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Data-Driven Insights Into Sustainable Village Development in Central Java

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Abstract: This study aims to analyze the relationship between village infrastructure and the development performance of villages within the Central Java Province. The research provides crucial insights into the significance of comprehending the role of village infrastructure in enhancing village development performance. In this study, village infrastructure is measured through three dimensions: social, physical, and institutional. The methodology employed in this research utilizes descriptive analysis to depict the characteristics of village infrastructure and village development performance in the Central Java Province. Furthermore, correlation analysis examines the relationship between village infrastructure variables and development performance. The research findings indicate that social, physical, and institutional infrastructure in villages in Central Java exhibit diverse characteristics and weak relationships.

Keywords: village infrastructure; Developed Village Index; Village Original Revenue; Village-Owned Enterprises.

1. Introduction

Rural infrastructure has gained public attention in establishing a sustainable public infrastructure in rural areas, which can be directly Infrastructure projects have been recognized as a fundamental tool in improving the socio-economic conditions of the population, especially in rural areas and national development (Hussain et al., 2022). This is because rural areas serve as the base for natural resources, agriculture, and other economic potential, the primary drivers of national and regional economic growth. Investment in rural infrastructure is critical to stimulating economic growth in rural areas. Infrastructure development in each sector is expected to expand employment opportunities, enhance productivity, and reduce disparities between urban and rural areas (Biriescu & Babaita, 2014).

Effective rural infrastructure development will enhance accessibility, improve public services, raise the quality of life for the population, and create opportunities for local economic development (Laksana, 2021). Infrastructure has the potential to impact the performance of the rural economy in three distinct ways. First, it facilitates the expansion of resource utilization, specifically in terms of labor and capital, where infrastructure facilities assume a crucial role. Second, it acts as a catalyst, drawing additional resources to rural areas. Third, it contributes to enhancing the productivity of the rural economy (Fox & Porca, 2001).

Akinyosoye (2010) found that infrastructure contributes to economic development by enhancing productivity and providing services, including improving the quality of life. The availability of efficient infrastructure and services significantly influences the success of production activities. This was evidenced in a study conducted by Briceno-Garmendia and Foster (2009), which revealed that over half of the growth performance improvement in sub-Saharan Africa was attributed to infrastructure development. Chakamera and Alagidede (2018) observed that infrastructure has a favorable and substantial influence on economic growth. Specifically, in the realm of productivity within the private business economy, encompassing essential elements such as highways, airports, mass transit, electrical and gas facilities, sewers, and water, the identified impact coefficient was 0.24%. Consequently, an incremental rise of 1% in the foundational infrastructure component is associated with an annual elevation of productivity by 0.24%. A study in rural China indicated that rural infrastructure is crucial in alleviating poverty, community development, and agricultural growth (Shen et al., 2011). Furthermore, Qin et al. (2020) stated that infrastructure determines rural development in Jiangsu Province, China. Additionally, Chaurey (2022) asserted in their research that electric and road infrastructure in rural areas have a positive impact on underprivileged villages in India.

Central Java Province is characterized as a province with an average Developed Village Index (Indeks Desa Membangun, IDM) that falls into Indonesia's "developed" category. This classification is supported by data published by the Central Bureau of Statistics (BPS) in 2019 regarding the IDM status. In Central Java Province, there are a total of 7,809 villages with an average IDM of 0.682. This suggests that most villages in Central Java Province are categorized as developed villages. The village status in Central Java Province can be observed in Figure 1. Based on Figure 1, out of the 7,809 villages in Central Java Province, 5,560 villages are classified as developed villages. Central Java Province encompasses various geographical features, including lowlands, mountains, coastal areas, and diverse ethnic groups. This diversity provides an opportunity to conduct research with a wide range of variables. In studying the relationship between village infrastructure and sustainable village

development performance, this variable variability can help obtain comprehensive data that represents conditions across different regions. Furthermore, the IDM constitutes a Composite Index constructed through three distinct indices. These indices encompass the Social Resilience Index, comprising Health Education, Social Capital, and Housing; the Economic Resilience Index, encompassing Community Production Diversity, Access to Trade Centers and Markets, Logistics Access, Banking and Credit Access, and Regional Openness; and finally, the Ecological/Environmental Resilience Index, which incorporates Environmental Quality, Natural Disasters, and Disaster Response.

Meanwhile, Central Java Province plays a strategic role in national development. It is Indonesia's hub for industry, transportation, trade, and agriculture. Consequently, research conducted in this province can yield vital insights into village infrastructure and sustainable village development performance, with potential implications for national development. This study aims to underscore the significance of data and information acquired through research in Central Java Province, emphasizing their critical role in assisting the central government in formulating relevant and effective development policies. Additionally, the research findings in this province can serve as a valuable reference for studies conducted in other regions within Indonesia or countries confronting analogous conditions.

Hence, analyzing the relationship between village infrastructure and sustainable village development performance is of utmost importance to gauge the extent to which village infrastructure has contributed to enhancing village development performance and supporting the attainment of sustainable development goals (Qin et al., 2020). Despite the abundance of research on village infrastructure and sustainable village development, there remains a gap in research focusing on the connection between village infrastructure and the performance of village development towards sustainability. Therefore, research that addresses the interplay between village infrastructure and sustainable village development performance is still warranted. This research can enhance our understanding of the significance of village infrastructure in achieving sustainable village development and create opportunities to identify key factors influencing their relationship.

2. Methods

The data source used in this research is the 2019 Village Potential (PODES) data, which covers 7,809 villages in the Central Java Province. The independent variables utilized in this study are as follows: (a) Social infrastructure, which includes (i) Educational infrastructure represented by the number of educational facilities, (ii) Healthcare infrastructure encompassing the number of healthcare facilities, (b) Physical infrastructure, including (i) Communication infrastructure derived from the number of households using cable or mobile phones, (ii) Housing infrastructure represented by the number of households using electricity in rural areas, and lastly, (c) Institutional infrastructure, comprising the number of markets, cooperative institutions, and banks in the villages. Meanwhile, the dependent variables in this research include (i) the Developed Village Index (IDM), (ii) Village Original Revenue (PADes), and (iii) the number of Village-Owned Enterprises (BUMDesa).

This study's meticulous and multifaceted approach to data analysis, encompassing descriptive and correlation analyses, is undertaken. The first step involves clearly defining the research objectives to guide the process. The study draws upon secondary data from Potensi Desa (PODES 2019), a comprehensive dataset that aligns with the research goals. The data collection follows rigorous

criteria to ensure its representativeness and relevance to the research scope. Tableau software is utilized for descriptive analysis to map each independent variable against the dependent variables, followed by an analysis of the results. Data visualization uses scatterplots, placing various data points on horizontal and vertical axes. Through these scatterplots, patterns or correlations between two variables can be identified. The patterns formed can be observed in quadrant diagrams or graphs, as depicted in [Figure 1](#). Simultaneously, correlation analysis explores relationships between variables, unveiling potential patterns and associations within the dataset. This step involves statistical techniques to quantify the degree and direction of relationships, offering a more nuanced understanding of the interplay between different factors. The correlation analysis in this study is represented by the symbol "r." The findings from both descriptive and correlation analyses are interpreted in the context of the research objectives, shedding light on significant patterns or trends in the data.

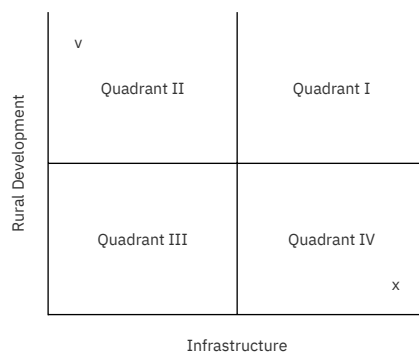


Figure 1. Scatterplot Quadrant

The quadrant analysis identifies infrastructure and village development performance patterns, facilitating subsequent data analysis. When the pattern tends to be in Quadrant I, it indicates that villages with a considerable infrastructure can deliver good village development performance. Villages in Quadrant II imply that they can optimally utilize the existing infrastructure, even if the quantity of infrastructure is limited, yet village development performance remains satisfactory. On the other hand, Quadrant III suggests that a village with few infrastructures also exhibits low village development performance. Finally, for the last condition, Quadrant IV, many infrastructures exist in a village but do not contribute to good village development performance.

As for correlation analysis, it measures the relationship between two variables and the direction of the relationship between them. Quantitatively, this relationship is represented by a value known as the correlation coefficient (r). The output from the analysis techniques employed is expected to yield a map or a comprehensive overview of the connection between village infrastructure and village development performance, considering the uniqueness or typological differences among the analyzed villages.

3. Results and Discussion

Based on the analysis results of [Figure 2](#), it is found that rural development in Central Java Province is associated with the level of education. It is observed that secondary education tends to have a distribution located in Quadrant I. The presence of education determines the quality of the human resources within that area. It can be noted that elementary education is less numerous than secondary education. However, the impact is more evident in the distribution patterns of secondary

education. In other words, secondary education has a greater capacity to produce more productive generations. This is evidenced by the distribution of IDM, PADes, and the number of Village-Owned Enterprises (BUMDesa) units, which tend to exceed the average values (see Figure 2).

Through secondary school, the thought patterns or logical thinking of rural communities are sharpened, leading to the emergence of innovation and inspiration for the development of the village, both in terms of increasing PADes and the development of BUMDesa units, ultimately boosting the IDM value of the village. It is undeniable that the presence of elementary education is also crucial. Therefore, the equitable distribution of elementary and secondary education is required in every village in Central Java so that the population has equal opportunities to access education. If educational facilities are distributed evenly, it will certainly lead to the equitable development of villages in the Central Java Province (see Figure 2).

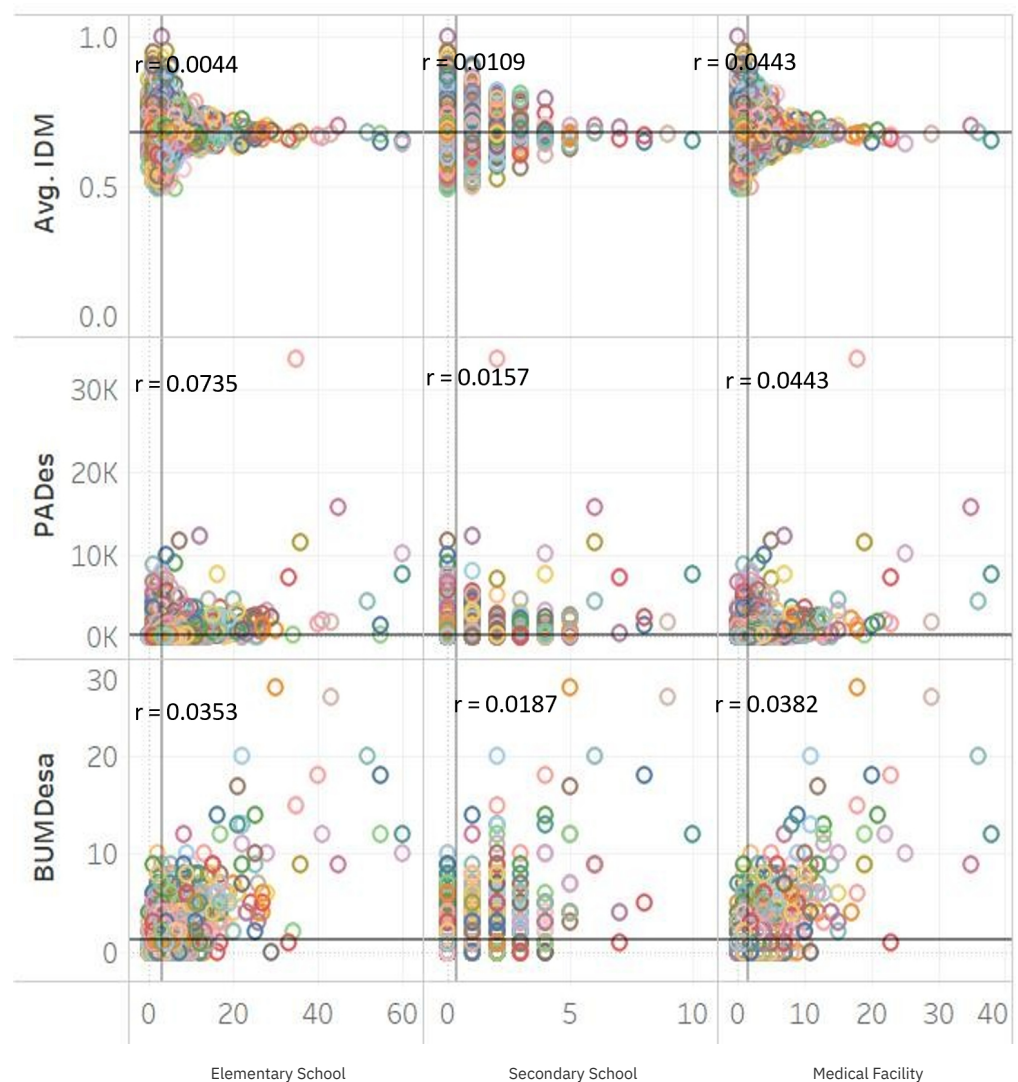


Figure 2. Mapping Pattern of Social Infrastructure and Village Development Performance

Meanwhile, to prepare the community for education, the health aspect is also essential. The presence of healthcare facilities also reflects the quality of human resources in the village. Figure 2 shows that the distribution of healthcare facilities tends to be in Quadrant III. Most villages have healthcare facilities exceeding the average, and many villages are without healthcare facilities. Thus, the result is that

residents must go to the city to access healthcare facilities. This claim is supported by Weiss et al. (2020) that Rural inhabitants are disproportionately inclined to undertake extensive journeys when seeking healthcare services, especially those categorized as subspecialist services.

Interestingly, some villages with limited healthcare facilities have a relatively good village development performance. This could be attributed to the city's superior quality of facilities compared to the villages' healthcare facilities. Therefore, the impact of healthcare facilities is not maximized. Hence, a re-evaluation of the presence of healthcare facilities is necessary to ensure that the services provided are optimal, thus making the impact on the community more tangible.

Examining the relationship between the conditions of each considered variable and conducting correlation estimations can provide a clearer picture of the relationships between each variable, especially concerning the relationship between infrastructure conditions and village development performance. Based on the correlation estimation results, as depicted in Figure 2, indicate that there is only a minimal or even no relationship between social infrastructure and village development performance. Each variable has a low correlation value, signifying a very weak relationship between the variables. Thus, it is evident that education and healthcare are not the sole determinants of whether a village will have high village development performance. In other words, many other factors can support the success of village development, especially in the Central Java Province.

Communication facilities are crucial in connecting a village with the surrounding areas outside the village. From Figure 3, it can be observed that the distribution of communication facilities in the villages in Central Java tends to be low. However, the limited access to communication does not deter Central Java villages from actively pursuing village development programs, as evidenced by the high IDM, PADes, and the number of Village-Owned Enterprises (BUMDesa) units.

Nevertheless, many villages in Central Java have communication facilities, yet their village development performance falls below the average. This may be attributed to the fact that many communication facilities are not primarily used for productive activities but as long-distance communication tools. Consequently, the IDM, PADes, and the number of BUMDesa units are relatively low and below average (see Figure 3).

Regardless of communication facilities, electricity can also support physical infrastructure. Electricity has become a basic necessity for every community. Rural communities can access non-formal education, updated healthcare services, and communication tools through electricity. Therefore, its role in rural development is of paramount importance. Figure 3 reveals that many villages in Central Java still lack access to electricity. Interestingly, villages with limited access to electricity have relatively high IDM values, exceeding the average.

An intriguing observation pertains to the villages endowed with electricity access, as they exhibit an adept utilization of this resource for constructive purposes, as evidenced by their above-average Developed Village Index (IDM), PADes (Village Potential Development), and the quantity of BUMDesa (Village-Owned Enterprises) units. This underscores the pivotal role of electricity in the context of village development initiatives. Consequently, there is a pressing need to fortify the utilization of communication and electricity facilities, with a particular emphasis on those capable of augmenting productivity. Such enhancements are poised to substantially influence rural development, particularly within the Central Java region.

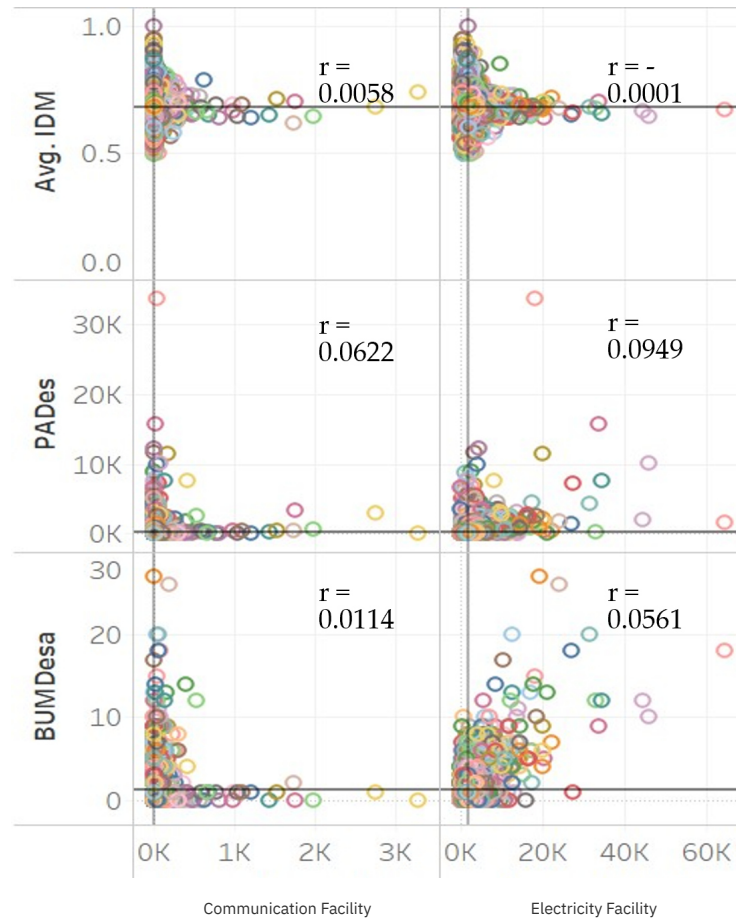


Figure 3. Mapping Pattern of Physical Infrastructure and Village Development Performance

Concerning the association between communication facilities, electricity users, and village development performance, the findings suggest a positive correlation between both aspects. The correlation coefficients in the accompanying table reveal values below 0.1, indicating a weak relationship. Despite the weak correlation, the outcomes of this research bear notable implications in the realm of telecommunications technology development and communication accessibility within villages. Encouraging the active involvement of the Village Government in facilitating the adoption of telecommunications technology can enhance village connectivity and afford improved access to communication services for the rural populace at large.

Notably, advancements in communication facilities can assist rural communities in acquiring information, augmenting business outcomes, and increasing profits through online sales, thereby contributing to rural development, including aspects of village income. Additionally, the substantial number of electricity users in villages can bolster the efforts of Village-Owned Enterprises (BUMDesa) in attaining their objectives to stimulate the local economy, enhance community services, and advance overall village development.

Regarding economic infrastructure, the illustrated distribution pattern in Figure 4 reveals a positive association between indicators of economic infrastructure and the assessment of village development performance. Notably, the presence of banking institutions and cooperatives emerges as pivotal for advancing villages in the context of capital resource availability. Figure 4 demonstrates that villages surpassing the average in the number of banking institutions and cooperatives generally manifest

commendable village development performance. This is discernible through the elevated values of the Developed Village Index (IDM), Village Potential Development (PADes), and the number of Village-Owned Enterprises (BUMDesa) business units, all of which tend to surpass the established averages.

Through the utilization of banking institutions and cooperatives, the village community and other local institutions gain access to capital, facilitating the planning and execution of village development initiatives or the expansion of village institutions. Cooperatives further enable collaboration among the rural population in the production of goods. This establishes a symbiotic relationship between banking institutions, cooperatives, and the village community. The significance of markets also cannot be overstated; their presence reflects the economic conditions of the village and the purchasing power of its residents. A scarcity of markets tends to correlate with lower village development performance, while a prevalence of markets indicates robust economic activity, contributing positively to the village's development performance. When these three elements of economic infrastructure—banking institutions, cooperatives, and markets—are equitably distributed within a village, they collectively bolster the village development program.

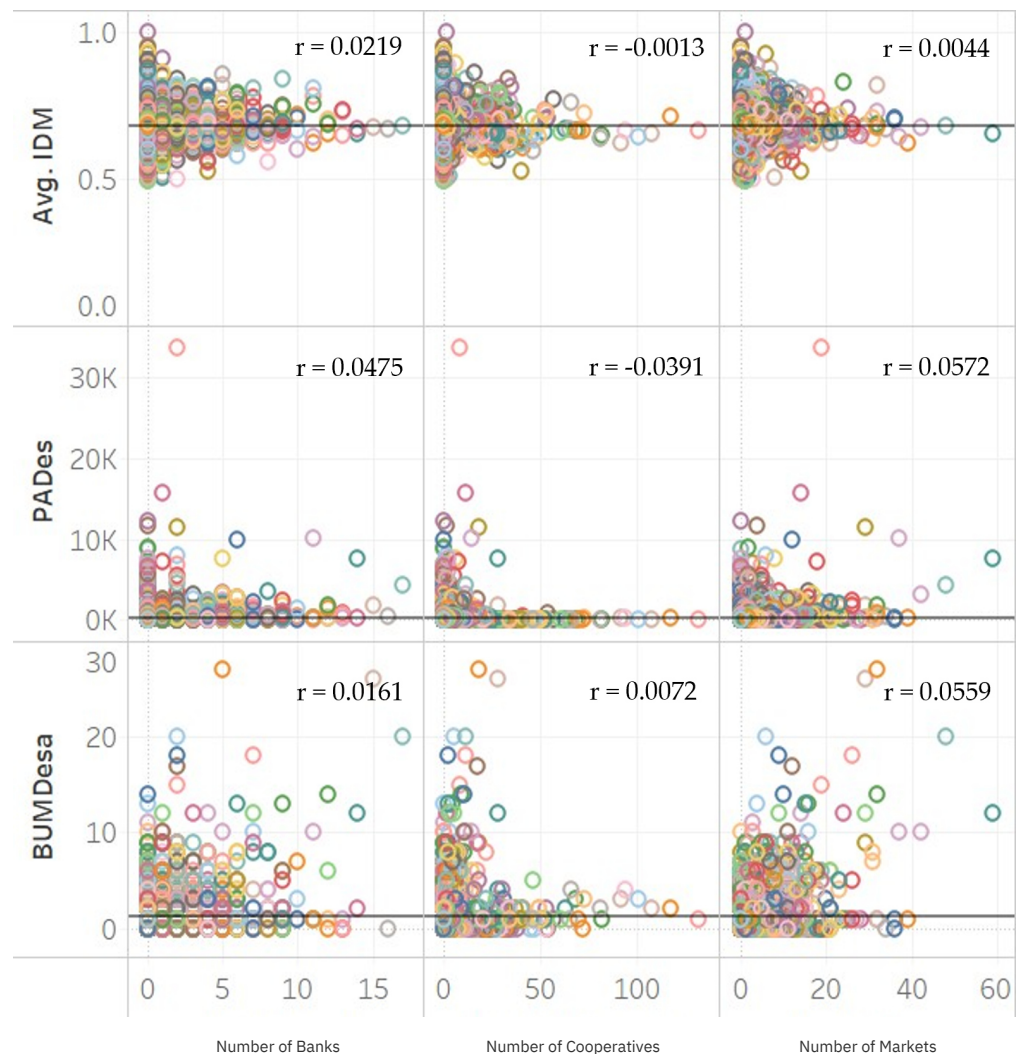


Figure 4. Mapping Patterns of Economic Infrastructure and Village Development Performance

To examine the relationship between banking institutions and village development performance, refer to Figure 4. From the figure, we can conclude that

the relationship between the number of banks and development performance is quite low, approaching zero. This indicates the weak relationship between the number of banks and village or regional development performance. Similar conditions are observed in the relationship between the number of markets and village development performance. The absence of a relationship between the number of banks and markets and village development performance can be attributed to various factors. Village development is a complex process involving various aspects, including infrastructure, education, healthcare, access to basic services, and many more. The number of banks and markets in a village may only be a few factors that have relationships and roles in village development. Therefore, other more significant factors may overshadow the relationship with the number of markets. Additionally, each village has unique characteristics and conditions. This diversity can make it challenging to find consistent correlations. Some villages may have very active markets with a positive impact on development, while others may have less or less impactful markets.

However, an intriguing revelation emerges in the correlation between the quantity of cooperatives and the performance of village development. Notably, cooperatives exhibit an inverse association with the Developed Village Index (IDM) and Village-Owned Enterprises (BUMDesa). These findings imply several considerations: cooperatives and Village Potential Development (PADes) pursue distinct objectives and areas of emphasis. Typically, cooperatives foster economic collaboration among their members, spanning sectors such as agriculture, consumer, or financial services. Conversely, PADes represent the income accrued by the village government from diverse sources, encompassing taxes and levies. Owing to their disparate goals and focuses, cooperatives may not directly contribute to PADes.

Furthermore, cooperatives within villages may encounter limitations in the scope of their activities or operational scale. If cooperatives are predominantly centered on a specific business type or face constraints in production or distribution capacity, their overall impact on village development may be circumscribed. Additionally, the prosperity of cooperatives is often contingent upon the economic and social milieu within the village.

Conversely, cooperatives function as business entities emphasizing economic collaboration among their members. Given their potentially distinct goals and operations from BUMDesa, their activities and memberships may not invariably overlap. Moreover, contextual factors in diverse villages or regions may influence whether BUMDesa and cooperatives exhibit correlation or divergence. The heterogeneity in economic, social, and cultural conditions across each village may yield diverse patterns in the relationship among local economic entities.

4. Conclusion

This study utilized 2019 Village Potential Data (Podes), focusing on over 7,809 villages in Central Java. It examined two main variable categories—rural infrastructure and village performance—to understand their impact on economic development. Despite expectations that the findings would offer insights for improving economic development in Indonesian rural areas, particularly in Central Java, the results reveal a lack of substantial connections between rural infrastructure variables and economic development indicators.

Specifically, no discernible relationship was found between social infrastructure (educational and healthcare facilities) and economic development indicators such as Village Development Index (IDM) or Village Original Revenue (PADes). Similarly,

physical infrastructure (communication and electricity) showed no strong correlation with village economic development performance, as evidenced by factors like commute distance, transportation costs, and electricity or telephones. Additionally, institutional variables such as the number of markets, cooperative institutions, and banks in villages demonstrated a weak correlation with economic development indicators.

In conclusion, the study suggests that, within the context of this research, rural infrastructure variables do not significantly influence the economic development performance of Central Java's villages. It implies that other unexplored factors might play a more substantial role, warranting further investigation in subsequent research endeavors.

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