



Regional Priority Analysis for Equal Distribution of Educational Facilities in West Java Using the Analytical Hierarchy Process (AHP) Method

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Abstract: Inequality in educational infrastructure remains a strategic challenge in West Java Province, where disparities in facility availability across regions hinder equitable access to education. This study aims to analyze and map regional priorities for the development of educational facilities (Elementary to Vocational High Schools) using the Analytical Hierarchy Process (AHP) method. Utilizing secondary data from 27 districts/cities, this study converts school availability data into standardized "Gap Scores." The criteria weighting results reveal that Vocational High Schools (SMK) have the highest urgency for intervention with a priority weight of 41%, followed by Senior High Schools (SMA) at 29%, Junior High Schools (SMP) at 21%, and Elementary Schools (SD) at 10%. This finding indicates a strong policy focus on vocational education. Based on the final synthesis, Kuningan Regency ranks first in development priority with a total score of 73.87%, followed by Majalengka Regency (69.84%) and Cirebon Regency (65.61%). Conversely, urban areas such as Bekasi City (6.92%) and Depok City (15.56%) show relatively adequate facility fulfillment. This study contributes a Data-Driven Decision Making model for the provincial government to allocate education infrastructure budgets more objectively, targeting regions with the highest disparities.

Keywords: AHP, Education Facilities, West Java, Regional Priority, Decision Support System

1. Introduction

Human resource development is fundamentally dependent on the quality of education. According to the 1945 Constitution and Law No. 20 of 2003 regarding the National Education System (Sisdiknas), every citizen possesses an inherent right to quality education [1]. The President of the Republic of Indonesia has emphasized that public accessibility to adequate educational facilities is a critical determinant of human resource quality. Nevertheless, disparities persist within the national education system. A significant gap exists between urban centers,



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which offer comprehensive facilities, and rural or remote areas that often lack basic infrastructure. These disparities exacerbate socio-economic inequalities, preventing individuals in disadvantaged regions from achieving their potential [2]. Equitable access to education is a strategic investment with a direct impact on the Human Development Index (HDI). Beyond a legal mandate, a high HDI fosters a more productive, creative, and competitive workforce, which subsequently drives regional economic growth. Conversely, prolonged accessibility constraints risk creating "pockets" of structural poverty, where the potential of the younger generation remains untapped. As Amartya Sen argued, development is a process of expanding freedoms, and education serves as a primary "capability" that enables individuals to achieve such freedom [3].

As the most populous province in Indonesia, West Java faces significant challenges regarding educational equity. Despite being home to numerous advanced economic and educational hubs, several regions—particularly in the northern and southern sectors—suffer from a deficit of educational facilities. Data from the West Java Open Data portal reveals a stark disparity in the distribution of educational institutions across all levels, from Elementary (SD) and Junior High (SMP) to Senior High (SMA) and Vocational High Schools (SMK). Each educational tier serves a specialized function within a continuous academic chain. Secondary education (SMA/SMK) is a critical transition point for students entering higher education or the workforce, while basic education (SD/SMP) provides the foundation for the twelve-year compulsory education program [4]. A disruption in any segment of this chain results in systemic failure. Quantitatively, this disparity is reflected in the Gross Enrollment Rate (APK) and Net Enrollment Rate (APM) across different regions. The issue is not merely a shortage at the secondary level; it is a potential systemic breakdown. The availability of secondary schools becomes irrelevant if students lack access to the foundational SD or SMP levels. Conversely, a robust primary education system is rendered ineffective if there are insufficient secondary institutions to accommodate graduates.

Systemic dropout rates are often the result of this fragmented facility chain. To address these needs, provincial governments (responsible for SMA/SMK) and municipal/regency governments (responsible for SD/SMP) must navigate resource constraints, including budgetary limits, land availability, and personnel shortages. Consequently, an objective and accountable framework is required to determine regional priorities. Decisions based solely on political intuition risk misallocating resources, ensuring that development aid fails to reach the most critical areas. Therefore, a Decision Support System (DSS) is essential to aggregate diverse data and criteria into systematic policy recommendations [5]. The complexity is multifaceted: should priority be given to establishing a new SMP in a void in Region A, or is Region B in greater need of an SMA/SMK to accommodate its SMP graduates? How should budgets be balanced between the rehabilitation of dilapidated primary schools and the construction of New School Units (USB) for secondary levels? Within the framework of good governance, public policy must be data-driven and accountable. An objectively designed DSS serves as a vital instrument for ensuring transparency and accountability.





Regional prioritization is the core of Multi-Criteria Decision Making (MCDM). Various criteria must be evaluated simultaneously, including gaps in SD, SMP, SMA, and SMK availability, alongside the school-age population at each level. Moreover, these criteria carry varying degrees of relative importance. The Analytical Hierarchy Process (AHP), developed by Thomas L. Saaty, is a widely recognized and validated MCDM method suitable for addressing such complexities [6]. AHP is particularly effective due to its ability to quantify subjective preferences and qualitative data through pairwise comparisons—a feature that distinguishes it from purely quantitative methods like TOPSIS or SAW. This is vital, as determining the weight of the "Elementary Gap" relative to the "Secondary Gap" is an expert-driven judgment rather than a simple absolute calculation. According to Saaty, AHP excels at decomposing complex problems into a logical hierarchical structure [7]. Furthermore, AHP allows experts to provide subjective assessments while maintaining logical consistency. Previous research has successfully employed AHP for resource allocation, public facility siting, and performance evaluation [8][9][10]. Accordingly, this study utilizes AHP to develop a prioritization model to identify regions in West Java that require urgent intervention to achieve equity in educational facilities across all levels.

2. Method

2.1 Research Stages

This study was conducted through four systematic and sequential stages. The process initiated with **Preparation: Alternative Performance Data**, which focused on collecting secondary data from *West Java Open Data* and transforming it into "Gap Scores" for 27 regencies and cities. The subsequent stage was **Analysis: Criteria Weighting**, where the core of the AHP method was employed to determine the importance weights of each criterion (SD, SMP, SMA, and SMK Gaps) through a pairwise comparison process. The resulting weights were then evaluated for validity in the **Validation: AHP Consistency Test** stage to ensure that the assessments were logical and consistent ($CR < 0.1$). Finally, the validated criteria weights and alternative performance scores were integrated in the **Synthesis: Final Ranking** stage to generate the priority order of the regions.

2.2 Preparation: Alternative Performance Data

This stage serves as the foundation for data collection and standardization for all evaluated options. This process is critical to ensure that each regency and city is evaluated using fair and comparable metrics. **Data Collection:** Data were sourced from the West Java Provincial Open Data portal and the Central Bureau of Statistics (BPS). Two primary datasets were collected for the 27 regencies and cities: data regarding the number of villages (*village/sub-district*)





possessing educational facilities, categorized by educational level (SD, SMP, SMA, and SMK), and data encompassing the total number of villages within each regency or city.

Data Transformation: Since each regency or city has a different total number of villages, raw data—such as "221 villages have an SMA"—cannot be utilized directly. Therefore, the initial data must be converted into a reliable ratio. **Gap Score Calculation:** In this study, the performance metric used is the "Gap Score." This metric is calculated to determine the extent of the deficiency or disparity in facilities. These criteria are classified as cost attributes, where higher values indicate poorer performance—or a larger gap—thereby signifying that intervention should be prioritized. **Gap Score Formula:** To calculate the gap score for each level (j) in each regency/city (i), the following formula is used [11]:

$$Time = 100\% - \left(\frac{\text{Number of Villages Having Facilities}}{\text{Total Villages in Regency/City}} \times 100\% \right)$$

2.3 Analysis: Criteria Weighting

The purpose of the Analytical Hierarchy Process (AHP) at this stage is to determine the relative importance of each criterion (C1-C4) using a comprehensive expert assessment process.

1. Hierarchical Structure: The research problem is structured into three clear levels.
 - a. Level 1 serves as a goal, and includes regional priorities for equitable distribution of educational facilities.
 - b. Level 2 serves as the criteria, with C1 covering the elementary school gap, C2 covering the middle school gap, C3 covering the high school gap, and C4 covering the vocational school gap.
 - c. Level 3 serves as an alternative, and covers 27 districts/cities in West Java.
2. Pairwise Comparison: Expert judgment is used to determine the weight of the criteria. In this study, experts (or researchers) fill out a 4 x 4 pairwise comparison matrix questionnaire. To evaluate how important one criterion (e.g., High School Gap) is compared to another criterion (e.g., Vocational High School Gap), Saaty's 1-9 scale is used.
3. Priority Vector (Weight) Calculation: The completed pairwise comparison matrix is mathematically processed. First, the matrix values are normalized by dividing the total of the cell values in each column by the sum. Next, a priority vector—also known as the criterion weights—is created by calculating the average of each row in the normalized matrix. The result is a weight set $W = \{W_{sd}, W_{smp}, W_{sma}, W_{smk}\}$, where the total $W = 1$.

2.4 Validation: AHP Consistency Test





This is a crucial step in validating the reliability of the data from step 2.3. Consistency testing is conducted to ensure that expert judgments are rational, reasonable, and not random.

1. Maximum Lambda Calculation: Maximum eigenvalue (λ_{max}) is obtained from the pairwise comparison matrix and the priority vector.
2. Consistency Index (CI) Calculation: Consistency Index (CI) is created to calculate the difference from pure consistency [12].

$$CI = \frac{\lambda - n}{n - 1}$$

3. Consistency Ratio (CR) Calculation: The consistency ratio (CR) value can be calculated by comparing the consistency ratio (CI) with the Random Index (RI), which is the average CI value generated from a random matrix with the same scale. For $n=4$, the standard RI value is 0.90 [13].

$$CR = \frac{CI}{RI}$$

4. Validation: If the CR value is less than 0.1 (or 10%), then the criteria weight can be used. The assessment process in step 2.3 must be reviewed if $CR > 0.1$ [14].

2.5 Synthesis: Final Ranking

To produce a single priority score for each alternative, the synthesis stage is the final step where the subjective criteria weights (see stage 2.3) are combined with the objective performance scores (see stage 2.2).

1. Score Aggregation: The simple addition subtraction (SAW) method is used to perform aggregation[15]. To determine the performance score of each district or city, the gap score, which is the performance score, is multiplied by the appropriate criteria weight, and then the results are added together.
2. Total Score Formula: Total score for each district/city i
3. Ranking and Interpretation: All alternative districts/cities are ranked based on their S_{Total} . Since the criterion used is the "Gap Score," which is a cost attribute, the HIGHEST total score indicates the largest accumulated gap. Therefore, the region with the highest score should be prioritized for intervention in the education facility equalization program.

3. Results and Discussion

3.1 Preparation: Alternative Performance Data





3.1.1 Data Collection

This study used secondary quantitative data. Data were collected through documentation studies and non-participant observation of digital archives available on public data portals. The West Java Province Open Data Portal (opendata.jabarprov.go.id) was used as the primary data source for the 2024 educational facility availability data. Furthermore, publications from the Central Statistics Agency (BPS) were used to verify the validity of comparative data, including the total number of villages and sub-districts per district or city. Two primary data sets were collected for 27 districts and cities in West Java:

- Facility Availability Data shows how many villages or sub-districts have school facilities, sorted by elementary, middle, high, and vocational school levels.
- Total Area Data shows the total number of villages or sub-districts in each district or city.

Data on the availability of school facilities and the number of villages/sub-districts in each district/city in Karawang can be seen in Table 1.

Table 1 Data on Availability of School Facilities in West Java

Regency	Village	Elementary School	Junior High School	Senior High School	Vocational School
Bogor	435	435	400	221	235
Sukabumi	386	385	351	179	155
Cianjur	360	360	304	139	148
Bandung	280	280	255	152	104
Garut	442	442	384	210	153
Tasikmalaya	351	351	289	139	125
Ciamis	265	265	183	79	61
Brass	376	376	142	57	38
Cirebon	424	423	211	90	85
Majalengka	343	343	164	52	51
Sumedang	277	277	150	52	66
Indramayu	317	317	187	74	105
Earrings	253	253	165	66	82
Purwakarta	192	192	121	55	43
Karawang	309	309	184	64	96
Bekasi	187	187	161	108	113





West Bandung	165	165	152	103	78
Pangandaran	93	93	70	22	29
Bogor City	68	67	60	38	46
Sukabumi City	33	33	26	24	18
Bandung	151	145	122	93	67
Cirebon City	22	22	20	14	15
Bekasi City	56	56	56	51	50
Depok City	63	63	62	48	50
Cimahi City	15	15	15	11	9
Tasikmalaya City	69	69	59	41	36
Banjar City	25	25	21	9	12

In the pre-processing stage, the second data point—Total Area—is crucial for use as a denominator. The goal is to convert absolute data into ratio data so that a "Gap Score" can be objectively calculated and comparisons between regions can be made fairly.

3.1.2 Data Transformation

Raw data on facility availability obtained from the portal *open data*(e.g. "Bogor Regency has 221 villages/sub-districts with high school facilities") is absolute. This absolute value cannot be compared directly between regions (in terms of *apples-to-apples*), because each district/city has a different total number of villages/sub-districts (denominator). Comparing absolute values without considering the total population will lead to bias and erroneous conclusions. Therefore, raw data must go through a standardization (normalization) stage before it can be analyzed. In this study, standardization was carried out by transforming availability data (which is *Benefit*) into a gap metric (which is *Cost*). This metric is called the "Gap Score." This metric was chosen because it directly measures the proportion of areas that are *Not yet* underserved, which aligns with the research objective of identifying equity priorities. A high Gap score indicates a high level of inequality, meaning the region has a more urgent intervention priority. The results of the proportion calculation can be seen in Table 2.

Regency	Gap Elementary School	Middle School Gap	High School Gap	Vocational High School Gap
Bogor	1,000	0,920	0,51	0,54





Sukabumi	0,997	0,909	0,46	0,40
Cianjur	1,000	0,844	0,39	0,41
Bandung	1,000	0,911	0,54	0,37
Garut	1,000	0,869	0,48	0,35
Tasikmalaya	1,000	0,823	0,40	0,36
Ciamis	1,000	0,691	0,30	0,23
Brass	1,000	0,378	0,15	0,10
Cirebon	0,998	0,498	0,21	0,20
Majalengka	1,000	0,478	0,15	0,15
Sumedang	1,000	0,542	0,19	0,24
Indramayu	1,000	0,590	0,23	0,33
Earrings	1,000	0,652	0,26	0,32
Purwakarta	1,000	0,630	0,29	0,22
Karawang	1,000	0,595	0,21	0,31
Bekasi	1,000	0,861	0,58	0,60
West Bandung	1,000	0,921	0,62	0,47
Pangandaran	1,000	0,753	0,24	0,31
Bogor City	0,985	0,882	0,56	0,68
Sukabumi City	1,000	0,788	0,73	0,55
Bandung	0,960	0,808	0,62	0,44
Cirebon City	1,000	0,909	0,64	0,68
Bekasi City	1,000	1,000	0,91	0,89
Depok City	1,000	0,984	0,76	0,79
Cimahi City	1,000	1,000	0,73	0,60
Tasikmalaya City	1,000	0,855	0,59	0,52
Banjar City	1,000	0,840	0,36	0,48

3.1.3 Gap Score Calculation

At this stage, the gap value mapping is carried out (*gap*) availability or need for educational infrastructure for each level (elementary, middle, high, and vocational school) in each district/city. *gap* This represents the difference between ideal conditions (needs) and actual conditions (availability) in the field. Based on the processed data, variations in the value are





visible. *Gap* significant differences between regions. For example, Kuningan and Majalengka Regencies show significant differences between regions. *gap* which is quite high at the secondary education level (SMA and SMK), while urban areas such as Bekasi City and Depok City tend to have high values *gap* lower, indicating the availability of facilities that are closer to the needs compared to the district area. Raw data *gap* This is then converted into a standardized numerical value so that it can be calculated with the criteria weight.

3.1.4 Gap Score Formula

To determine the priority of handling, the weighted summation method is used (*Weighted Sum Model*) which combines the values *gap* normalized with the criteria weights generated from the AHP method. The mathematical formula used to calculate the Priority Value (V_i) for each regional alternative is as follows:

$$V_i = \sum_{j=1}^n W_j \times X_{ij}$$

Where:

- V_i = Final priority value for Regency/City i .
- W_j = Priority weight for the j th level of education.
- X_{ij} = Score value *gap* in the i -th Regency/City for the j -th level of education.
- n = Number of criteria.

Specifically based on the criteria used, the equation is:

$$Score = (Gsd \times 0,10) + (Gsmg \times 0,21) + (Gsma \times 0,29) + (Gsmk \times 0,41)$$

3.1.5 Stage Results

Based on the calculation of the value *gap* Purely before weighting, the data distribution is as follows:

- **Vocational High School Level Gap:** Contributing the largest variance between regions. Kuningan Regency has a score of *gap* The highest vocational school (0.90), followed by Majalengka Regency (0.85).
- **Elementary School Level Gap:** Most areas show values *gap* which is very small or close to 0 (such as Karawang, Purwakarta, Subang), which indicates that the distribution of basic education is relatively more fulfilled than secondary education.





- **Gap between Junior High and Senior High School Levels:** Shows a moderate trend, where the Regency area tends to have *gap* greater than the city area (for example, the high school gap in Cirebon Regency is 0.79 compared to Cirebon City 0.36).

3.2 Analysis: Criteria Weighting

Determination of the weight of interests between levels of education is carried out using a pairwise comparison matrix (*Pairwise Comparison Matrix*) AHP. Based on *expert judgment* which is quantified, the following priority vector is generated:

- 1) **Vocational High School (Weight 0.41 or 41%):** Be a top priority. This shows that In the context of this research, the development or fulfillment of vocational education needs is considered most crucial.
- 2) **High School (Weight 0.29 or 29%):** Occupying second priority.
- 3) **Junior High School (Weight 0.21 or 21%) :**Occupying third priority.
- 4) **SD (Weight 0.10 or 10%) :**Has the lowest weight.

This analysis reveals a policy preference focused on senior secondary education (SMA/SMK), with a total weighted contribution of 70%, compared to primary education (SD/SMP), which only accounts for 30%. The comparison matrix indicates that vocational schools are rated three times more important than elementary schools and two times more important than senior high schools in the context of prioritizing this issue.

3.3 Validation: AHP Consistency Test

To ensure the logical validity of the weighting, a consistency test was performed on the comparison matrix. The calculation results show the following parameters:

- a. **Lambda Max (λ_{max})** : 4,1407
- b. **Consistency Index (CI)** : 0,0469
- c. **Random Indices (RI)** :0.90 (for n = 4)

Based on these values, the Consistency Ratio (CR) obtained is:

$$CR = \frac{CI}{RI} = \frac{0,0469}{0,90} = 0,0521$$

Because the CR value = 0.052 < 0.10 (the maximum threshold limit required by Saaty), the comparison matrix is stated **CONSISTENT**. Thus, the resulting weights are valid and can be used for the ranking synthesis stage.





3.4 Synthesis: Final Ranking

The synthesis stage combines the AHP criteria weights with the scores. *gap* each region. The results of the priority ranking of handling from highest to lowest are as follows:

a. Top 3 Priorities:

- 1) **Kuningan Regency** ranked first with priority score **73,87%**. This high score is driven by the large *gap* at the vocational school (0.90) and high school (0.85) levels, which are the criteria with the greatest weight.
- 2) **Majalengka Regency** is in second place (69.84%).
- 3) **Cirebon Regency** is in third place (65.61%).

b. Lowest Priority (Bottom 3):

- 1) The administrative area of "City" tends to occupy the lower position, with **Bekasi City** as the last priority (6.92%), followed by **Depok City**(15.56%) and **Cimahi City** (23,92%).

These results imply that policy interventions or resource allocation should be prioritized in the Regency area, especially Kuningan and Majalengka, with the main focus on improving vocational (SMK) and secondary (SMA) education levels.

4. Conclusion

This research successfully developed a Decision Support System (DSS) model to map educational facility development priorities in West Java. Based on the AHP analysis, it was found that equitable distribution of vocational secondary education (SMK) was the top priority, with an importance weight of 41%. The ranking results indicate that disparities in educational facilities are most pronounced across districts, with Kuningan Regency (73.87%), Majalengka (69.84%), and Cirebon (65.61%) as the three regions most urgently seeking infrastructure budget allocation.

The managerial implications of this research are the need to shift the policy focus from simply fulfilling the nine-year compulsory education (elementary and junior high) to strengthening access to universal secondary education (SMA/SMK) in remote areas. A limitation of this research lies in the use of a single variable, "availability of school units." Future research is recommended to integrate the variables "teacher-student ratio" and "physical condition of buildings," and to use hybrid methods such as AHP-TOPSIS to improve the accuracy of recommendations.





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