

INTEGRATED RURAL DEVELOPMENT AND ENVIRONMENT ISSUES IN INDONESIA: IS THE QUINTUPLE HELIX MODEL SUSTAINABLE?

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ABSTRACT

This research evaluates the feasibility of implementing the Quintuple Helix Development Model in Indonesia by analysing complex environmental issues and integrated rural development aspects. The Quintuple Helix method integrates government, academia, industry, civil society and the environment to advance sustainable development. To achieve long-term rural revitalisation and expansion, it is essential to incorporate organisations, industries and spatial characteristics into rural development. Effectively consolidating rural land and introducing new incentives are crucial for promoting structured land use and integrated urban–rural development. Key sustainability factors for integrated rural development include spatial and temporal characteristics, challenges associated with urban–rural integration and the impact of transportation infrastructure on rural industrial integration. Ensuring equal access to fundamental public services and adjusting institutional functions are vital for the successful integration of urban and rural communities.

Keywords: rural development practice, Quintuple Helix, social-ecology justice, Indonesia.

1 INTRODUCTION

Rural development practices encompass various activities that attempt to enhance the standard of living and stimulate socio-economic progress in rural regions [1]–[3]. This involves implementing diverse strategies and policies to address the unique challenges faced by rural communities. These practices go beyond improving agriculture to include improving rural infrastructure, reducing poverty, and empowering rural residents [1], [4], [5]. A crucial element of rural development practice is the engagement of local communities through non-governmental organisations and village associations. These local entities are crucial in maintaining the dynamism and appeal of rural areas as residential locations [4], [5]. Overall, rural development practice adopts a multidimensional approach that integrates economic, social, and environmental considerations to foster sustainable development in rural areas. Through the Quintuple Helix Development Model, which emphasises local community involvement, the use of technology, the promotion of tourism, and the implementation of innovative models, rural development practitioners can strive to create thriving and resilient rural communities [6]–[8].

The Quintuple Helix Development Model is a comprehensive framework that fosters collaboration among five crucial components: the creative community, local government agencies, the social media community, academics, business players, and the natural

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environment. Hence, the Quintuple Helix underscores the imperative for a socio-ecological transformation of both society and the economy in the 21st century. In the context of the Quintuple Helix innovation model, it is important to recognise that the natural environment, society, and the economy play a crucial role in driving knowledge production and innovation in rural development. They also present chances for economic growth and creativity in rural areas [6]–[8]. ‘The Quintuple Helix Model is both interdisciplinary and transdisciplinary: The complexity of the five-helix structure implies that a full analytical understanding of all helices requires the continuous involvement of the entire spectrum of disciplines, ranging from the natural sciences (to account for the natural environment) to the social sciences and humanities (to consider society, democracy, and the economy)’ [8], [9].

Regarding rural development in Indonesia, as outlined in the National Medium-Term Development Plan (RPJMN) 2020–2024, the emphasis is on transformation and sustainable development [10]. The Indonesian government aims to enhance coordination among different sectors in order to achieve higher effectiveness and integration. It seeks to promote coordinated actions to enhance efficiency, allocate funds to villages, and maximise resource utilisation to enhance the well-being of village communities [11], [12]. Currently, there is a lack of comprehensive mapping of all sectoral programs at the village level, resulting in a disconnect between villages’ requirements and the possible financing and support provided by sectoral ministries and agencies. The implementation of measures to optimise institutions in order to minimise resource wastage and enhance governance effectiveness is anticipated to enhance the well-being of rural populations in Indonesia [11], [12]. The Indonesian government acknowledges the significance of engaging village communities in rural development by empowering village-owned enterprises (BUMDes) to serve as the catalyst for the village economy. The Indonesian government has implemented several projects, including the Village Tourism Program, Digital Village and Smart Village, with the objective of enhancing the well-being of rural communities while also addressing concerns related to environmental sustainability, climate change, and disaster risks. Nevertheless, the anticipated outcomes of these rural development initiatives have not been realised as of yet [11], [12].

The development in Tarumajaya and Alamendah villages, located in Bandung Regency, Indonesia, is a tangible initiative aimed at enhancing the income of the local residents, as well as enhancing the quality of education, healthcare, environment, and village community resources. This aligns with several aspects of Indonesia’s National Sustainable Development Goals (SDGs) [2], [3], [7], [13]. In Indonesia, the rural development model focuses on achieving village self-sufficiency through cross-sectoral and multi-actor approaches. Rural communities must demonstrate both the desire and capability to develop and advance in unison with urban areas, fostering a harmonious relationship [10]. By implementing integrated, collaborative, creative, and innovative measures, we anticipate enhancing community well-being, village economic growth, and environmental sustainability while also achieving even more significant results.

Prior research has suggested that rural development, in relation to the Quintuple Helix model, highlights the significance of integrating innovation processes with rural development. This entails the allocation of novel roles and duties within the development scope [14]. Another study suggests that numerous local initiatives and policies are ineffective in fostering innovative processes in rural regions due to their lack of contextualisation to the specific conditions and demands of the villages. Hence, it is imperative to carry out the innovation process in a transparent manner in order to enhance the participation of additional stakeholders or industries [15]. Research conducted by Abdillah et al. [8] suggest different players and sectors within the helix model play distinct roles in fostering innovation for rural development in Indonesia, ultimately leading to sustainable development. The study by



Buchari et al. [7] assert that the integration of innovation and knowledge-based development processes plays a significant role in Indonesia's rural development. All relevant stakeholders must coordinate their efforts to successfully implement rural development.

Using a variety of reviews of previous important research on rural development in Indonesia, this study checks if the Quintuple Helix Development Model could work in Indonesia by looking at environmental issues and rural development elements that work together. The case study of Tarumajaya village offers a comprehensive analysis of the interactions between a tiny village in a remote location and several development stakeholders when chosen as a recipient of national development programs. The Alamendah village case demonstrates how engaging in diverse connections among stakeholders fosters creativity in development, empowering the community, conserving the environment, and promoting the growth of tourist communities.

2 METHODS

The Quintuple Helix model's theoretical framework and its implementation in the context of rural development serve as the foundation for this study. The case studies undertaken in Tarumajaya and Alamendah villages provide a thorough understanding of the relationship dynamics between village communities and several development stakeholders in the area. These communities benefit from national development interventions as part of Indonesia's rural innovation process. A highly efficient strategy for facilitating rural and regional development in Indonesia is to foster cooperation among many specialised organisations by using the Quintuple Helix Model, a framework that prioritises environmental sustainability. This model illustrates the dynamic interplay of five creativity factors [6]–[9].

A knowledge-driven approach to innovation and development, the Quintuple Helix concept necessitates the active participation of the creative community, local government agencies, social media organisations, academics, commercial players, and the natural environment. These results constitute the first part of our investigation. The following section of the paper delineates the application of the Quintuple Helix approach to foster sustainable rural development in Indonesia. The author interviewed a total of 26 individuals representing rural communities in Tarumajaya and Alamendah villages, as well as officials in Bandung Regency, Indonesia, between 2023 and early 2024 to gain a more comprehensive understanding of this issue. Furthermore, the authors conducted field observations on seven separate occasions in Tarumajaya village and twice in Alamendah village.

Additionally, this investigation involved discussions with many scholars from institutions such as Universitas Padjadjaran, as well as a thorough examination of 12 directly relevant research papers and four documentary studies obtained from the councils of Tarumajaya and Alamendah village in Bandung Regency. We conducted an analysis of the data obtained from interviews, document studies, and literature reviews using the Quintuple Helix method. We used this analytical approach to examine the dynamic relationships among different stakeholders engaged in the endeavour of rural and regional development in Indonesia. We methodically categorised and arranged the findings based on specific criteria. Following that, we performed interpretive and qualitative-interactive evaluations to obtain the most optimal results from this study. Interactive analysis is a methodical technique for classifying and arranging data obtained from interviews, notes, and documents into sets and then drawing readily comprehensible conclusions.



3 RESULTS AND DISCUSSION

3.1 Overview of rural development practices in Indonesia

A village is a defined geographical region where a community lives and has its own autonomous system of governance. According to Law No. 6 of 2014, a village is a legally recognised communal entity with defined boundaries that has the power to administer and oversee local government matters. The governance structure of the Republic of Indonesia recognises and values communal initiative, ancestral rights and/or traditional rights as the foundation of its authority. People often perceive urban areas as more evolved than rural communities. Rural communities have more substantial challenges, including higher poverty rates, lower health standards, less consumer spending, lower human development indices, fewer infrastructure compared to urban areas, and lower educational attainment [16].

Indonesia has a total of 73,670 villages. Indonesia currently has 5,559 villages that are considered self-reliant, accounting for 7.55% of the total. There are also 54,879 villages classified as developing, making up 74.49% of the total. Additionally, there are 13,232 villages categorised as lagging, representing 17.96% of the total. In 2023, the Indonesian Central Bureau of Statistics (BPS) identified rural poverty as the primary concern in rural areas of Indonesia, with a poverty rate of 12.22%, which is greater than the urban poverty rate of 7.29% [16]. Therefore, achieving equitable development targets not only reducing disparities between western and eastern Indonesia but also disparities between urban and rural areas.

The persistence of various issues in Indonesian villages is the main catalyst and pressing need for promoting sustainable rural development in Indonesia. Using integrated, collaborative, creative, and innovative development strategies in rural areas can resolve the existing problems. Development efforts should not solely prioritise the well-being and economic success of communities; they should also extend beyond those goals. This is in line with Indonesia's Vision 2045 for the development of villages, which focuses on integrating village development across all sectors and stakeholders with the goal of achieving village self-sufficiency. Rural communities should demonstrate both the willingness and capacity to develop and advance in a harmonious manner alongside urban regions. and actors, towards village self-reliance. Villages should be willing and capable to grow and progress harmoniously with urban areas [2], [3], [17].

Based on Law No. 6 of 2014 concerning villages, Article 78 (1), village development includes the improvement of basic services, construction and maintenance of infrastructure and the environment, development of productive scale agricultural economics, development and utilisation of appropriate technology, and enhancement of the quality of order and tranquillity of rural communities. The conditions of Tarumajaya and Alamendah villages in Indonesia represent primary examples of creative village development initiatives encouraged in the western part of Indonesia. Both villages possess various strengths and advantages in driving development in Indonesia, as shown in Table 1.

Based on Table 1, Tarumajaya and Alamendah villages are considered highly suitable for development into tourist villages, prompting numerous development programs in these areas [7]. Tarumajaya village boasts natural resources and human potential that are ripe for development, thus accelerating village progress [13]. Not only rich in natural tourist attractions, these tourist villages also feature abundant agriculture, plantations, natural conservation villages, heritage sites (Dutch buildings), educational tourism, and more. Alamendah village also hosts several art villages, processed strawberry foods, extensive tea



Table 1: Strengths and advantages of rural areas (Tarumajaya and Alamendah villages) in Indonesia. (Source: *Compiled from various sources (assisted with NVivo 12 Plus) 2024.*)

Villages	Highlighted problems	Village potential
<p>Tarumajaya village is one of the villages that has implemented this concept. Located at the foot of Mount Wayang, kilometre zero of the Citarum River in Kertasari District, Bandung Regency, it boasts several tourist destinations including Situ Cisanti, kilometre zero of Citarum, Bukit Paesan, Pakawa Pine Forest and Tawides or the Village Educational Tourism Park. In addition to these destinations, there are also cultural and heritage attractions [18], [19].</p>	<p>Issues related to the Upper Citarum River Basin governance: Environmental pollution due to domestic and sewage waste, high use of chemical fertilizers; Poverty and community welfare issues (landlessness); Land degradation, land slide, mud flood.</p>	<p>Situated at km 0 of the upper Citarum, one of Indonesia's longest rivers. Possessing beautiful nature and designated as a Natural Conservation Area. Abundant in many water sources. Home to creative community groups like KIM Cerdas Tarumajaya. Rich in heritage (Dutch colonial buildings).</p>
<p>Alamendah is situated in the Bandung Regency of west Java. Designated as a tourism village on February 2, 2011. At its inception, the Alamendah Tourism Village (DWA) lacked any offerings or tour packages for prospective travellers. Consequently, DWA had a far lower number of tourist visitors over the initial 8 years. At the start of 2019, the management team of DWA initiated a strategic effort to create product innovations and tour packages by capitalising on the existing potential within the village. The offered activity package encompasses farming, production of food goods and souvenirs by small and medium firms, engagement in Pencak Silat, observation of Karinding art performances, cow milking, acquisition of knowledge about coffee processing and cycling within the village. The endeavours yielded results [19].</p>	<p>The loss of forest, land use change, causing floods and landslide; High traffic during weekend and long holidays; The community raise concern on crime issue related to alcoholic drinks and illicit drugs.</p>	<p>Well-established Islamic Boarding School based cooperative that already kopontren al itifaq. One of the best tourist destination in Bandung Regency with easy transportation access, strong cultural heritage and great agriculture area. High community attention in village development. One of the priority tourist development villages in Bandung Regency. Creative economy driven and facilitated by Tourism Village Board</p>

plantations, and other promising villages. In 2019, approximately ten tourist villages were identified and developed by the Bandung Regency government as tourist villages under the Decree of the Regent of Bandung Regency Number 556.42/Kop7Dispapar/2011 [7]. The development in these villages aims to bolster and sustain economic growth in rural areas by involving various development actors and sectors in Indonesia. The development of village tourism in creative village development is crucial due to its impact on economic growth and community welfare in other villages across Indonesia.

In Indonesia, villages are a part of the governance structure of the Republic of Indonesia and are currently a focal point of development [10], [16]. With a total of 73,670 villages in 2019, it is understandable that village development forms the foundation of national development. Various sustainable development programs based on SDGs have proven beneficial for villages, contributing significantly, with villages accounting for 74% of the national SDGs achievement in Indonesia. Village development aims not only to increase community income but also to improve education, health, environment, community resources, and various aspects of Indonesia's National SDGs [2], [3], [17].

3.2 Quintuple Helix model in Rural Development in Indonesia: A review of Tarumajaya and Alamendah villages

The Quintuple Helix model has garnered attention in the context of rural development in Indonesia. This model emphasises collaboration among five key actors: local government, academia, industry, community, and social environment [20]. By integrating these actors, the Quintuple Helix model aims to promote innovation, entrepreneurship, and sustainable development in rural areas [15]. This model is designed to stimulate knowledge production, innovation participation, and ecosystem development to support the transition towards self-reliant and sustainable rural areas [8]. Additionally, the Quintuple Helix model is seen as a tool to promote sustainable development and social ecology, aligned with goals of achieving sustainability and disaster preparedness in rural areas [9].

Based on the identification and analysis of research through various available data sources (as seen in Table 2), the significant role in rural development through the quintuple helix model in Indonesia is played by local and village governments, but not without the assistance and support from creative community groups, universities, and the private sector, as well as the abundant natural resources in both villages. This indicates that in practical rural development in Indonesia, support from every sector is crucial to maintain sustainable innovation and development that benefits the villages and communities.

In recent studies, Wirawan et al. [21] highlighted that Tarumajaya village is advancing towards a circular regenerative green economy. The village's environmental sector shows significant potential, supported by the serious attention of the local government and creative community towards sustainable village development. Nafliyon and Akbar [22] underscored the role of the village government and the KIM Cerdas community in promoting village tourism and introducing village businesses on social media, fostering effective village development and smart business initiatives in Tarumajaya. Budiman and Kurniasari [23] discussed how Alamendah village's development is led by the village government, involving community training tailored to local businesses. They also emphasised crucial factors like skilled human resources, district funding, marketing strategies, and institutional support for Alamendah's development. Indratno et al. [24] noted the extensive development efforts in Alamendah, driven by high community engagement and focus on village growth. This aligns with Supriatna [25], who emphasised maximising natural resources for village tourism as a key strategy in Alamendah's development.



Table 2: Quintuple Helix Model in Rural Development Practice in Indonesia. (Source: Compiled from various sources (assisted with NVivo 12 Plus) 2024.)

Helix model	Objective	Output
<p>Village of Tarumajaya facilitating the progression of the innovation process as a crucial component of creative and sustainable development.</p>	<p>The village administration implements development initiatives and encourages the rural population and innovative community organisations to participate.</p>	<p>Increasing community participation in village development. Enhancing innovation processes and knowledge-based development. University involvement in various research, training, and community service activities in villages. Natural resources.</p>
<p>Innovative initiatives in Alamendah village shape the future of rural development. Governance capability, political and leadership quality, active community engagement, ICT, and environmental sustainability have a significant impact on the extent to which innovation succeeds.</p>	<p>The village government initiates development programs and encourages extensive involvement by many stakeholders.</p>	<p>Increased participation of various development actors such as village governments, private sector, and creative community groups. Opening up national and international markets. Involvement of various universities. Natural resources.</p>

In short, the Quintuple Helix model in the cases of Tarumajaya and Alamendah villages offer a comprehensive framework to promote innovation, sustainability, and collaboration among various stakeholders in rural development and beyond. By engaging key actors from multiple sectors, this model provides a holistic approach to addressing community challenges and driving positive environmental change (see Table 3).

This paper examines the Quintuple Helix model as a catalyst for sustainable innovation growth in Alamendah and Tarumajaya villages, located in Bandung Regency, Indonesia. Based on the data presented in Table 3, it is evident that the local creative community, business actors, assistance, and support from the local government of Bandung Regency, and the abundance of beautiful rural environments play a crucial role in the development of creative tourist villages in Bandung Regency, Indonesia. The active participation of social media communities significantly facilitates the promotion of several tourist villages in Bandung Regency, attracting visitors and investment from business actors. Most tourist villages in Bandung Regency engage commercial entities to promote the growth.

The present study investigates the effect of the Quintuple Helix model on the promotion of sustainable innovation growth in the villages of Alamendah and Tarumajaya, situated in Bandung Regency, Indonesia. The analysis of the data in Table 3 clearly indicates that the local creative community, business actors, aid, and support from the local government of Bandung Regency, and the plentiful picturesque rural landscapes are essential factors in the growth of creative tourist villages in Bandung Regency, Indonesia. The active engagement of social media communities greatly enhances the promotion of several tourist villages in Bandung Regency, drawing in tourists and soliciting investment from commercial entities. Bandung Regency's tourist villages predominantly involve commercial enterprises to facilitate the development of both natural and manmade tourism destinations in the area. The natural and environmental sectors play a crucial role in providing support to tourist villages in Bandung Regency. More precisely, most tourist villages in Alamendah and Tarumajaya villages in Bandung Regency depend on the implementation of natural tourism projects. The Quintuple Helix Model, comprising the natural environment, academia, government, industry, and civil society as the fifth component, diagrams the interconnections between many domains and their potential impact on the development of tourist villages in Alamendah and Tarumajaya villages, Bandung Regency. The aim of this concept is to promote sustainable tourism in Alamendah and Tarumajaya village by activating collaborative innovation and engaging relevant stakeholders. Nevertheless, some limitations hinder its effective execution.

An ongoing obstacle is the intricate nature of stakeholder engagements. The Quintuple Helix approach necessitates the participation of several stakeholders, encompassing local communities, governmental bodies, enterprises, and academic institutions. Individual stakeholders have distinct interests and objectives, therefore giving rise to potential conflicts and a lack of alignment. For example, we must emphasise that stakeholders often criticise collaborative governance methods due to varying levels of engagement and dedication, potentially impeding the development of cohesive policies for tourism growth [8]. Furthermore, it is important to acknowledge that the participation of several sectors may add complexity to the decision-making process because divergent priorities may result in fragmented endeavours instead of a cohesive strategy for tourism growth [24], [25].

Furthermore, the capabilities and resources of the host community frequently constrain the efficacy of the Quintuple Helix concept. Several tourist communities suffer from a shortage of human resources and expertise required to effectively operate under the Quintuple Helix framework. For instance, there is a widespread recognition that the absence of highly



Table 3: Multi-stakeholders' role based on the quintuple helix model. (Source: *Processed from various sources, 2024.*)

Helix elements	Roles	Objectives	Outputs
Creative community	Village tourism development in Alamendah and Tarumajaya villages.	The promotion of creativity in village development and learning.	Understanding the principles of target and segmentation marketing is crucial. They possess the ability to create new products that cater to the unique needs of travellers. The objective is to expand market share. Proficient in implementing marketing and e-marketing strategies that leverage technology.
Local government and village government	Program initiation, policy and legal support	The training methods are designed to enhance the competencies of communities and small and medium enterprises in the field of business management. Facilitators of stakeholder engagement play a crucial role in managing tourist villages.	The provision of guidance and training to the community serves to strengthen the resilience of local enterprises and facilitate the adoption of optimal strategies in human resource management. Enhancing the community's knowledge and proficiency in tourism.
Social media community	Social media and information technology.	Expanding small business networks and promoting tourist villages on a larger scale.	Comprehending the advantages of becoming a member of business networks on diverse digital platforms. Enrolling in small business networks on both national and international scales.
Academics/ university	Creating knowledge and innovation	An enhancement to the management framework for village tourism products. Entry to financial establishments. Enhancing the community's comprehension and viewpoints in the sustainable administration of village tourism is crucial.	Gaining knowledge and understanding of the various phases of institutional management for enterprises and the administration of tourism in villages. Encourage village tourist organisations to establish organisational structure, implement standard operating procedures, build business plans, promote community development, and produce reliable financial reports.
Business actors/ private sectors	Market internationalisation and entrepreneurial motivation.	International market penetration.	Analysing and overseeing the development of tourist villages. Engaging in investment activities for the advancement of tourist villages
Environment/ nature	Natural resources in Tarumajaya and Alamendah villages	Utilisation of natural resources. Ecosystems services.	Natural resources are the foundation for implementing development and empowering rural areas.



skilled individuals in rural areas could hinder the implementation of collaborative projects, leading to ineffective stakeholder engagement [26], [27]. Bikse and Rivza [15] explicitly acknowledge this constraint and note that stakeholders often fail to maximise their involvement in tourist development, resulting in suboptimal cooperation and outcomes.

4 RESEARCH IMPLICATIONS AND LIMITATIONS

Rural development practices in Indonesia have broad implications for economic growth, environmental conservation, poverty alleviation, community empowerment, and cultural preservation. By addressing challenges, leveraging social capital, promoting sustainable livelihoods, and harnessing digital empowerment, Indonesia can advance inclusive, sustainable rural development initiatives beneficial to local communities. Achieving sustainable rural development requires building relationships among governments, community organisations, industries, creative. The implementation of rural development strategies in Indonesia has significant consequences for several aspects such as economic expansion, environmental preservation, poverty reduction, community empowerment, and cultural safeguarding. Indonesia may promote inclusive and sustainable rural development objectives that benefit local people by tackling obstacles, utilising social capital, fostering sustainable livelihoods, and harnessing digital empowerment. To achieve sustainable rural development, it is necessary to establish connections between governments, community organisations, industries, creative groups, and environmental stakeholders in rural regions (as exemplified by Tarumajaya and Alamendah villages) through active interactions involving many actors and sectors, following the quintuple helix model. Furthermore, this model emphasises the need for comprehensive digital finance for rural regions and tackles the geographical and temporal dimensions of urban–rural integration.

Furthermore, particularly in Indonesia, the Quintuple Helix model has been explored in various contexts beyond rural development. For instance, there have been studies on its application to address challenges such as malaria eradication [26], enhancing SME competitiveness [27], and developing homestay industries in tourist villages [27]. These studies highlight the versatility of the Quintuple Helix model in tackling diverse issues across different sectors. The Quintuple Helix model is not limited to Indonesia but has been applied globally across various fields. It has been used to analyse the impact of climate change on innovation [6], assess the sustainability of marine fisheries under climate change pressure [28], and explore aspects of higher education investment in sustainability [29]. These applications demonstrate the broad use of the Quintuple Helix model in addressing complex challenges and promoting sustainable development.

The quintuple helix concept has limitations and challenges in developing tourist villages in Alamendah and Tarumajaya villages, including complex relationships and interactions among stakeholders, resource constraints, environmental integration, and pressure for sustainable innovation, all of which create significant obstacles. The resolution of this challenge requires collective efforts to build capacity, promote effective communication among stakeholders, and prioritise the fundamental development needs.

5 CONCLUSIONS

The Quintuple Helix approach combines the participation of government, academia, industry, civil society, and the environment to promote sustainable development in Tarumajaya and Alamendah villages. In order to accomplish sustainable rural regeneration and growth, it is crucial to integrate community groups, industry, and spatial characteristics into rural development. Efficiently merging rural land and implementing new incentives are essential for promoting organised land utilisation and integrated urban–rural development.



Essential elements for achieving long-lasting integrated development in rural areas encompass spatial and temporal attributes, obstacles associated with the integration of urban and rural areas, and the influence of transportation infrastructure on the integration of industries in rural regions (as evidenced in Tarumajaya and Alamendah villages).

It is imperative to guarantee equitable access to vital public services and adjust institutional operations in order to effectively merge urban and rural populations. Implementing sustainable land use practices in rural regions is crucial for addressing the conversion of unproductive hillside land and its ecological consequences. Concerns about generalisability, subjectivity in data analysis, and challenges in data interpretation limit the research. To address these concerns, we employed NVivo 12 Plus technologies to mitigate any potential biased analysis and bolster the legitimacy of our research findings.

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