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Research Paper

Village Development Sustainability Analysis: A Case Study in Cijeruk, Bogor Regency

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Abstract

Having abundant natural resources, the village is the foundation of the city. Villages have the potential to develop various natural, physical, social, demographic, and cultural resources that have not been optimally utilized. Therefore, sustainable village development is necessary to improve villagers' welfare and quality of life. This study aims to identify the status of village sustainability and sensitive attributes in village development through a case study in Cijeruk Village, Cijeruk District, Bogor Regency. The study examined four aspects of sustainability, ecology, economy, socio-culture, and legal and institutional dimensions using a Multidimensional Scaling (MDS) analysis called Rap-BUSAJI (Rapid Appraisal of Cijeruk Village Development). The study found that Cijeruk Village has a relatively sustainable status, with an overall index of 53.29%. The study also identified ten sensitive attributes that could be used to evaluate development. These ten attributes include three ecological dimension attributes (clean water sources for communal MCK, availability of clean water, and availability of MCK in every house); 3 attributes of the economic dimension (marketing range of main commodities, types of main commodities, and availability of supporting industries for main commodities); 3 attributes of the socio-cultural dimension (average community education level, number of agricultural workforces, and number of unemployment); and one attribute of legal and institutional dimensions (maps of disaster-prone areas availability).

Keywords: Village; Development; Multidimensional Scaling (MDS); Sustainability

1.   Introduction

According to The World Bank (2022), middle-income countries are home to 75% of the world's population and 62% of the world's poor. Poverty is influenced by uneven development between urban and rural areas due to urbanization, which risks the production economy in the village (Junaenah, 2018). Indonesia is a developing country with a large rural area. BPS data from 2022 showed that 12.36% of people living in rural areas are considered indigent, compared to 7.53% in urban areas. This condition is considered ironic because the village has abundant natural resources. Villages have the potential to develop various natural, physical, social, demographic, and cultural resources. However, this potential has not been optimally utilized, which has hindered village development (Ariadi, 2019).

According to the Minister of Home Affairs Regulation Number 114 of 2014 concerning Village Development Guidelines, village development is an attempt to improve the quality of life and livelihoods for the benefit of the villagers as much as possible (Kementerian Dalam Negeri, 2014). Increasing village development could be done by empowering the local economy, creating local transportation access to growth areas, and accelerating the fulfillment of basic infrastructure. Village development is directed at advancing the economy and strengthening rural communities as the subject of development to address the national development gap (Adisasmita, 2018).

The village's development is based on its potential for natural resources, humans, the economy, society, and the culture of the community (Novi & Ella, 2019). The sustainable rural development approach is a holistic development approach in which the basic daily needs of rural residents can be met by public utilities with the support of technical, socio-economic, and environmental conditions (Mihai & Latu, 2020). Village development aims at improving the welfare of villagers and their quality of life, as well as overcoming poverty by meeting basic needs, building facilities and infrastructure of the village, developing local economic potential, and using natural resources and the environment sustainably.

In relation to a city, a village has an important role. A village functions as a food supplier area for a city. In addition, a village is also a barn for raw materials and productive labor (Suparmini & Wijayanti, 2015). Even though it has an important role in a city, the potential of a village has not been optimally utilized. Therefore, it is necessary to develop sustainable villages by utilizing the available resources with due regard to aspects of sustainable development, specifically environmental, social, and economic aspects, along with the village community institution (Parlupi, 2020).

Cijeruk Village is one of the villages in Cijeruk District, Bogor Regency, which had a population of 10.483 people in 2021 or 11,23% of the total population (Badan Pusat Statistik Kabupaten Bogor, 2022). This village plays a crucial economic center in Cijeruk District and has experienced rapid economic growth thanks to its abundant natural resources. Based on interviews with the village secretary and the head of economics and development of Cijeruk Subdistrict in 2022, these natural resources in Cijeruk Village have been explored by its villagers and investors to develop tourist attractions. The increasing number of tourist attractions in Cijeruk Village could certainly cause a problem for the local economic structure and the environment. Based on the results of land use digitized in 2015 and 2022, there have been significant changes, especially in agricultural fields. The conversion of agricultural land to tourist attractions is already happening, as shown by the significant decrease in agricultural fields, from 301.50 ha in 2015 to 292.887 ha in 2022. The Cijeruk villagers will lose their jobs as a farmer if the conversion of agricultural land continues to occur. It would also have an impact on socio-cultural conditions and community institutions.

Conducting a sustainability analysis is crucial to ensure sustainable development in Cijeruk Village. This analysis helps determine the current status of sustainability in the village development and provides valuable insights for evaluating the progress of village development.

A considerable number of studies have been conducted on village and village sustainability. Research conducted by Hardini et al. (2022) focused on the assessment of the economic sustainability level of the industrial villages based on sustainable production indicator factors using fuzzy methods. Marhesa et al. (2022) analyzed the sustainability of a tourism village based on five dimensions of sustainability (ecology, economy, social, infrastructure, and institution), using Multidimensional Scaling Rappish that was modified into Rap-Tourism, leverage analysis, and Monte Carlo analysis. Meanwhile, Hafidah et al. (2019) concentrated on analyzing the sustainability of a tourism village based on dimensions of ecology, economy, and social sustainability using a modified Multidimensional Scaling Rapfish and leverage

analysis. However, no research has been conducted on the sustainability of village development based on ecological, economic, socio-cultural, legal, and institutional dimensions using a Multidimensional Scaling (MDS) analysis called the Rap-BUSAJI approach.

2. Methods

2.1 Variables

To assess the sustainability status of Cijeruk Village's development, a multidimensional analysis was conducted, which included ecological, economic, socio-cultural, legal, and institutional dimensions combining all the attributes in the development of Cijeruk Village. The attributes in the study consist of 24 attributes, as shown in Table 3. The attributes were obtained based on various literature related to village development. The criteria for selecting attributes were adjusted to suit the characteristics of villages in Indonesia.

Table 1. Variables in Each Dimension of Cijeruk Village Development

Dimension	Attributes	Sources
Ecology	Paddy fields area	Persada (2015)
	Carrying capacity of the settlement area	Dwikorawati (2012), Putera et al. (2013) and Persada (2015)
	Availability of clean water	Persada (2015), Putra et al. (2021), and Neksidin et al. (2021)
	Clean water sources for communal MCK (*Mandi, Cuci, Kakus*)/ public bathing, washing, and latrine facilities	
	Availability of latrine in every house	Rahayu (2012)
	Local government's ability to manage waste	Dewi (2011) and Dwikorawati (2012)
	Frequency of occurrence of natural disasters	Thamrin et al. (2007) and Dwikorawati (2012)
Economy	Type of the main commodity	Thamrin et al. (2007)
	Market availability	Thamrin et al. (2007), Rahayu (2012), and Supardi et al. (2017)
	Marketing range of the main commodity	
	Availability of supporting industries for main commodities	Thamrin et al. (2007)
	Road condition	Supardi et al. (2017)
	Availability of public transport	Thamrin et al. (2007), Dewi (2011) and Rahayu (2012)
	Number of households subscribed to PLN	Dewi (2011) and Putra et al. (2021)
Socio-culture	Level of community participation	Thamrin et al. (2007), Dewi (2011), and Putera et al. (2013)
	Average community educational level	Thamrin et al. (2007), Dewi (2011), and Dwikorawati (2012)
	Number of the agricultural workforce	Thamrin et al. (2007), Dewi (2011) and Rahayu (2012)
	Local wisdom level	Putera et al. (2013)
	Number of unemployment	Persada (2015) and Putra et al. (2021)
	Availability of public facilities	Thamrin et al. (2007)
Legal and institutions	Availability of spatial regulation	Thamrin et al. (2007), Persada (2015), and Supardi (2017)
	Availability of maps of disaster-prone areas	Supardi (2017)
	Availability of social institutions	Thamrin et al. (2007), Dwikorawati (2012), and Putera et al. (2013)
	The level of the role of social institutions	Putera et al. (2013)

2.2 Method of Collecting Data

This research used secondary and primary data. Secondary data were obtained from the Regional Development Planning, Research and Development Agency (Bappeda) of Bogor Regency, Central Bureau District (BPS), and Cijeruk Village Office. For more details regarding the secondary data used, see Table 2.

Table 2. Secondary Data

Data	Institution

- Bogor Regency Thematic Map
   1. Paddy fields were in 2022
   2. Carrying capacity of settlement area in 2022
   3. Availability of clean water
	Regional Development Planning, Research and Development Agency of Bogor Regency

Frequency of occurrence of natural disasters in 2021	Bogor Regency Regional Disaster Management Agency

- Village Potential Documents for 2021
   1. Source of clean water for MCK (*Mandi, Cuci, Kakus*)/ public bathing, washing, and latrine facilities
   2. Availability of latrine in every house
   3. Main commodity types
   4. Availability of supporting industries for main commodities
   5. Availability of social institutions
- Bogor Regency in Figures
   1. Local government's ability to manage waste
- Cijeruk District in Figures
   1. Availability of public transport
   2. Number of households subscribing to PLN
   3. Availability of public facilities (number)
	Central Bureau of Statistics

- Village Profile Document
   1. Average community educational level
   2. Number of the agricultural workforce
   3. Number of unemployment
   4. Availability of public facilities (number)
   5. Good road conditions
	Cijeruk Village Office

Primary data, on the other hand, were collected through interviews and Focus Group Discussions (FGDs). The interviews were conducted with resource persons related to the development of Cijeruk Village using purposive sampling methods as suggested by Hermawan & Amirullah (2016). FGDs were held with village apparatus, farmers, ranchers, entrepreneurs, and community institutions at the Cijeruk Village Office to discuss the village's potential and problems. Table 3 provides more information on the primary data, and Figure 1 depicts the administrative area of Cijeruk Village.

Table 3. Primary Data

| Data	Sources
- Availability of spatial regulation - Availability of maps of disaster-prone areas	Interview with government Staff
- Marketing range of the main commodity	Interview with farmers, ranchers, entrepreneurs, and government staff
- The level of the role of social institutions - Local wisdom level - Level of community participation	FGD with village apparatus and village communities consisting of farmers, ranchers, entrepreneurs, and community institutions
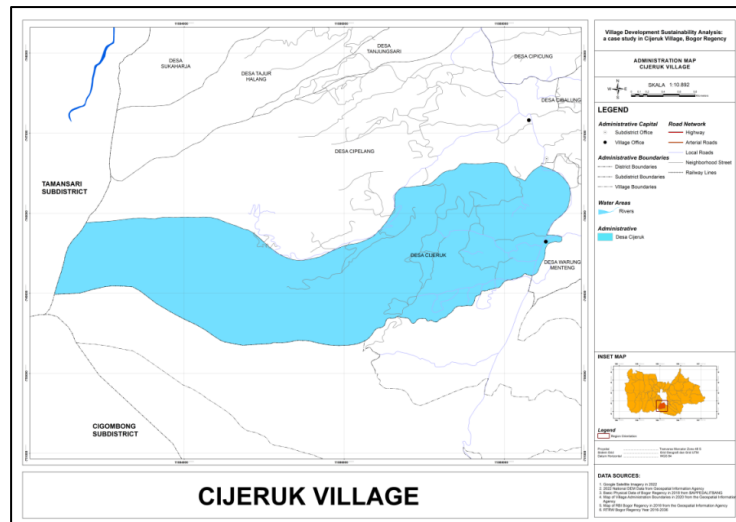
Figure 1. Cijeruk Village

2.3 Analysis Method

This research used a Multidimensional Scaling (MDS) analysis technique called the Rap-BUSAJI (Rapid Appraisal Pembangunan Desa Cijeruk) to determine the status of sustainable development of Cijeruk Village. The MDS analysis is a statistical technique that tries to carry out multidimensional transformations into lower dimensions (Mulyana et al., 2014). The MDS analysis aims to determine the sustainability status of each dimension so that it can be identified if there is an imbalance in the dimension (Pratama & Umar, 2020). The data consisted of sustainability aspects, including ecological, economic, socio-cultural, legal, and institutional dimensions. This multidimensional analysis was carried out by combining all the attributes to get the results of the sustainable development of Cijeruk Village. The data used for MDS calculation are primary and secondary, as shown in Table 1.

The stages of sustainability analysis of Cijeruk Village development involved several steps: 1) identifying the attributes to be assessed; 2) assigning scores or values to each attribute; 3) conducting multidimensional scale analysis with RAPFISH software for each dimension that will produce MDS values and voltage values and coefficients of determination; 4) conducting Monte Carlo analysis as a comparison of MDS values; and 5) leverage analysis to determine the sensitivity of variables that affect sustainability.

a. *Multidimensional Scaling (MDS)*

The MDS technique visualizes the position of the sustainability point through the horizontal and vertical axes with sustainability index values of 0% (bad) and 100% (good). If the system has a sustainability index value of 50%, it is said to be sustainable, whereas if it is <50%, it is categorized as unsustainable (Supardi et al., 2017). The ordination method (distance determination) in MDS was based on the Euclidean Distance, which can be written in n dimension using equation 1. The ordination of objects or the points in MDS was confirmed by regression of the Euclidean Distance from point *i* to *j* with the origin of equation 2 (Fauzi & Anna, 2002).

$$d = \sqrt{(|x_1 - x_1|^2 + |y_1 - y_2|^2 |y_1 - y_2|^2)} \tag{1}$$

$$d_{ij} = a + \beta \delta_{ij} + \varepsilon \tag{2}$$

Information:

d	= Distance		β	= slope
x, y	= Attribute		ε	= error
d_{ij}	= Euclidean Distance from *i* to *j*		δ_{ij}	= Origin/ Euclidean Distance
a	= intercept			

The sustainable status obtained was projected onto the horizontal line of the ordinate scale between the two extremes from bad (0) to good (100), as shown in Figure 2. The sustainability status of Cijeruk Village development in each dimension was stated with a sustainability index scale. The sustainability index scale lies between 0-100, as shown in Table 4.
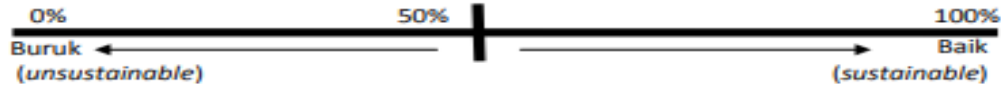

Figure 2. Sustainability Point Position

Source: Fauzi (2019)

Table 4. Sustainability Index Value

Index Value	Category
0,00—25,00	bad: unsustainable
25,01—50,00	less: less sustainable
50,01—75,00	quite: quite sustainable
75,01—100,00	good: very sustainable

Source: Thamrin et al. (2017)

b.   Stress Value and Determination Coefficient Value (R2)

The ALSCAL technique optimizes the squared distance of squared data (origin $=o_{ijk}$), that is, in three dimensions (i, j, k). The S-Stress value formula was calculated by equation 3. The low-stress value indicates good compatibility, whereas the high S value indicates the opposite (Supardi et al., 2017).

$$S = \sqrt{\frac{1}{m}\sum_{k-1}^{m} \left[\frac{\sum_i \sum_j (d^2_{ijk}-o^2_{ijk})^2}{\sum_i \sum_j o^4_{ijk}}\right]} \qquad (3)$$

$$d^2_{ijk} = \sum_{a=1}^{i} W_{ka}(x_{ia} - x_{ja})^2 \qquad (4)$$

c.   Leverage Analysis

Leverage analysis is sensitive to the value of sustainability and is used to identify sensitive attributes (Supardi, 2017). Attributes or leverage factors are attributes with sensitive values that influence the sustainability status. The higher the RMS value, the higher the attribute's influence on sustainability status sensitivity (Kavanagh & Pitcher, 2004). The RMS equation can be seen in equation 12.

$$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N} (X_{red} - X_{flip})^2} \qquad (12)$$

Information:
X_{red} = attribute reduction ordinate results ($V_{flip-remove}$)
X_{flip} = results of ordination without reduction of attributes (V_{flip})
N   = the number of objects analyzed

3.   Results and Discussions

3.1   The Sustainability Status of Cijeruk Village Development in the Ecological Dimension

Based on Table 1, seven attributes are influencing the sustainability of the development Village on the ecological dimension, namely the paddy fields area, the carrying capacity of the settlement area, the availability of clean water, clean water sources for Mandi, Cuci, Kakus/public bathing, washing, and latrine facilities, the availability of latrine in every house, the local government's ability to manage waste, and frequency of occurrence of natural disasters. Based on these attribute data and MDS analysis using Rap-BUSAJI, it was found that the sustainability index value of the ecological dimensions of Cijeruk Village development was 54.57% and was categorized as moderate/quite sustainable. The results of the leverage analysis produced three sensitive attributes that affected the sustainability index value of the ecological dimension: 1) clean water sources for communal public bathing, washing, and latrine facilities, 2) availability of clean water, and 3) availability of latrine in every house. Sustainability index values and sensitive attributes from the results of the ecological dimension analysis are shown in Figure 3.
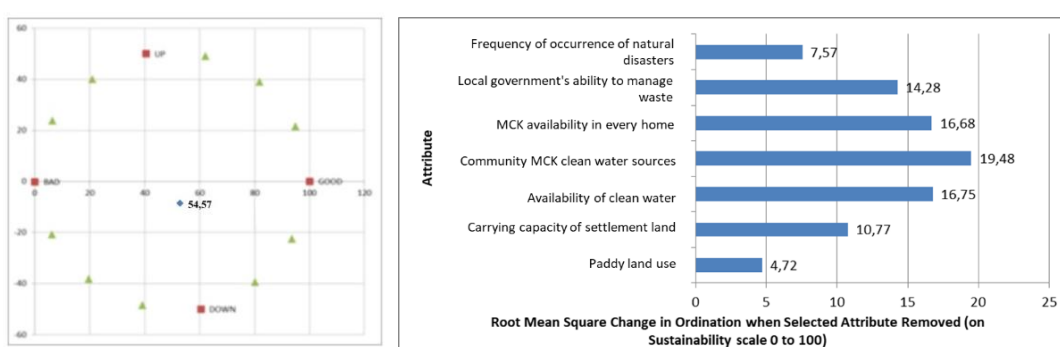

Figure 3. Sustainability Index Values and Ecological Dimension Sensitive Attributes, 2022

Source: Author's Analysis (2022)

Those three sensitive attributes in Cijeruk Village are of good quality, except for the clean water source. The villagers still use rivers/ponds as clean water sources for public bathing, washing, and latrine facilities (Badan Pusat Statistik [BPS], 2021a). On the other hand, Cijeruk Village has several springs that are being used by regional drinking water companies. It is located in RW 04 and RW 05 Cijeruk Village and causes harm to the community neighborhood (Setiawan, 2012). As for the other attributes, based on the previous analysis, the availability of clean water in Cijeruk Village in 2022 was 91%. Sanitation facilities in Cijeruk Village consist of public bathing, washing, latrine, and private latrine facilities. Currently, most of Cijeruk Village communities already have private latrines, but the village still provides public bathing, washing, and latrine facilities for the community to use (Badan Pusat Statistik Kabupaten Bogor, 2022).

3.2   The Sustainability Status of Cijeruk Village Development in the Economic Dimension

Seven attributes were influencing the development sustainability of the village on the economic dimension, the types of main commodities, the market availability, the marketing range of main commodities, the availability of supporting industries for main commodities, the road condition, the availability of public transportation, and the number of households subscribed to PLN. The attributes influencing the development sustainability of the Village on the economic dimension were obtained based on the results of analysis of literary studies as shown in Table 2. The results of the MDS analysis using Rap-BUSAJI indicates that the index value of the development sustainability of the economic dimension of Cijeruk Village was 74.35% and categorized as moderate/ quite sustainable. The results of the leverage analysis show that three sensitive attributes affected the value of the economic dimension of the sustainability index: 1) the marketing range of the main commodities, 2) the types of main commodities, and 3) the availability of supporting industries for main commodities. Sustainability index values and sensitive attributes from the results of the economic dimension analysis are shown in Figure 4.
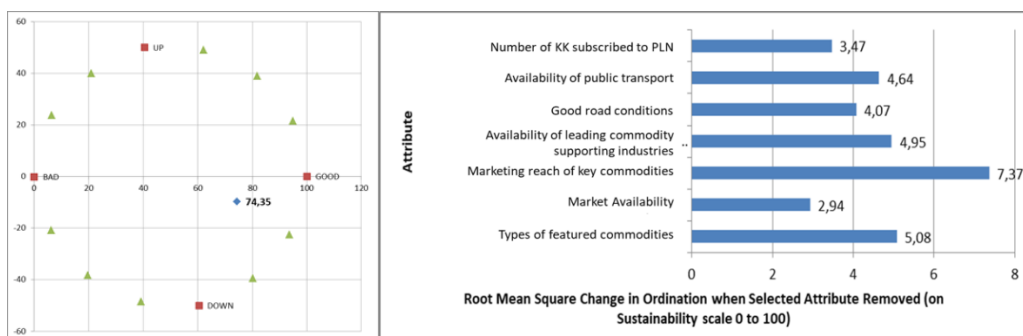
Figure 4. Sustainability Index Value and Sensitive Attributes of the Economic Dimension, 2022

Source: Author's Analysis (2022)

Those three sensitive attributes had a high RMS value. Based on the results of interviews and FGD, sheep farming, one of the main commodities in Cijeruk Village, had reached the national market, such as Bogor, Jakarta, Bandung, and Bekasi. In contrast, the rice commodity was only marketed within the Cijeruk District, while natural tourism attracted tourists from nearby areas around Cijeruk village. In addition, Cijeruk Village had three rice mill houses, four inns, and a slaughterhouse as supporting industries for main commodities (Badan Pusat Statistik, 2021a).

3.3　The Sustainability Status of Cijeruk Village Development in the Socio-cultural Dimension

Six attributes were influencing the development sustainability of the village on the socio-cultural dimension, the level of community participation, the average community education level, the number of agricultural workforces, the local wisdom level, the number of unemployed, and the availability of public facilities. The results of the MDS analysis using Rap-BUSAJI shows that the sustainability index value of the sociocultural dimensions of the Cijeruk Village development was 61,16% and categorized as moderate/quite sustainable. Based on the leverage analysis, it was found that three sensitive attributes were influencing the value of the socio-cultural dimension of the sustainability index: 1) the average community educational level, 2) the number of agricultural workforce, and 3) the number of unemployment. Sustainability index values and sensitive attributes resulting from the analysis of the sociocultural dimensions are shown in Figure 5.
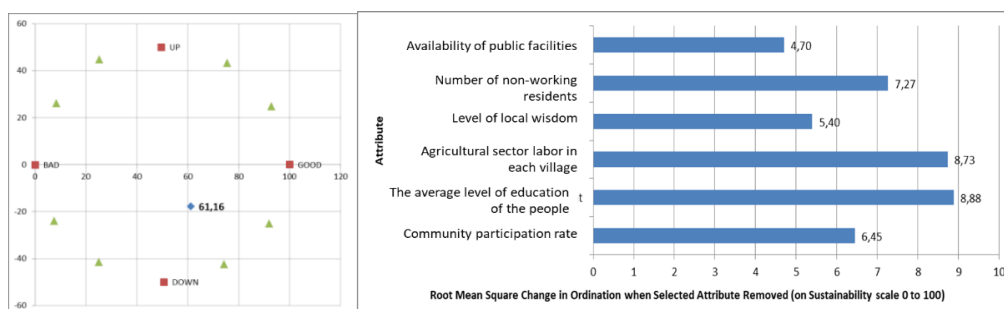

Figure 4. Sustainability Index Value and Sensitive Attributes of Socio-Cultural Dimensions, 2022

Source: Author's Analysis (2022)

Those three sensitive attributes had a high RMS value. In 2021, the average education level of the villagers was in elementary school and junior high school levels, while the educational facilities in Cijeruk Village were quite adequate. Based on Village Potential data in 2021, Cijeruk Village had adequate educational facilities, ranging from kindergarten to high school/vocational high school (Badan Pusat Statistik, 2021b). Some villagers in Cijeruk Village also studied at Islamic boarding schools, which created a strong religious environment. Furthermore, the agricultural workforce in Cijeruk Village was 54,4%,

meaning that more than half of working-age villagers were farmers (Badan Pusat Statistik, 2021b). This is aligned with Bogor Regency Spatial Plan (RTRW) in 2016–2036, which stated that Cijeruk Village is directed at developing agricultural areas such as plantations and dry land (Pemerintah Kabupaten Bogor, 2016). The number of unemployment in Cijeruk Village was 3,7% (Badan Pusat Statistik, 2021b), which is below the percentage of open unemployment in rural areas (4.17%) (Badan Pusat Statistik, 2023).

3.4 The Sustainability Status of Cijeruk Village Development in Legal and Institutional Dimensions

Six attributes were influencing the development sustainability of Cijeruk Village in the legal and institutional dimension, consisting of the availability of spatial regulation legal products, the availability of maps of disaster-prone areas, the social institutions' availability (Neighbourhood, Hamlet, and Youth Organizations), and the level of the role of social institutions. The results of the MDS analysis using Rap-BUSAJI found that the sustainability index value of the legal and institutional dimension of the Cijeruk Village development was 41,24% and categorized as less sustainable. Based on the leverage analysis, it shows that there was only one sensitive attribute that influenced the value of the legal and institutional dimension of the sustainability index, the availability of maps of disaster-prone areas. Sustainability index values and sensitive attributes resulting from the analysis of legal and institutional dimensions are shown in Figure 6.
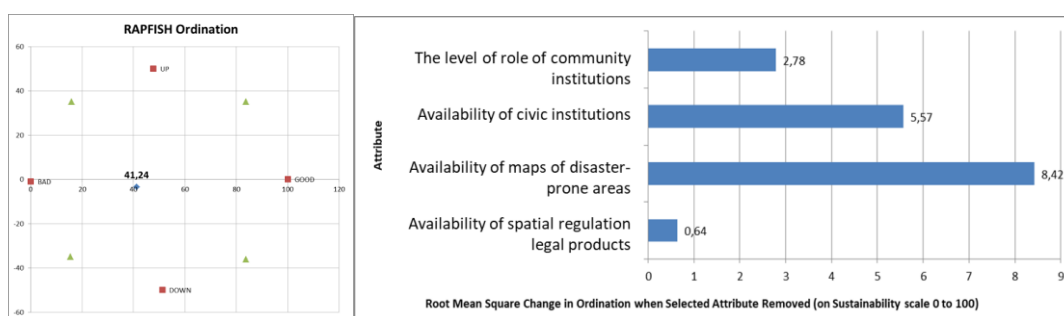

Figure 6. Sustainability Index Value and Legal and Institutional Dimension Sensitive Attributes, 2022

Source: Author's Analysis (2022)

The availability of disaster-prone maps had a high RMS value. Cijeruk Village did not have a map of disaster-prone areas. Based on data from Badan Perencanaan Pembangunan dan Penelitian Pengembangan Daerah Kabupaten Bogor (2020), Cijeruk Village had a moderately disaster-prone area of 19% and a high landslide-prone area of 81%. In 2021, there were seven events of landslides in Cijeruk Village (Badan Penanggulangan Bencana Daerah Kabupaten Bogor, 2022). Furthermore, the total built-up area in landslide-prone areas was 74,59 ha, whereas the largest built-up area was in high landslide-prone areas at 67,28 ha.

3.5 The Sustainability Status of Multidimensional Cijeruk Village Development

The MDS analysis using Rap-BUSAJI revealed that the multidimensional sustainability index value for the development of Cijeruk Village is 53.29%, indicating a reasonably sustainable status. Figure 7 shows the multidimensional sustainability index value for the Cijeruk Village development. The other four interrelated dimensions formed the multidimensional development sustainability status index. Figure 7 indicates that there was no integration between those four dimensions because there was no balance between them. The ecological, economic, and socio-cultural dimensions had fairly sustainable status, while the legal and institutional dimensions were less sustainable. Therefore, it is important to maintain the ecological, economic, and socio-cultural dimensions while improving the legal and institutional dimensions to ensure the long-term sustainability of Cijeruk Village development.
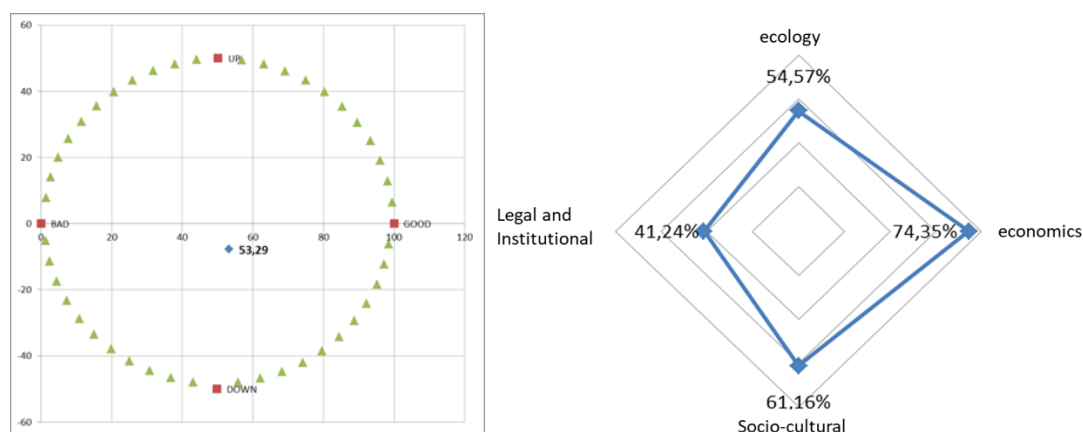
Figure 5. Multidimensional Sustainability Index Value and Sustainability Status Index Diagram, 2022

Source: Author's Analysis (2022)

Conclusions

This research aims to analyze the status of sustainable development in Cijeruk Village and identify the attributes that influence its development. The findings indicate that three dimensions, namely the economic (74.35%), ecological (54.57%), and socio-cultural (61.16%) dimensions, have a relatively sustainable status. However, the legal and institutional dimensions get less sustainable status with an index of 41,24%. Although the multidimensional analysis shows a relatively sustainable status at 53.29%, there is a lack of integration among the four dimensions. Therefore, it is necessary to enhance the legal and institutional dimensions while maintaining the sustainability of the other three dimensions for the sustainable development of Cijeruk Village.

There are ten sensitive attributes in the development of Cijeruk Village, consisting of 3 attributes on each of the economic, ecological, and socio-cultural dimensions and one attribute on the legal and institutional dimensions. The ecological dimension consists of clean water sources for communal MCK, clean water availability, and MCK availability in every house. The economic dimension consists of the marketing range of the main commodities, the types of main commodities, and the availability of supporting industries for main commodities. The socio-cultural dimension is sensitive to the average community education level, the number of agricultural workforces, and the number of unemployed individuals. Finally, the availability of maps indicating areas prone to disasters impacts the legal and institutional dimension.

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