Climate Science di Malaysia.

Zshelda Tiara Zelvany adalah mahasiswa Teknik Geologi di UPN "Veteran" Yogyakarta. Ia pernah menjalani magang di industri nikel dan aktif berkontribusi dalam Seksi Mahasiswa – Ikatan Ahli Geologi Indonesia (SM-IAGI). Ia memiliki ketertarikan riset pada bidang geologi struktur, geologi dinamis, dan eksplorasi sumber daya mineral.

Falkis Edo Favali adalah mahasiswa Teknik Geologi UPN "Veteran" Yogyakarta dan merupakan anggota aktif Seksi Mahasiswa – Ikatan Ahli Geologi Indonesia (SM-IAGI). Ia Memiliki minat kajian pada bidang mineral dan geologi struktur, terutama analisis deformasi batuan, pemetaan geologi, dan eksplorasi sumber daya mineral.

Muhammad Reyfangga Aji Putra Nugraha adalah mahasiswa Teknik Geologi UPN "Veteran" Yogyakarta. Ia aktif menulis, termasuk artikel tentang potensi geotermal di Rembang, dan tergabung dalam organisasi SM-IAGI.

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