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A School Mapping Research: The Areas for Junior High School Establishment in *Cianjur* based on Geographic Information System (GIS)

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Abstract

This research recommends areas for establishing junior high schools in Cugenang, Pacet, and Cipanas (3 districts in Cianjur, Indonesia). It uses a descriptive quantitative. The spatial classification and analysis method with the Union feature Geographic Information System (GIS) overlay technique is applied – considering seven parameters: roads, slope, land use, population, fault, landslide danger, and earthquake danger. All of them are used as indicators to determine the suitability of the area. As a result, a map showing areas with five categories is created. Furthermore, in areas with very suitable categories, the researchers provide further testing with Satellite Imagery reviews to validate the coordinates of priority options. The researchers determined forty-nine priority option coordinates in nineteen villages and adapted these into a number script for user convenience. Supporting educational equality as one of the national priorities for 2030, the researchers are proposing these results.

Keywords

Educational equality policy, planning, geographic information system, school mapping.

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Introduction

The 9-year compulsory education policy was established by the government of the Republic of Indonesia (RI) in 2008 through Government Regulation Number 47 concerning 9-year compulsory education (Sari & Khoiri, 2023). Regional governments in several large cities in Indonesia have developed this target of 12 years (Syaeh et al., 2023). However, the average length of school for the Cianjur community until 2022 is 7.20. It means that on average, the people of Cianjur drop out of school in class 8 at Junior High School (SLTP)when the mid-term assessment approaches in the first semester. Making them a community entity that is 1.80 years behind the achievement target of 9 years of compulsory education, or 4.80 years adrift when compared to the achievement target of 12 years that has been set by several big cities. This data also makes the Cianjur community ranked second lowest in the Average Years of Schooling (RLS) list in regencies and cities, in West Java Province, as in Table 1 below.

Table 1. *Average years of schooling (RLS) for the Cianjur community 2018-2019*

Year	2018	2019	2020	2021	2022
RLS	6.93	6.97	7.18	7.19	7.20

Source:

For the direction of national policy in the education sector, the government through the decree of the Minister of National Development Planning Number KEP. 136/M.PPN/HK/12/2021 has set 10 global targets. One is the national priority to increase access to primary and secondary education. This national priority should be followed up by regional government policies that are in harmony (Patandung & Panggua, 2022), for example, carrying out school mapping (Akudo et al., 2021) to regulate where school establishment areas are connected to the number of school-age children, settlements, and social conditions in society (Basri et al., 2021). This action will be useful for preventing school crowds in certain areas (Mukhlis & Harudu,2019).

To analyze this issue further, the researchers conducted pre-research through virtual interviews (Santarone, 2019) with the Head of the Cianjur Regency Education Office for 2022-2023. This position is the authority to issue operational permits (Op) for the founders of public and private elementary schools (SD) and junior high schools (SLTP). The researchers received information that there are no operational permit issuance area guidelines yet. So far, the Cianjur Education Service has tended to only pay attention to fulfilling the document requirements of parties requesting Op permits. Without considering where a new school will operate, this mechanism creates opportunities for random schools, including inappropriate areas (Djuraini et al., 2023).

Up to this point, two problems that the researchers have identified are first, a large gap between the average length of schooling for the Cianjur community and the achievement targets for compulsory education set by the government since 2008. Second, there is a contradiction between the national priority policy in increasing educational equality and the mechanism for issuing Op permits for new schools at the Cianjur Education Office.

These two crucial problems seem to have increased to three - especially for the people of Cugenang District. An earthquake with a magnitude of 5.6 on 21st November 2022 and claimed 602 lives occurred there (Khaerudin, 2023). This earthquake caused massive damage,

including 313 elementary schools and 97 junior high schools or equivalent which were also affected. This earthquake caused the government to roll out a Relocation policy. Apart from the call for people to move where they live, the government is also encouraging the relocation of educational units. Besides the relocation policy, the results of geological research carried out after the earthquake revealed several findings. These studies found a "new" active fault called the Cugenang fault was the cause of the quake. However, the relocation policy and research results attached to the geographical profile of Cugenang District have not succeeded in encouraging the relocation of all local communities. Several people affected by this earthquake preferred reconstruction to relocation (Yusri et al., 2023). Those who remain there still need educational services that they can access. This condition encourages research into school mapping models (C. Ibara, 2019).

Based on the problems above, this research aims to design recommendations for suitable areas for the Junior High Schools (SLTP)in Cugenang District, Pacet District, and Cipanas District with Geographic Information System (GIS). Therefore, researchers have formulated the following research questions (RQ).

- How do you create a map that can show areas with five categories?
- In areas with very suitable categories, where are the coordinates of priority options?

Literature Review

The use of GIS in school mapping is becoming a research trend that can support school mapping with a high level of accuracy (Kavathekar et al., 2019; Murad et al., 2020). GIS with spatial data is beneficial in infrastructure planning, resource management, crisis handling, and decision-making for optimal solutions (Alhaj & Abdalla, 2022). It is hoped that the research results can provide an alternative. Both for local communities and private entities who are planning to establish schools, supporting the national priority agenda, and for the Cianjur Regency Education Office to use as a reference in directing areas for school establishment and activities in these three sub-districts.

Additionally, the researchers determined seven aspects to design recommendations for feasible areas for establishing secondary schools in the three sub-districts, such as roads (Meena et al., 2023), slope (Xia et al., 2023), land use (Mohan et al., 2021), population (Moos et al., 2021), fault, landslide danger (Arrisaldi et al., 2023), and earthquake danger (Sitharam & James, 2018). All of them are used as indicator parameters to determine the area suitability strictly. The selection of these seven aspects cannot be separated from consideration of the geographical and sociological elements in the three sub-districts.

The road aspect is chosen because it indicates accessibility (Lee & Kim, 2021). The slope aspect is chosen because it is beneficial in analyzing the topography of the three sub-districts, which resemble a valley. This aspect can also indicate potential landslides (Sepúlveda, 2022). The population aspect is chosen because the ideal school coordinates must be near residential areas to support student absorption (Westford, 2018). The fault aspect is to follow up on the findings of the Cugenang fault because school establishments need to consider the safe distance from the fault (Chen et al., 2017) to avoid the potential for damage if one day the Cugenang fault moves again. Meanwhile, the earthquake hazard aspect was specifically chosen due to historical earthquakes that occurred previously (Rapaport & Ashkenazi, 2019). Therefore, the school establishment area that the researchers recommend is more likely to provide risk mitigation measures if one day an earthquake occurs again.

Methodology

Research design, site, and participant

Descriptive quantitative (Kurniawan & Gunawan, 2023), classification methods, and spatial data analysis (Kavathekar et al., 2019), are used in this research. The overlay technique (Alkhuzaie & Janna, 2018) of the Geographic Information System (GIS) union feature is used with ArcGIS Pro as a support application tool (Qiang, 2017). Data sources include various georeferenced data (Thorn, 2022) according to aspects of the feasibility indicator parameters for the specified school establishment area. The analysis focused on three sub-districts, namely Cugenang, Pacet, and Cipanas– as a research site. Cugenang Subdistrict was chosen since there is still a need to establish schools as an alternative for local communities who need schools at close range. Meanwhile, Pacet Subdistrict and Cipanas Subdistrict are chosen as two Subdistricts adjacent to Cugenang, with the assumption that these two districts could be alternatives - if the establishment of a school in Cugenang Subdistrict is still considered to be at high risk. The recommended areas that the researchers have designed are prioritized for the junior high school establishment, considering the urgency of the need for acceleration from RLS 7.20 years to reach RLS 9.00 years in Cianjur Regency.

Data collection and analysis

Shapefile data models and raster data are the basic data that the researchers process in this research. For shapefile parameters for road aspects, land use, and regional boundaries, use the Geospatial Information Agency (BIG) geoportal. From the same portal, the researchers mined raster data, namely the National Image Digital Elevation Model (Demnas), as basic data to identify slope. The researchers internalized data on earthquake susceptibility and landslide susceptibility from the National Disaster Management Agency (BNPB) geoportal in raster files. Next, the researchers obtained data on the Cugenang Fault from the Meteorology, Climatology, and Geophysics Agency (BMKG). Meanwhile, the researchers obtained population data from the Statistics Agency (BPS) publication of Cianjur Regency in 2023, as in Figure 1 until Figure 7 below.

Figure 1. *Roads*

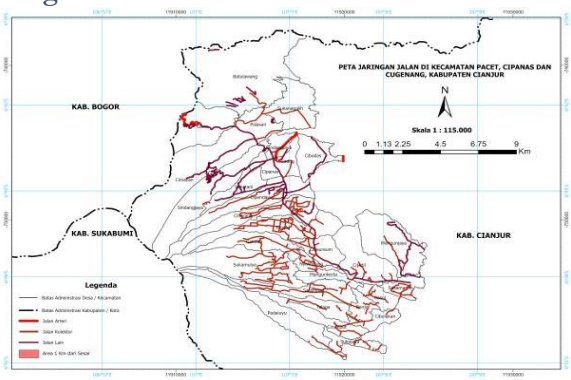


Figure 2. *Slope*

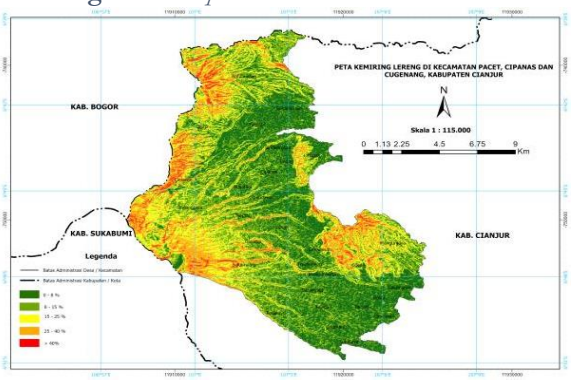


Figure 3. *Land Use*

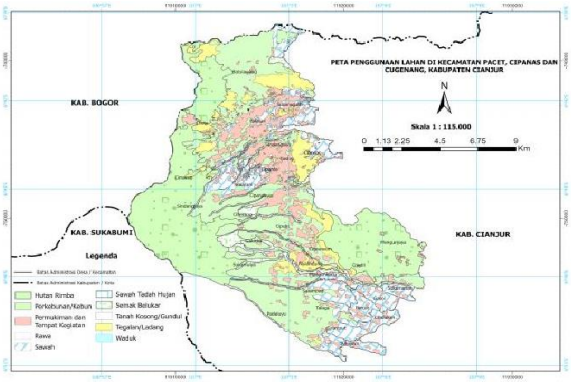


Figure 4. *Population*

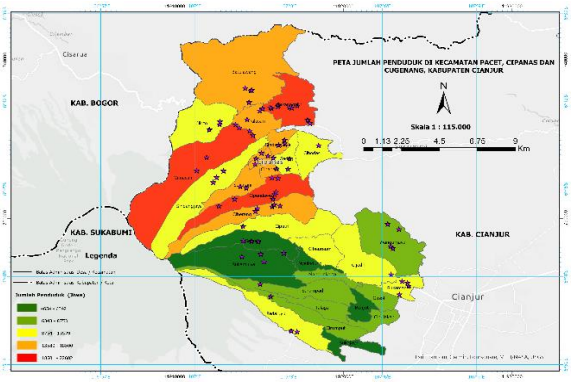


Figure 5. *Fault*

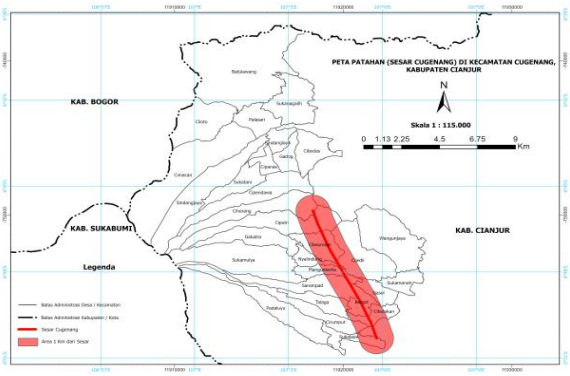


Figure 6. *Landslide Danger*

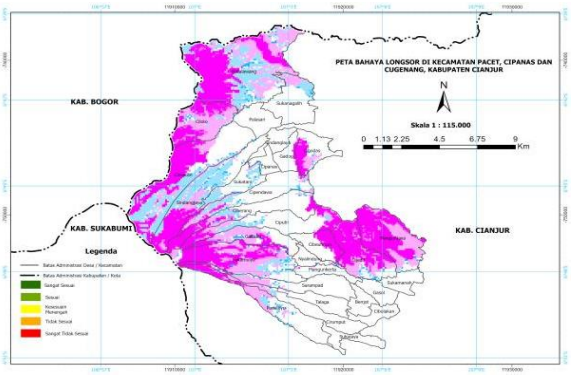
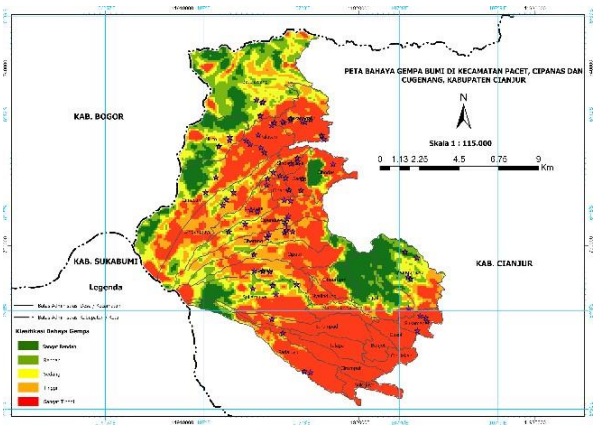


Figure 7. *Earthquake danger*



After compiling the data, the researchers used ArcGIS Pro version 3.0 software for the data processing. For road data, it used a multiring buffer, creating distance coverage of the road. This treatment was to classify accessibility values. Scoring is set so that the closer a definite area is to the road, the greater the weighting. The distance categories between areas and roads that the researchers determined are fifty meters, one hundred meters, 150 meters, three hundred meters, and five hundred meters. Regarding land use data, the researchers

conducted weighting to select which categories of land are suitable for use for establishing schools, as shown in Table 2.

Table 2. *Land use scoring*

Land category	Land use score
Jungle	1
Plantation or garden	3
Public residential and public activity places	4
Ricefield	2
Shrubs	5
Vacant land	5
Moors and fields	3

Source: Haq and Susilo (2023)

Afterward, the researchers converted the data on earthquake susceptibility and landslide susceptibility, which were previously in a raster file to vector form, so you can fill in the table attributes and weigh them. Areas that are highly susceptible to earthquakes and landslides are given low weight. Meanwhile, areas with a low level of vulnerability are given greater weight. Because schools need to be in areas with a low level of earthquake vulnerability and landslide vulnerability (Arrisaldi et al., 2023; Sitharam & James, 2018).

The researchers again performed a multiring buffer on the Cugenang fault data. The buffer distances the researchers set are differentiated into 1 Kilo meter, 2 Kilo meters, and >3 Kilo meters from the Cugenang fault. This distance determination refers to the Cianjur earthquake hazard map with the Cugenang fault source, a news item published by BMKG on 8th January 2023. Our primary consideration is that it is very dangerous if schools are built within the reach of the Cugenang fault. Therefore, the weighting of the area for this parameter is that the further away from the Cugenang fault, the higher the score is given. For slope data containing elevation information from the earth's surface, the researchers carry out slope categorization from the categories flat, sloping, steep, somewhat steep, and very steep. The researcher's sighting is determined with the condition that the steeper it is, the smaller the score because the construction of school facilities is more effective in flat areas.

Meanwhile, for population parameters, the researchers analyzed the data to identify population associations. In areas where the population is known to be high, the school's existence is increasingly needed. At the same time, student absorption can have more potential. For this reason, areas with a high population are given a large value. Many school mapping model studies also include rivers as an indicator of area suitability parameters because it is beneficial for effectively preventing schools from potential flooding (Yousefi et al., 2020).

However, river parameters were deliberately not used in this research because the three sub-districts that the researchers studied are in the upstream areas category with minimal potential for flooding. After the seven feasibility parameters have been processed and weighed, the next step is to unite all these parameters using the overlay technique with the union feature. At this overlay stage, the researchers determine the presentation weight for each location feasibility indicator parameter, as in Table 3.

Table 3. *Presentation weight of location feasibility indicator parameters*

Parameter	Presentation Weight
Earthquake vulnerability	20%
Landslide vulnerability	20%
Distance from Cugenang Fault	20%
Land use	5%
Total population	10%
Slope	20%
Distance from the road	5%

Findings and Discussion

RQ1: How to create a map that can show areas with 5 categories?

By the research objectives, the researchers set 2 targets as the output of this research, namely map illustrations and recommendations for priority options, which the researchers presented in the form of coordinated choices. In the map illustration output, to make it easier for readers, the researchers have provided colour markings to differentiate each area category in the context of junior high school establishment. Among other things, dark green indicates a suitable area, light green indicates a suitable area, and yellow indicates a medium-level suitability category. The orange colour indicates areas that are not suitable, and the colour red indicates very unsuitable areas., as in the following Table 4.

Table 4. *Color markings and suitability categorization of junior high school establishment areas*

Color markings	Markings categorization of the suitability of secondary school establishment areas
	Very Suitable
	Suitable
	Medium Suitability
	Not Suitable
	Very Unsuitable

Meanwhile, to output recommendations for priority options, the researcher displays them in a table that presents village aspects in certain sub-districts, hectares in area (Ha), and the coordinates of the priority options. This coordinate aspect is the specific location that the researchers most recommend for establishing a junior high school in addition to recommendations for other areas. Specifically, for these coordinates, additional treatment has been conducted, namely satellite image testing- in addition to having passed the previous selection of seven feasibility parameter indicators, as in Figure 8 below.

Figure 8. *Map of recommendations for the establishment of junior high schools*

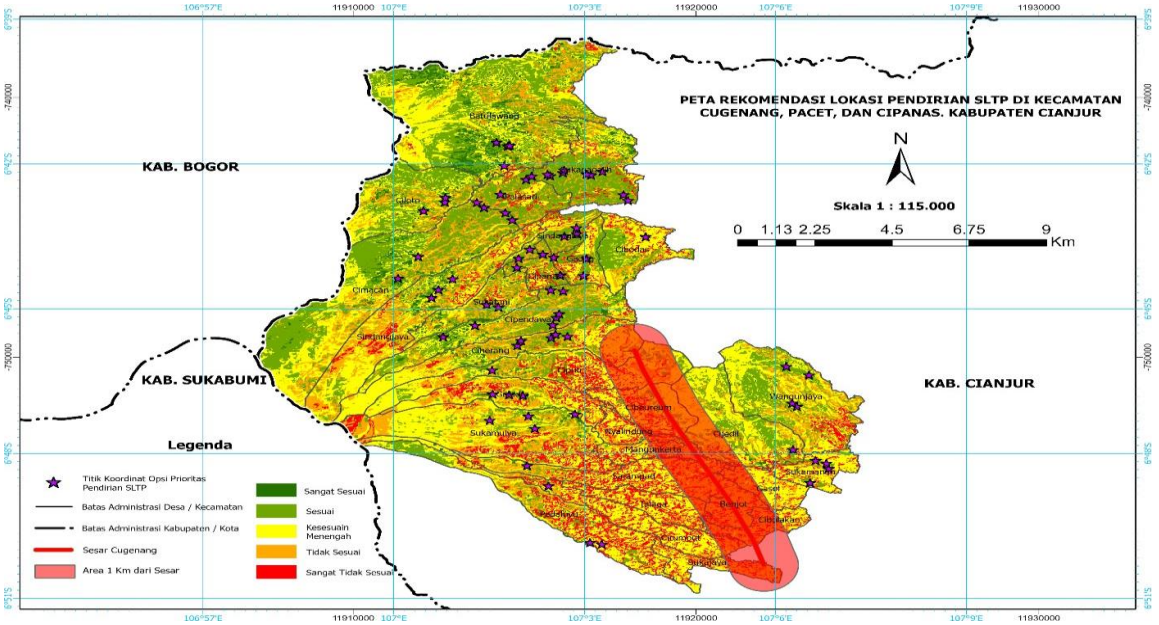


Figure 8 is the first output that the researchers produced with the research stages mentioned previously. In the map visualization, the diversity of color markers indicates the differences between categories that the researchers found based on the selection using 7 feasibility indicator parameters—dark green areas indicate highly suitable areas. Light green areas indicate appropriate areas. The area in yellow indicates the middle-level suitability category.

Orange areas indicate non-conforming areas. Furthermore, the red area means an area that is not very suitable for establishing a junior high school. The elongated red line that dominates the other parts is the Cugenang Fault. The map layout scale that the researchers use is 1: 115.000 Kilometres. Meanwhile, the violet star icons scattered randomly in Figure 8 are the coordinates that the researchers propose as recommended priority options.

RQ2: In areas with very suitable categories, where are the coordinates of priority options?

These coordinates are specifically made only in areas that are very suitable and have undergone further testing using satellite imagery. It is the explanation for certain dark green areas. This area is very appropriate if measured using only 7 feasibility parameters. However, satellite inspection shows that some of them are areas with strict permits, such as protected forests, national parks, and tourism areas. Establishing a school in an area like that may be possible but requires a more complex approval process and takes time. Therefore, the researchers did not choose it as a recommended priority option. To make it easier for parties planning to build a school, the researchers adapted the visually visible coordinates of the priority options into coordinates in a numbered script. On commonly used related platforms such as Google Maps, coordinates in a numbered script can be input directly to automate the

location discovery that the researchers propose. Pay attention to Table 5, Table 6, and Table 7 as the second output the researchers produced in this research.

Table 5. *Coordinates of priority options for establishing a junior high school in Cugenang subdistrict*

Village	Area assessment category	The size of the land area (Ha)	Priority option coordinates	
			Coordinate x	Coordinate y
Cirumput	Very Suitable	2.039181	107.040529	-6.811244
Galudra	Very Suitable	6.760833	107.030215	-6.779749
	Very Suitable		107.025901	-6.779513
Padaluyu	Very Suitable	7.832937	107.054502	-6.831336
	Very Suitable		107.051436	-6.830813
Sarampad	Very Suitable	3.761787	107.034928	-6.804248
Sukamanah	Very Suitable	0.365234	107.113926	-6.805252
Sukamulya	Very Suitable	17.391377	107.036965	-6.791402
	Very Suitable		107.025134	-6.78858
	Very Suitable		107.035255	-6.787126
	Very Suitable		107.047494	-6.786462
Wangunjaya	Very Suitable	16.621147	107.105613	-6.783798
	Very Suitable		107.104397	-6.782683
	Very Suitable		107.108793	-6.772951
	Very Suitable		107.102847	-6.769991

The Cugenang Subdistrict consists of 16 villages. The 15-priority option coordinates the researchers produced are spread across seven villages. These locations could be the first alternative for establishing a junior high school in Cugenang Subdistrict, considering many people affected by the earthquake who still live and need a school closest to where they live. The second alternative for them is a school that operates in the subdistrict directly adjacent to the Cugenang Subdistrict, namely the Pacet Subdistrict.

Table 6. *Coordinates priority options for establishing junior high schools in Pacet Subdistrict*

Village	Area assessment category	The size of the land area (Ha)	Priority option coordinates	
			Coordinate x	Coordinate y
Cibodas	Very Suitable	8.787729	107.065999	-6.725203
Ciherang	Very Suitable	16.566244	107.03237	-6.76274
	Very Suitable		107.033333	-6.761031
	Very Suitable		107.041261	-6.760083
	Very Suitable		107.045529	-6.759615
	Very Suitable		107.042386	-6.75892
Cipendawa	Very Suitable	43.436988	107.012924	-6.759735
	Very Suitable		107.021283	-6.755821
	Very Suitable		107.041637	-6.755652
	Very Suitable		107.042579	-6.75315

	Very Suitable		107.043341	-6.751807
	Very Suitable		107.044383	-6.743958
Ciputri	Very Suitable	12.152813	107.025751	-6.771287
Gadog	Very Suitable	1.537654	107.041893	-6.732314
	Very Suitable	33.385951	107.027434	-6.74949
	Very Suitable		107.024339	-6.748633
Sukatani	Very Suitable	33.385951	107.024339	-6.748633

In the Pacet Subdistrict, which is divided into seven villages, the researchers found seventeen coordinates spread across Cibodas, Ciherang, Cipendawa, Ciputri, Gadog and Sukatani. The Pacet Subdistrict is an exclave area characterized by territorial discontinuity. Sukanagalih Village is part of Pacet District, which is geographically separated and located farthest from the Cugenang Subdistrict. However, the seventeen coordinates the researchers found in six villages in the primary area of Pacet Subdistrict. It makes the coordinates close even for the people of Cugenang Subdistrict. Another aspect the researchers found to be supportive of is the public transport infrastructure that can mobilize well between the two sub-districts. Furthermore, seventeen priority option coordinates were found spread across six villages in Cipanas District. The most identified coordinates were in Sindanglaya village, with five coordinates followed by Batulawang Village, which has four coordinates.

Table 7. *Coordinates of priority options for establishing Junior High Schools in the Cipanas Subdistrict*

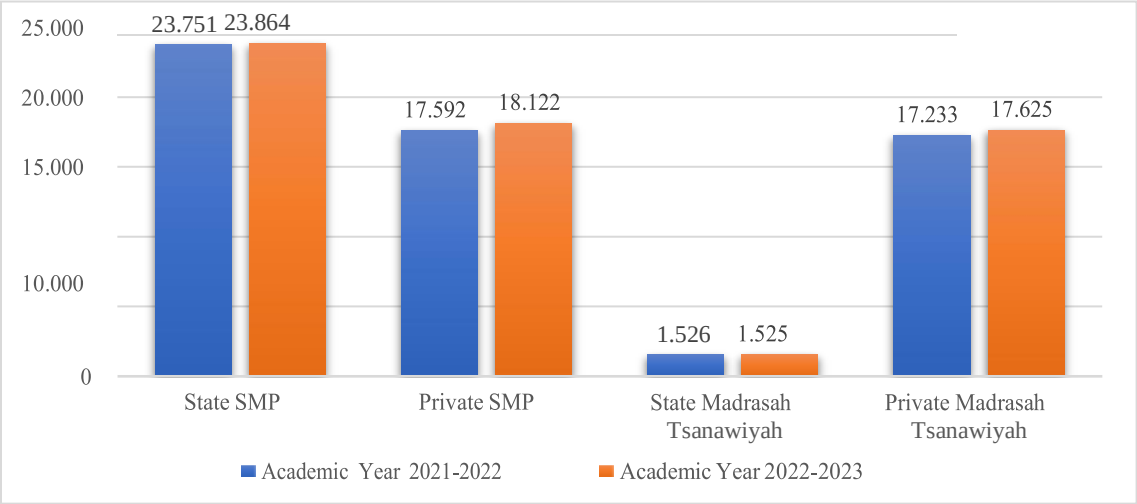
Village	Area assessment category	The size of the landarea (Ha)	Priority option coordinates	
			Coordinate X	Coordinate Y
Batulawang	Very Suitable	288.618357	107.026887	-6.700663
	Very Suitable		107.029895	-6.693942
	Very Suitable		107.030382	-6.693686
	Very Suitable		107.026887	-6.692575
Ciloto	Very Suitable	49.926779	107.013361	-6.713256
	Very Suitable		107.013544	-6.711663
Cimacan	Very Suitable	92.721631	107.006396	-6.732057
Cipanas	Very Suitable	3.041836	107.043601	-6.738477
	Very Suitable		107.032254	-6.735787
	Very Suitable		107.039089	-6.731231
Sindangjaya	Very Suitable	56.407367	107.009879	-6.746229
	Very Suitable		107.011699	-6.743455
Sindanglaya	Very Suitable	0.855852	107.032697	-6.732685
	Very Suitable		107.035639	-6.729561
	Very Suitable		107.044712	-6.724993
	Very Suitable		107.04794	-6.724195
	Very Suitable		107.04786	-6.722088

Tables 5, 6, and 7 estimate that our findings amounted to 49 coordinates of priority options for establishing secondary schools. These coordinates are spread across 19 villages in

Cugenang, Pacet, and Cipanas District. All of them can be an alternative for people affected by the earthquake who still live in Cugenang District and school-aged people who live in Pacet, Cipanas, and surrounding districts. The absorption of more people into junior high school will contribute to efforts to increase the average number of years of schooling (RLS) for the people of Cianjur, which is ranked second worst in West Java province (Ummah et al., 2022).

In a broader view, regulation of school establishment locations can increase educational accessibility and equality (Deniz, 2024; Wang et al., 2021; Chen et al., 2023), which is currently a national priority for the government of the Republic of Indonesia. However, until now, the existence of schools in Indonesia is still uneven (Wirandana & Khoirunurrofik, 2022). Many schools operate in locations that are too far from residential areas, while the national target is to ensure that the school-age population can be fully absorbed by 2030 in a fair, equitable, equal, and free manner (Rahadianto et al., 2021). If efforts to achieve this target only rely on zoning policies that regulate people who need to go to the nearest school, while definite communities are too far from school. The researchers will see a trend of disparities and injustice in Indonesian education (Tasyirifiah & Pitaloka,2023) again. An example of a case that the researchers found that shows the weakness of the recent zoning policy is SDN Tumenggungan Number 28 Solo. Due to the zoning policy, the school only received one new student in 2023. The principal said that the increase in the number of students was partly due to the residential location being far from the school where he served. The regulations on school establishments in Indonesia in the past were not based on mapping for educational equality (Siska et al., 2023). It requires too many resources if schools that have been operating for a long time ago then will be relocated. However, for schools that will be established in the future, school mapping is necessary for educational equality (Agrawal & Gupta, 2016; Kavathekar et al., 2019). One of the findings from the data search further strengthens the urgency of school mapping. Only in one year (2022-2023), 16 junior high school level units were established in Cianjur. Meanwhile, in all areas of Indonesia, 1.035 junior high school level units were established in the same year, 113 were established by the government, and 922 others were initiated by private institutions, as in Figure 9 below.

Figure 9. *Increase in the number of junior high schools' level in Indonesia in 2022-2023*



Source: *Badan Pusat Statistik* (2023)

The number of junior high school levels has increased in one year. The most drastic increase was initiated by private institutions, which contributed >89%to it. It shows an elevated level of interest in the establishment of the school by people. This aspect is a strength of the mission to increase the quantity of junior high schools. However, if these junior high school positions are not directed effectively, the researchers are afraid that this force can give rise to recent problems like the uneven distribution of schools (Yan et al., 2018) until no longer threats to student safety (Aschale, 2017). In this situation, school mapping is needed by the educational policymakers (Kavathekar et al., 2019; Kenneth, 2018). For the agenda to establish schools initiated by the private institution or government, the government can direct where new schools need to be established so the schools are close and easily accessible to the community (Zheliaskov et al., 2018) and educational equality is projected.

Conclusion

There are areas in the category that are very suitable for the junior high school establishment in Cugenang, Pacet, and Cipanas Subdistricts in Cianjur Regency, West Java, Indonesia. Our identification was strictly based on Geographic Information System (GIS) by applying seven parameter aspects as feasibility indicators, successfully visualized in a map. Furthermore, the researchers provide further testing for each area by reviewing satellite imagery to validate and determine the coordinates of recommended priority options. The researchers found forty-nine coordinates of priority options for establishing a junior high school. The coordinates are spread across nineteen villages. The researchers adapted the whole thing to scripted number coordinates for ease of use. Considering the average number of years of schooling for the Cianjur Community, the history of the Cugenang earthquake, and the policy of educational equality as one of the targets in the national priorities for 2030, the researchers are proposing these forty-nine coordinates. By considering the effectiveness of using GIS for school mapping needs, similar further research is recommended in other areas.

Declarations of Conflicts of Interest

The authors declared that there are no potential conflicts of interest.

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