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ARTICLE

QUADRUPLE HELIX COLLABORATION IN DEVELOPING A VILLAGE CREATIVITY AND INNOVATION POLICY MODEL

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Abstract

Quadruple helix collaboration synergy is an essential pillar in the formulation of the Village Creativity and Innovation Policy Model. Based on the understanding that the government faces limited resources and scope of authority in policymaking, this study examines the roles of stakeholders in the quadruple helix collaboration between the Center for Village and Disadvantaged Region Competitiveness Development (BPI) of the Ministry of Villages, Development of Disadvantaged Regions (Kemendes PDT RI), Gadjah Mada University, Gedhe Nusantara University, and village communities in developing these policy recommendations. The method used in writing this journal article is a qualitative approach with descriptive methods to understand the conditions of a natural object. This study aims to examine the roles of stakeholders in the quadruple helix collaboration in developing policy recommendations, namely the Village Creativity and Innovation Policy Model. Data collection techniques were through observation and semi-formal interviews. The subject of this study is the role of the stakeholders involved, while the object of research is the quadruple helix collaboration, focusing on the roles and involvement of stakeholders.
Keywords: Policy Model, Village Innovation, Quadruple Helix

A. INTRODUCTION

The 2025–2029 National Medium-Term Development Plan (RPJMN) targets energy self-sufficiency as a key policy direction. Through Presidential Regulation No. 79 of 2014 concerning the National Energy Policy (KEN), the government stipulated an increase in the use of New and Renewable Energy (NRE). In 2024, Indonesia's NRE mix only reached 14.65%, while the KEN target was 23% in 2025 and 31% in 2050. Efforts to meet primary energy needs still rely on oil, gas, and coal through mining and fuel imports, yet national demand remains insufficient (Pramudiyanto & Agung Suedy, 2020). However, fossil fuel mining activities actually cause ecosystem damage, threatening the agricultural sector, human health, and aquatic life (Impacts of Mining Activities on the Environment and Mitigation Solutions, 2023).

Biomass energy is beginning to be utilized to reduce dependence on fossil fuels and their environmental impacts. Biomass (biogas, bioethanol, and biodiesel) has been used in electricity generation and as a biofuel to replace coal, oil, and gas. According to a number of journals cited by Khairuna et al. (2024), several countries, such as Germany and Sweden, have made biomass a key component of their energy strategies, supported by significant investment and policies such as the feed-in tariff in Germany and the widespread use of district heating in Sweden. Both countries have been shown to reduce emissions and dependence on fossil fuels (Khairuna et al. 2024). Indonesia has significant biomass

potential, particularly in rural areas, which can be utilized to support national energy independence. One source of biomass in Indonesia comes from the livestock subsector.

The livestock subsector plays a significant role in the national economy and employment, particularly in cattle farming, which supplies domestic meat and milk. However, cattle farming also produces waste in the form of feces, urine, leftover feed, and wash water. This waste has significant potential for utilization, including as an energy source through biogas production. The Central Statistics Agency (BPS) reports on its website that the livestock population in Indonesia, based on livestock type, in 2024 was as follows: 485,809 dairy cattle, 11,749,780 beef cattle, 556,794 buffalo, 125,800 horses, 15,710,055 goats, 9,219,176 sheep, and 4,115,030 pigs.

This large livestock population produces large volumes of manure, which, if not managed, has the potential to cause water, soil, and air pollution, particularly due to indiscriminate waste disposal into rivers or accumulation near pens. This situation triggers odors and social conflict in communities (Basri, A.K., 2019). However, livestock waste has economic value because it can be processed into energy, one of which is biogas. Biogas is produced through the fermentation of organic waste, including animal manure, in a biodigester with a specific water mixture. The fermentation process for cattle waste generally takes 14–21 days to produce biogas (Soeprijanto et al., 2017).

Biomass utilization has been proven to reduce carbon emissions by up to 85% compared to fossil fuels. However, this potential has not been fully utilized, with production capacity remaining below optimal (Khairuna et al., 2024). For example, the "Guo Mandiri" Farmers Group in Padang once managed to produce organic fertilizer for its own needs, but this activity was discontinued due to a lack of knowledge, skills, and management skills in processing livestock manure. Livestock waste can be recycled into compost and biogas, potentially replacing firewood and LPG. The limited utilization of biogas is further compounded by unstable LPG prices and often uneven distribution (Sonata MS et al., 2024).

Secretary General Decree Number 73 of 2025 establishes the Monitoring and Evaluation Guidelines for 12 Priority Actions for Building Villages and Building Indonesia, including priority action number 3, energy self-sufficiency. In achieving the action plan, the Center for the Development of Competitiveness of Villages and Disadvantaged Regions plays a role in increasing the competitiveness of villages so that they are able to meet their energy needs independently while contributing to environmental sustainability. The Ministry of Villages is committed to encouraging villages to produce their own energy by mapping energy potential such as solar and biomass, then providing training in managing renewable energy technology to the community.

In producing this policy recommendation, the Center for the Development of Competitiveness of Villages and Disadvantaged Regions cannot do it alone, but rather collaborates to create collaboration between stakeholders to achieve the stated goals. This statement is in line with the idea put forward by Ansell & Gash (2007); Bryson et al. (2015) that one of the drivers of collaboration is the government's limitations regarding authority and resources in carrying out innovation. Therefore, the Center for the Development of Competitiveness of Villages and Disadvantaged Regions collaborates with academics (Gadjah Mada University), non-governmental organizations (Gedhe Nusantara), and village communities to synergize in a quadruple helix collaboration to realize competitive villages through an energy self-sufficiency program. This collaboration includes several stages that produce policy recommendations in the form of a Village Creativity and Innovation Policy Model, with observations of good practices of village model innovation in Bantul Regency, Yogyakarta Special Region.

B. LITERATURE REVIEW

Quadruple Helix

The Quadruple Helix theory explains a collaborative innovation model involving four main actors: government, academia, the non-governmental/industry sector, and communities as co-creators of public policy and innovation. In this approach, communities are no longer positioned as mere recipients of policy but rather as active actors contributing to the process of policy formulation, implementation, and evaluation. The Quadruple Helix emphasizes the importance of cross-actor knowledge exchange to generate contextual and sustainable innovation. This model is considered more adaptive in addressing complex regional development issues, particularly at the local and rural levels. In the context of village policy, the Quadruple Helix enables the simultaneous integration of local knowledge, institutional capacity, and policy support (Carayannis & Campbell, 2021; Cai & Lattu, 2022). Indicators:

- Government involvement in regulation and policy facilitation
- Academic contributions to research and model development
- The role of NGOs/non-governmental actors as mediators and facilitators
- Active participation of village communities in the innovation process
- Intense coordination and knowledge exchange between actors

Collaborative Governance

Collaborative Governance views public policy as the result of a collaborative process between state and non-state actors working as equals in a joint decision-making forum. This theory emphasizes that limited government resources and authority drive the need for cross-sector collaboration to achieve public goals. The collaborative process is characterized by ongoing dialogue, mutual trust, and a shared commitment to collective goals. The success of collaborative governance is strongly influenced by institutional structures, facilitative leadership, and clear coordination mechanisms. In the context of village innovation policy development, this theory is relevant for explaining how policy recommendations can emerge from inclusive and deliberative multi-stakeholder synergy (Emerson & Nabatchi, 2020; Bryson et al., 2022). Indicators:

- Inclusive multi-stakeholder collaboration forum
- Clarity of roles and responsibilities between actors
- Level of trust and shared commitment
- Coordination and decision-making mechanisms
- Sustainable collaboration in the policy process

Community-Based Social Innovation

The theory of Community-Based Social Innovation emphasizes that sustainable innovation arises from local initiatives and capacities of communities in responding to social and economic problems in their environment. This approach views communities as primary sources of contextual knowledge and agents of change capable of creating innovative solutions based on real needs. Social innovation is not only oriented towards technological aspects, but also towards changes in social practices, collaboration patterns, and local governance. The success of community-based innovation is largely determined by institutional support, mentoring, and adaptive policies. In the village context, this theory is relevant to explain the role of communities as drivers of local creativity and innovation, which are then institutionalized through public policy (Neumeier, 2021; Moulaert et al., 2023). Indicators:

- Local initiatives of village communities
- Utilization of local knowledge and resources
- Community participation in the innovation process
- Policy and institutional support

- Sustainability of village social innovation

C. RESEARCH METHODOLOGY

This research uses a qualitative approach with descriptive methods. This aims to understand the conditions of a natural object. It utilizes relevant theories as the basis for analysis without adding or subtracting from the theory's substance (Setianingrum et al., 2024). This study aims to examine the roles of stakeholders in the quadruple helix collaboration between the Center for Village and Disadvantaged Region Competitiveness Development (BPI) of the Ministry of Villages, Development of Disadvantaged Regions of the Republic of Indonesia, Gadjah Mada University, Gedhe Nusantara University, and village communities in developing policy recommendations, namely the Village Creativity and Innovation Policy Model. Therefore, this study uses a qualitative approach. The research data sources are information sources the researcher found to obtain any information related to the quadruple helix collaboration in developing policy recommendations. The data are divided into primary and secondary data. Primary data was collected through observation and semi-formal interviews with several informants in the field. Meanwhile, secondary data was collected through a literature review that included journal articles, research reports, data and information websites, and official government documents relevant to the quadruple helix topic and within the Ministry of Villages and Disadvantaged Regions. The objective of this research is to examine the role and involvement of each stakeholder in developing the Village Creativity and Innovation Policy Model. The subjects included the Ministry of Villages and Development of Disadvantaged Regions (government), Gadjah Mada University (academics), Gedhe Nusantara (non-governmental organization), and the village community. The objective is the quadruple helix collaboration in developing the Village Creativity and Innovation Policy Model.

D. RESULT AND DISCUSSION

The Role of the Government (Center for the Development of Competitiveness in Villages and Disadvantaged Regions)

In the quadruple helix synergy, the government acts as a regulator or policymaker, developing policies that are effectively implemented by other stakeholders. Regulations serve as the primary foundation for determining the next steps before implementing a policy model. The Center for the Development of Competitiveness in Villages and Disadvantaged Regions, the Development and Information Agency, and the Ministry of Villages and Disadvantaged Regions play a role in this role. Article 217 of Regulation of the Minister of Villages and Disadvantaged Regions of the Republic of Indonesia Number 1 of 2024 concerning Organization and Work Procedures mandates the development of competitiveness in villages and disadvantaged regions. Through priority action number 3, namely energy self-sufficiency, in the 12 Strategic Action Plans of the Ministry of Villages and Disadvantaged Regions, the Center for the Development of Competitiveness in Villages and Disadvantaged Regions plays a role in increasing the competitiveness of villages and disadvantaged regions by developing policy recommendations in the form of the Village Creativity and Innovation Policy Model.

The government acts as the planner, controller, and is responsible for developing collaborative partnerships involving the development of policy recommendations. These activities include planning, implementation, coordination, legal support, and promotion. Another role is fostering cooperation through collaboration between non-governmental organizations, academics, and the community. The central and regional governments are coordinating to support a village innovation model for utilizing local energy developed in

several villages in Bantul Regency, Yogyakarta Special Region. This involves a biodigester for processing livestock waste into biogas, which can be used as cooking gas instead of firewood/Liquified Petroleum Gas (LPG). This local potential requires government support to encourage other communities to participate in adopting this biogas energy utilization. This is supported by policy recommendations, in this case, in the development of the Village Creativity and Innovation Policy Model.

Government is closely linked to public services, as one of its responsibilities is to provide services to the community. Therefore, the government is required to be able to respond to various public issues, including village governments. The village government is the first point of contact for the community to experience public services (Yuliartika Dewi & Suryana, 2024). Similar to village governments, every branch of government works together to create effective coordination in developing this policy model. Regional governments are also involved in coordination with the central government.

The Center for the Development of Village Competitiveness and Disadvantaged Regions coordinates with the Regional Government to coordinate with villages and village communities. Villages serve as examples of good practices in village innovation, as well as locations where observation/field visits are carried out by the Center for the Development of Village Competitiveness team, accompanied by the Regional Government, the Center for Land Resource Management Study team at Gadjah Mada University, and the village community. The Regional Government, involving the Community and Village Empowerment Office, also coordinates with the village community to inform them about these field visits in the context of preparing the Village Creativity and Innovation Policy Model, as well as a form of support for the implementation and licensing of activities.

These stakeholders coordinated directly with the site to observe the biogas utilization process in Selopamioro Village, Bantul Regency, Yogyakarta Special Region. This observation resulted in a Travel Report for the Coordination and Synchronization of the Development of Village Creativity and Innovation in Promoting New and Renewable Energy in the Yogyakarta Special Region Province. This report serves as a basis for subsequent follow-up to develop a Village Creativity and Innovation Policy Model.

The Role of Academics (Gadjah Mada University)

The government faces limited resources, so the Center for Competitiveness Development of Villages and Disadvantaged Regions is collaborating with Gadjah Mada University, specifically the Center for Land Resource Management Studies. Universities have sufficient capabilities to support the government in formulating public policies that meet community needs (Yuliartika Dewi & Suryana, 2024). The strategic role of universities, closely involved in village development, is to provide sources of theoretical knowledge, research, and community service. Indirectly, the Center for Land Resource Management Studies at Gadjah Mada University contributes by providing relevant expert support and ensuring that the policymaking process remains aligned with current scientific principles.

The Center for Land Resource Management Studies at Gadjah Mada University held a Focus Group Discussion (FGD) with the Center for Village Competitiveness Development (BPI) to coordinate and synchronize the development of the policy model. Furthermore, the Center also participated in field visits with the Center for Village Competitiveness Development (BPI) of the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration (Kemendes PDT RI) to villages still utilizing biogas, including Selopamioro Village, Bantul Regency, Yogyakarta Special Region. This village is part of UGM's mentored villages for best practices in utilizing biomass for biogas.

The Center for Land Resource Management Studies at Gadjah Mada University plays a strategic role in developing studies and guidelines for the policy model, which are expected

to be applicable to government technical units and village communities. This role goes beyond providing a theoretical foundation and also includes developing practical methods to connect field facts with public policy needs.

The Role of Non-Governmental Organizations (Gedhe Nusantara)

In this quadruple helix collaboration scheme, Gedhe Nusantara serves as a representative of non-governmental elements, bridging initiatives from the government and other stakeholders. Gedhe Nusantara serves as a key resource, sharing its practical experience in assisting village communities, particularly regarding local resource management and new and renewable energy (NRE). As a provider of information and input, Gedhe Nusantara is indirectly involved in the development of the policy model.

Through its field experience, Gedhe Nusantara provides contextual and realistic insights and input into the development of the Village Creativity and Innovation Policy Model. This is crucial to ensure that the formulated policy is not only theoretically sound but also applicable and responsive to the real dynamics and challenges faced by village communities. This direct involvement ensures that public perspectives and environmental sustainability are fully integrated into the policy document. Gedhe Nusantara's active participation helps identify potential social and economic barriers to biogas technology adoption, while also offering field-tested mitigation solutions. This synergy demonstrates a complementary role, where the government's limitations in resources and field coverage are offset by the NGO's agility and closeness to the environment.

Overall, Gedhe Nusantara's role is crucial as a catalyst accelerating the transfer of knowledge and innovation from the policy center to pilot villages, such as those in Bantul Regency. This mutualistic collaboration not only produces more holistic policy recommendations but also strengthens local institutional capacity to manage energy self-sufficiency independently and sustainably.

The Role of the Community (Village Communities)

Communities play a fundamental role in this quadruple helix collaboration. They not only act as beneficiaries of the policy but also as active participants in the field, sharing their aspirations within the village. Village communities serve as primary data providers and loci where good practices for converting biomass into biogas are already being implemented in their villages. During stakeholder observations, local communities explained the technical workings of the village innovation model, known as biodigester technology. Community participation in providing information through observations and semi-formal interviews is crucial to ensuring that the resulting policy recommendations are rooted in local socio-ecological realities.

This biodigester technology was developed through community initiatives and is being maintained collaboratively to harness the potential of biomass in their villages. This demonstrates that communities can be the driving force behind initiatives to develop local potential. Furthermore, village communities act as pioneers of innovation, demonstrating significant potential in supporting national energy independence through the utilization of local biomass, as exemplified by the use of biogas in Selopamioro Village. Their involvement in managing livestock waste into a biogas energy source directly demonstrates the technical and social feasibility of the policy model being developed. The community's direct experience in overcoming operational challenges, such as manure management and community participation, provides important insights into the success and failure factors of implementation on the ground.

This active community participation also includes coordination with various stakeholders involved during fieldwork and observation. This synergy demonstrates the community's adaptive capacity and willingness to adopt renewable technologies, provided they are

supported by appropriate policies and mentoring. Thus, the community's role ensures that formulated policies are more easily adopted and sustainable because they have been tested and aligned with the needs and values within the community. Village communities are at the heart of local energy innovation. They provide concrete evidence that village energy self-sufficiency is a realistic and achievable goal. Mutualistic Collaboration

Intersectoral collaboration is necessary to achieve village independence. Strong synergy between academics, NGOs, village communities, and the government creates a mutually beneficial collaboration that improves community welfare and utilizes local potential.

This collaboration involves academics, as part of universities, who have contributed knowledge and resources to the development of the Village Creativity and Innovation Policy Model. This includes providing input based on relevant scientific knowledge and theory, mentoring villages, and developing model studies and guidelines. Academics or universities provide expert support to ensure the policymaking process remains aligned with scientific principles. Through this role, academics have the opportunity to apply the Tri Dharma of Higher Education and test theoretical validity in the field. This ensures that the model studies and guidelines are not only theoretically sound but also applicable to internal technical units within the Ministry of Villages and Development of Disadvantaged Regions and related ministries/institutions.

The government, in this case the Center for Competitiveness Development of Villages and Disadvantaged Regions (BPI), Ministry of Villages, Development of Disadvantaged Regions (Kemendes PDT RI), and Regional Governments, serve as regulators and planners. The government provides a legal framework and policy framework to ensure that New and Renewable Energy (EBT) initiatives can be realized and aligned with national policy. This collaboration will facilitate the government's achievement of national energy mix targets and village energy self-sufficiency, while effectively addressing public concerns.

Gedhe Nusantara, as a representative non-governmental organization (NGO), bridges government initiatives in the collaborative implementation of policy model development. Gedhe Nusantara's practical experience contributes through input and knowledge transfer regarding the potential and obstacles in biogas technology adoption. For NGOs, this collaboration empowers them to strengthen partnership networks and ensure public perspectives are integrated into policy documents, indirectly accelerating knowledge and innovation.

Furthermore, village communities are not merely policy recipients but also play a fundamental role. Communities can support the development of this policy, for example by providing primary data and demonstrating the technical and social feasibility of the village innovation model, namely biogas technology. Communities also experience direct access to alternative energy sources that are more stable and affordable than using LPG or firewood. Therefore, regulatory support for this village innovation model is crucial to realizing the utilization of New and Renewable Energy (NRE). The hope is to realize independent initiatives in developing local potential that can be adopted by other villages.

E. CONCLUSION

Quadruple helix synergy is an essential pillar in formulating a policy model for village creativity and innovation, starting from the understanding that the government faces limited resources and scope of authority in advancing innovation initiatives independently. The core of this quadruple helix collaboration lies in a strategic division of roles, where each element involved—government, academics, NGOs, and village communities—complements each other to achieve village energy self-sufficiency through biomass utilization.

From this collaborative perspective, the central and regional governments serve as both regulators and coordinators, ensuring a solid legal framework relevant to the direction of national renewable energy policy. Academics and universities contribute scientific capabilities and the latest research results, ensuring the theoretical foundation of policies remains strong and applicable in the field. Non-governmental organizations act as catalysts, bridging field realities with central initiatives, providing contextual and realistic perspectives based on their practical experience. Meanwhile, village communities play a crucial role as active subjects, demonstrating the technical feasibility of village model innovations, namely biodigester technology, at good practice sites, providing primary data, and acting as driving forces for local initiatives.

Overall, this quadruple helix collaboration yields a comprehensive view that the development of the Village Creativity and Innovation Policy Model cannot be solely top-down. Instead, this approach leads to more adaptive, sustainable policy outcomes rooted in the real needs of the community, while strengthening the capacity of local institutions to independently manage their village's potential.

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