Analysis of Sustainability Status, Land Availability, and Projected Land Needs for the Development of Residential Areas in South Cikarang District

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Keywords: industrial growth, availability of residential land, sustainable residential.	**ABSTRACT** National economic growth is greatly influenced by industrial growth. Industrial activities in South Cikarang sub-district generally have an impact on regional development and increasing community welfare, industrial development can also increase population. This increase occurred due to the need for labor in numbers that could not all be provided by the labor in industrial locations, resulting in population migration. The increase in population brings major changes to the increase in basic human needs, namely the need for land as a place to live which will continue to increase naturally, while land is limited and tends to experience environmental degradation. The existence of industry and the increase in population threaten the sustainability of residential areas. This research aims to identify the condition of existing settlements; sustainability status in ecological, economic, social, and institutional dimensions; and analyze the availability of residential land and the need for residential land in 2031. The analysis techniques used were spatial analysis, Multi-Dimensional Scaling (MDS) analysis, and descriptive analysis. The results of the research show that the research location has a fairly sustainable and sustainable status in developing residential areas. In 2031, several villages in the research area lack land for residential areas, so direction is needed regarding plans for sustainable residential area development.

Introduction

South Cikarang District is the sub-district with the largest number of industrial estates, including Jababeka Industrial Estate, Lippo Cikarang Industrial Estate, East Jakarta Industrial Park, and Bekasi International Industrial Estate with an area of 2,395 hectares (Ardhiansyah, 2011). In the region, there are also 1,200 business units engaged in the industrial and warehousing sectors and 59 independent housing areas (Ministry of

ATR, 2023). Based on Bekasi Regency Regional Regulation Number 12 of 2011 concerning the Spatial Plan of Bekasi Regency for 2011 – 2031, South Cikarang is part of Development Area 1 (WP 1) which is directed with the main functions of industrial development, trade, and services, housing and settlements, tourism and supporting industrial activities (Ardiansyah, 2010). The role of South Cikarang as a center of industrial activity requires an area to meet the housing needs of its people (Novitasari et al., 2022).

Land use in Bekasi Regency for settlements has increased significantly, namely an increase of 14,947 hectares during the 11 years, namely in the range of 2007 to 2019. Land use for residential areas in Bekasi Regency in 2021 is 22,936 hectares (Noer & Wibowo, 2024). Meanwhile, the area of residential areas stipulated in the Bekasi Regency RTRW covers an area of 13,918 hectares, so there is a development of residential areas of 9,018 hectares. (Herlawati & Handayanto, 2024). This indicates the occurrence of potential sustainability threats to residential areas. The development of residential areas that are not by spatial patterns and the increase in industrial activities in South Cikarang District pose a threat to the sustainability of residential areas, both in terms of ecological, economic, social, and institutional dimensions. (Surya et al., 2021). In the ecological dimension, it is shown by the decline in environmental quality due to population density and air quality decline, in the economic dimension it is shown by the limitations in public facilities and infrastructure, in the social dimension it is shown by the limitations in social services, health, and education. The institutional dimension is shown by the guarantee of legal certainty for landowners, conformity with spatial patterns, and the availability of RTRW (Amri et al., 2023). The objectives of this study are (1) to identify the condition of existing settlements, (2) to analyze the status of sustainability in the ecological, economic, social, and institutional dimensions and (3) to analyze the availability of land and the need for residential land in 2031.

Method

Regional Scope

The research was conducted in South Cikarang District, Bekasi Regency, and is astronomically located at -7° 39' 12.46" S and 107° 6' 38.54" E. The research area includes 7 villages, namely Ciantra Village, Cibatu Village, Pasirsari Village, Serang Village, Sukasejati Village, Sukadami Village and Sukaresmi Village.

Data Collection Methods

The data used in this study include (1) raster data, namely aerial photo map data for the 2023 recording year. (2) vector data, land use maps in 2023; road network map; spatial pattern map; land value zone map; and Land ownership map. Data collection methods in this study are in the form of secondary surveys and primary surveys. The analysis of the sustainability status in the research area uses a secondary survey through visits to agencies and primary surveys in the form of interviews with the community in the research area regarding community participation in the environment, drainage conditions, and social

conflicts that arise in the community. The analysis of land availability was carried out using a secondary data collection method.

Data Analysis Methods

The analysis methods used in this study include spatial, descriptive, and tabulation analysis to complete the objectives (1); Multi-Dimensional Scaling (MDS) analysis based on ecological, economic, social, and institutional dimensions to solve objectives (2); spatial analysis (GIS) and geometric projections to accomplish the objectives (3). The use of attributes and scores in objective (2) is sourced from journals and research conducted by Dewi (2011), Janthy (2013), and Yusuf (2019).

Results and Discussion

Identification of Existing Residential Area Conditions

The type of land use in the research area is dominated by the use for settlements, which covers an area of 1,494 ha, the second largest type of land use is industrial use, which covers an area of 1,079 ha (Figure 2).

Figure 2. Existing Land Use Map

The condition of existing residential areas in the research area is seen based on ecological, economic, social, and institutional dimensions. (Suryo, 2017). Based on ecological dimensions, including population density attributes, building density, availability of Green Open Space (RTH), built-up land area, clean water conditions, waste management, air quality, and drainage conditions. An overview of the settlement area in each village is presented in Table 1.

Table 1
Condition of Residential Areas in Each Village Based on Ecological Dimensions

Village Name	Ecological Dimension Conditions							
	Population density	Building Density (KDB)	RTH Availability	Built-up Land Area (ha)	Clean Water Conditions	Waste Management	Air Quality	Drainage Conditions
Ciantra	71 soul/ha	96%	>30%	335,63	Good	Good	Bad	Good

Village								
Cibatu	11 inhabitants/ha	64%	>30%	838,18	Good	Good	Bad	Good
Pasirsari	44 inhabitants/ha	88%	<30%	525,69	Good	Keep	Bad	Good
Attack	41 inhabitants/ha	89%	>30%	300,96	Good	Keep	Bad	Keep
Sukadami	75 inhabitants/ha	93%	>30%	384,19	Good	Good	Bad	Good
Sukaresmi	12 inhabitants/ha	77%	<30%	744,54	Good	Keep	Bad	Keep
Sukasejati	18 inhabitants/ha	96%	>30%	166,54	Good	Keep	Bad	Good

In the economic dimension, the condition of residential areas is seen from 7 attributes, namely: the availability of infrastructure networks; availability of public transport; access to local activity centers; access to regional activity centers, the number of underprivileged populations, the status of village development (IDM) and land prices. The condition of the residential area in each village based on the economic dimension is presented in Table 2.

Table 2
Condition of Residential Areas in Each Village Based on Economic Dimensions

Village Name	Village Economic Status (IDM)	Availability of infrastructure network	Public transport availability	Number of Pre-prosperous Population (KK)	Land Price (Rp)	Distance to Local activity center (km)	Distance to Regional activity center (km)
Ciantra	Self-sufficient	Good	Limited availability	115	7.077.195	5,5	15
Cibatu	Self-sufficient	good	available	42	11.493.580	9,5	11
Pasirsari	Self-sufficient	Good	available	386	6.474.888	10,2	10,2
Attack	Self-sufficient	keep	Limited availability	1000	6.236.744	3,6	8,3

Sukadami	Self-sufficient	Good	available	886	4.257.096	2,2	8,9
Sukaresmi	Self-sufficient	keep	available	542	7.497.258	3,9	12,9
Sukasejati	Forward	Good	Limited availability	300	2.548.863	5,9	14

In the social dimension, the condition of residential areas is seen from 6 attributes, namely: the level of social facility services; health service levels; level of educational services; population growth rate; social conflicts; and community participation in environmental management. (Anas et al., 2024). The condition of the residential area in each village based on the economic dimension is presented in Table 3.

Table 3
Condition of Residential Areas in Each Village Based on Social Dimensions

Village Name	Number of social facilities (units)		Number of Health Facilities (units)	Number of Educational Facilities (units)	Population Growth Rate (2021 - 2022) %/year	Social Conflict	Community participation in environmental management
	Places of Worship	TPU					
Ciantra	46	7	7	35	0,05	Little	keep
Cibatu	29	10	14	27	0,07	Little	keep
Pasirsari	47	8	2	27	0,03	Little	keep
Attack	43	9	8	20	0,04	none	keep
Sukadami	60	10	5	34	0,06	Little	keep
Sukaresmi	46	6	4	12	0,01	Little	keep
Sukasejati	15	1	2	10	0,05	Little	keep

The population in the research area has a high tolerance and is open to various ethnicities and religions, the guidance of religious leaders prevents the emergence of social conflicts. Based on the results of interviews with respondents, the results were obtained that social conflicts between communities rarely occurred. Community participation in environmental management in the research area is quite limited. The selection of organic and inorganic waste is rarely carried out, but some residents sort waste and manage it in the waste bank, in general residents in the research area are aware of the environment by planting vacant land to be used as a vegetable garden. (Buchori et al., 2017).

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In the institutional dimension, the condition of residential areas is seen from 4 attributes, namely: legal certainty over land (land ownership status); incompatibility of residential land use with spatial patterns; availability of RTRW; and availability of detailed plans. Guarantee of legal certainty regarding persons or legal entities who are holders of land rights, and guarantees of legal certainty regarding the location, boundaries, and area of a land plot are carried out through land registration. With land registration, land rights holders will receive proof of land rights in the form of certificates. The percentage of land plot area at the research site that has been certified is 74% of the area of the research site.

Sustainability Status of Residential Areas

The analysis of the sustainability status in this study is based on 4 dimensions, namely ecological, economic, social, and institutional dimensions, and involves 25 attributes. The unit of analysis in this analysis is based on the village administration area.

Ecological Dimension

Based on the ordinance value (MDS) for the ecological dimension, it shows that the sustainability status varies from less sustainable to sustainable. Based on Table 5, 2 villages are less sustainable, namely Sukaresmi Village and Pasirsari Village. The main ecological problems experienced by the 2 villages are poor air quality and the availability of RTH which is less than 30%, this is exacerbated by the existence of the Jababeka Phase 2 Industrial Estate in Pasirsari Village and the East Jakarta Industrial Park Area in Sukaresmi Village. Poor air quality and limited availability of RTH hurt population health and environmental ecosystem disruption. Not only that, Sukaresmi Village also has a high density of buildings in residential areas, which is 88% of the area of residential areas. High building density means more land to be sacrificed, leading to environmental degradation.

Table 5
Sustainability Status of Ecological Dimension

It	Village	MDS Values	Sustainability Status
1	Ciantra	78,5	Sustainable
2	Cibatu	82	Sustainable
3	Pasirsari	46,78	Less Sustainable
4	Attack	64,42	Quite sustainable
5	Sukadami	79,29	Sustainable
6	Sukaresmi	42,81	Less Sustainable
7	Sukasejati	72,69	Quite sustainable

Based on leverage analysis or leverage analysis, it shows that the attribute that has the highest RMS value is the air quality attribute. This means that air quality has a major impact on the overall condition of the residential areas in the study area. As such, governments and other stakeholders need to focus on policies and actions to reduce air pollution.

Economic Dimension

The ordinance value (MDS for the economic dimension) shows that the sustainability status only has two statuses, namely moderately sustainable and sustainable (Table 6). Sukadami Village and Serang Village are villages with sustainable status, meaning that these villages have high potential for the development of residential areas. Serang Village has better access to local and regional activity centers than other villages because Serang Village is the capital of South Cikarang District and the village has an independent village economic status (IDM), meaning that the village can carry out village development and provide a decent livelihood for its community.

Table 6
Sustainability Status of Economic Dimension

It	Village	MDS Values	Sustainability Status
1	Ciantra	66,8	Quite sustainable
2	Cibatu	71,32	Quite sustainable
3	Pasirsari	72,39	Quite sustainable
4	Attack	76,32	Sustainable
5	Sukadami	86,51	Sustainable
6	Sukaresmi	60,91	Quite sustainable
7	Sukasejati	48,66	Less Sustainable

Based on the leverage analysis, it shows that from the economic dimension, the attributes that have the highest RMS value are the number of underprivileged people and access to local activity centers. The high number of pre-prosperous residents shows that the population in these areas has not been able to meet the basic needs of decent living such as the needs of clothing, food, board, health, and education, so the government must give priority to increasing these basic needs.

Social Dimension

The ordinance value (MDS) for the social dimension shows that the sustainability status has three status criteria, namely less sustainable, moderately sustainable, and sustainable (Table 7). The number of villages that have a less sustainable status is due to the lack of health and education facilities in the village, for example, Sukadami Village with the largest population in the region 47,031 people and has a higher population growth rate than others villages that only have one health center and 4 clinics, so that the health infrastructure is insufficient for the needs of its residents.

Table 7
Sustainability Status of Social Dimensions

It	Village	MDS Values	Sustainability Status
1	Ciantra	37,92	Less Sustainable
2	Cibatu	66,47	Quite sustainable
3	Pasirsari	49,8	Less Sustainable
4	Attack	79,46	Sustainable

5	Sukadami	36,26	Less Sustainable
6	Sukaresmi	56,35	Quite sustainable
7	Sukasejati	55,09	Quite sustainable

Based on the leverage analysis, it shows that from the social dimension, the attribute that has the highest RMS value in South Cikarang District is the attribute of the population growth rate. This means that the population growth rate is the most influential factor in the sustainability of residential areas in South Cikarang District. Thus, the government and stakeholders need to manage and control population growth effectively to maintain the sustainability of residential areas.

Institutional Dimension

The ordinance value (MDS) of South Cikarang District for the institutional dimension shows that the sustainability status has two status criteria, namely moderately sustainable and sustainable (Table 8). Pasirsari Village has the lowest ordinance value due to the high mismatch of residential locations with the spatial pattern of RTRW Bekasi Regency in 2011-2031. This discrepancy can result in various problems that affect the environmental, social, and economic dimensions of settlement sustainability. The average village in the research area has a sustainable status due to the spatial suitability between residential land use areas and spatial patterns, in addition that almost all land plots have certificates (> 75%) so this reduces legal uncertainty related to land ownership, thus allowing the government and developers to plan and manage residential areas by the provisions set out in the Bekasi Regency RTRW.

Table 8
Sustainability Status of Institutional Dimension

It	Village	MDS Values	Sustainability Status
1	Ciantra	76,09	Sustainable
2	Cibatu	72,46	Quite sustainable
3	Pasirsari	51,97	Quite Sustainable
4	Attack	76,09	Sustainable
5	Sukadami	76,09	Sustainable
6	Sukaresmi	71,55	Quite sustainable
7	Sukasejati	85,41	Sustainable

In a multidimensional way, the sustainability status of the research area is sustainable and quite sustainable. One village that is the object of the study has a sustainable status and six villages have a fairly sustainable status, the results of the sustainability status analysis are presented in Table 9. The kite diagram in Figure 3 shows a comparison of sustainability index values between ecological, economic, social, and institutional dimensions.

Table 9
Multidimensional Sustainability Status

| It	Village	MDS Values By Dimension				Multidimensional	Sustainability Status
		Ecology	Economics	Social	Institutional		
1	Ciantra	78,5	66,8	37,92	76,09	59,66	Quite sustainable
2	Cibatu	82	71,32	66,47	72,46	67,7	Quite sustainable
3	Pasirsari	46,78	72,39	49,8	51,97	59,14	Quite sustainable
4	Attack	64,42	76,32	79,46	76,09	75,76	Sustainable
5	Sukadami	79,29	86,51	36,26	76,09	70,26	Quite sustainable
6	Sukaresmi	42,81	60,91	56,35	71,55	54,94	Quite sustainable
7	Sukasejati	72,69	48,66	55,09	85,41	63,21	Quite sustainable
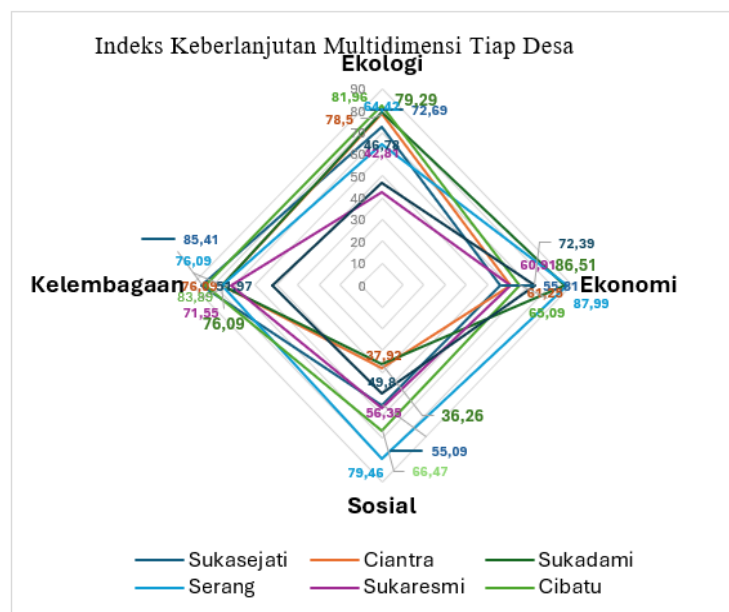
Figure 3. Multidimensional Durability Index Chart

In a multidimensional way, all villages in the research area are sustainable for the development of new residential areas, but several villages have limiting factors such as Sukaresmi Village and Pasirsari Village which have a less sustainable status in the ecological dimension so they need solutions to improve ecological sustainability such as the application of green industry in industrial areas that can reduce air pollution in the research area. Sukasejati Village has a less sustainable status in the economic dimension due to limitations in transportation facilities that reach the village area, where transportation is available but without routes.

The analysis of sustainability status in South Cikarang District using Rapfish is considered accurate which is indicated by the Stress value which is smaller than 0.25, namely 0.13 to 0.17 and the determination coefficient (R2) is close to 1, namely 0.91 to 0.95 (Kavanagh and Pitcher, 2004). This shows that the results of the MDS analysis are accurate in assessing the conditions of sustainable residential development in South Cikarang District. (Figure 3).

Analysis of Land Availability and Projected Land Needs for Settlements

Land availability is obtained from land use by looking at land that can be converted into residential land, land use that can be converted into residential land is non-developed land such as moors, vacant land, and plantations. The analysis of land availability was carried out to be able to see how much land can be used for settlement development. Based on the land availability indicators in this study, the area of land that can be used for the development of new residential areas is carried out by considering spatial pattern indicators, land use, and LSD. Based on the allocation of the residential space pattern at the research site, it can be known that the land area intended for the settlement function is 2,580 ha. Based on the use of land, non-developed land that can be used as land for the development of residential areas is the use of land with the type of use of open land, gardens, and fields, which covers an area of 1,497 ha. Based on the 2021 LSD Map issued by the Minister of Agrarian and Spatial Planning, there is an LSD area outside the forest area of 99.5 ha in South Cikarang District.

Based on the superimpose between the map for settlements, the map of non-built land available, and the LSD map in the study area obtained a land availability area of 744 ha (Table 10 and Figure 4). The village with the largest available land area is Cibatu Village while the village with the smallest available land area is Pasirsari Village. The use of land in the village is dominated by industrial use and 70% of the area has been built so that the village does not have a large land for the development of residential areas.

Table 10
Available Land Area

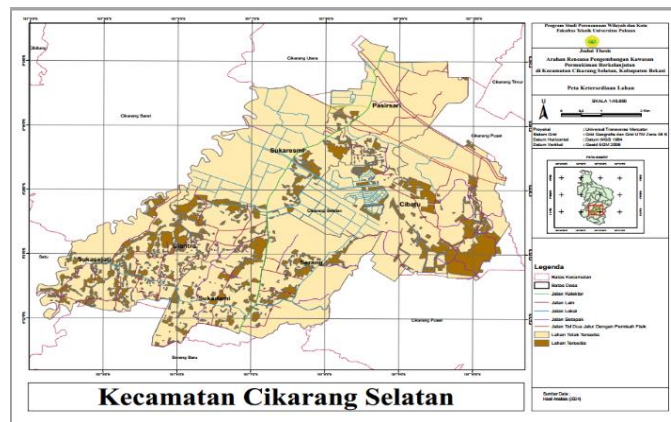| It	Village Name	Available Land Area (ha)
1	Ciantra	136
2	Cibatu	259
3	Pasirsari	26
4	Attack	55
5	Sukadami	101
6	Sukaresmi	69
7	Sukasejati	98
	Sum	744

Figure 4 Land Availability Map

The projection of residential land needs is carried out by calculating the projected population and calculating the amount of land needed to build house plots and land for residential facilities and infrastructure until 2031. The year 2031 is the final year of the validity period of the Bekasi Regency RTRW. Based on the results of the calculation using a geometric formula, the projected population in 2031 is 288,798 people, or an increase of 120,855 people. If it is assumed that every 1 family consists of 4 family members, the projected number of families in 2031 is 72,200 families or an increase of 7,553 families. The total land area requirement for residential areas in 2031 is obtained from the assumption of proportions based on housing development patterns in Indonesia with a balanced residential housing ratio of 1:2:3. Referring to SNI 03-1733-2004, the minimum area of residential plots in urban areas is 72 m² for the medium type, 144 m² for the medium type and 288 m² for the luxury type. In addition to the need for plots, there is also a need for facilities and infrastructure activities that support the environment, which is 30% of the residential land area. The total land requirement for residential areas in 2031 is 526.6 ha (Table 11).

Table 11
Land Needs in 2031

It	Village	Population Additional Projections	Additional Projection of the Number of Families	Simple type (m2)	Medium Type (m2)	Luxury Type (m2)	Total (m2)	Facilities and Infrastructure Needs	Total Land Needs
1	Ciantra	21.993	5.499	197.964	263.952	263.952	725.868	311.086	1.036.954

2	Cibatu	22.502	5.626	202.536	270.048	270.048	742.632	318.271	1.060.903
3	Pasirsari	2.477	620	22.320	29.760	29.760	81.840	35.074	116.914
4	Attack	25.619	6.405	230.580	307.440	307.440	845.460	362.340	1.207.800
5	Sukadami	30.629	7.658	275.688	367.584	367.584	1.010.856	433.224	1.444.080
6	Sukaresmi	8.479	2.120	76.320	101.760	101.760	279.840	119.931	399.771
7	Sukasejati	9.153	2.289	82.404	109.872	109.872	302.148	129.492	431.640
	Sum	120.851	30.217	1.087.812	1.450.416	1.450.416	3.988.644	1.579.927	5.266.423

Based on the availability of land with land needs for residential area development, it is predicted that in 2031, the research area will lack land for residential area development as much as 395 ha (Table 12).

Table 12
Comparison of land availability and needs in 2031

It	Village Name	Available Land Area (ha)	Land Requirement Area (ha)	Difference (ha)
1	Ciantra	136	207,39	-71,78
2	Cibatu	259	212,18	47,26
3	Pasirsari	26	23,38	2,49
4	Attack	55	241,56	-186,48
5	Sukadami	101	288,82	-187,37
6	Sukaresmi	69	79,95	-11,29
7	Sukasejati	98	86,33	11,86
	Sum	**744,30**	**1139,61**	**-395,31**

Conclusion

1. By comparing the function of existing land use and spatial patterns, it can be seen that in the research location, there is an inconsistency/inconsistency between the type of existing residential land use and the spatial pattern, which is 328.91 ha. The highest discrepancy is in the industrial designation function, which is 318.3, which can be an indication of the development of residential areas in industrial designation locations.

2. The availability of land for the development of residential areas is quite low, which is only 14% of the total area of the research area, this happens because most of the areas have been built;
3. Based on the results of the sustainability status analysis, the research area can be used as a residential area development area because it has sufficient sustainability and sustainability status.
4. Based on the projected land needs in 2031, four villages in the South Cikarang District area are experiencing a shortage of land for settlements

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