Southeast Asian Journal of Islamic Education
Volume 04, No. 02, June 2022
E-ISSN: 2621-5861, P-ISSN: 2621-5845
https://doi.org/10.21093/sajie.v4i2.8216

Analysis of Education Quality Mapping Based on Geographical Information System (GIS)

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Article History:

Received: October 9th, 2022 *Accepted: November 28th, 2022* *Published: November 29th, 2022*

Abstract

Improving the quality of education is an integral part of the government's program. Enhancing the quality of education requires mapping based on educational levels and regions to provide an up-to-date depiction of the implementation and distribution of education. The purpose of this research is to map the quality of education in East Kalimantan based on the Geographical Information System (GIS). One of the government's accelerated development programs is to ensure equal distribution in improving the quality of education across all regions of the Republic of Indonesia. One step in implementing this program is mapping the quality of education through schools. Mapping the quality of education through schools is expected to portray the actual conditions in the field. The mapping is intended to generate evaluations, policies, recommendations, and planning programs for future education quality improvement. This research discusses mapping education quality using a geographical mapping method through observation and interviews. The collected data is subsequently grouped according to the boundaries of each region, designing maps based on the geographical conditions of the areas to be mapped. OpenJUMP software for GIS is utilized to integrate observation data and polygon maps of East Kalimantan, describing the analysis results for each mapped area. The implementation of the research findings and drawing conclusions will use Ms. Excel 2010 and Open Jump for GIS. The conclusion drawn from the GIS-based education quality mapping is that the clustering method can effectively visualize the distribution of education quality for each area, facilitating visual analysis. Mapping Education Quality in East Kalimantan based on Geographic Information System (GIS) is capable and effective in spatially identifying the distribution of education quality. Based on the grouping according to 8 parameters of the National Education Standards, it is concluded that several parameters, particularly Infrastructure Standards and Process Standards, have the highest number of categories not meeting the National Education Standards in each mapped area. This indicates that each parameter of the National Education Standards is still unevenly implemented.

Keywords: Education quality, GIS (Geographical Information System), Mapping, Clustering, Spatial Analysis

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Citation: Zurqoni, Z., Rahman, F., Susmiyati, S., & Saugi, W. (2022). Analysis of Education Quality Mapping Based on Geographical Information System (GIS). *Southeast Asian Journal of Islamic Education*, *4*(2), 272–284. https://doi.org/10.21093/sajie.v4i2.8216

A. Introduction

Education is a process of activities conducted through vocational learning and training. The organization of education is expected to produce qualified human resources contributing to sustainable development in the future. Formal education in Indonesia is structured and hierarchical, ranging from elementary education (SD/MI, SMP/MTs), secondary education (SMA/SMK/MA), to higher education (Universities/Institutes/Higher Schools/Polytechnics). Formal education is institutionally organized, serving as a place for the transfer of knowledge and a social system that strengthens the character and personality of learners.

With the advancement of knowledge, technology, and global civilization, the government has implemented programs to expand access and improve the quality of education nationwide, aiming for equal opportunities and human resource distribution for the broader community. In this context, mapping the quality of education, especially through formal educational institutions, becomes essential. Mapping the quality of education through schools is expected to provide a real picture of the process and results of education in each region. The subsequent mapping of education quality serves as the basis for evaluation and recommendations for policy-making in further improving education quality.

Education mapping becomes a valuable source of information in decision-making processes. By mapping the conditions in a specific area, the geographical reality forms the basis for long-term education development in that region. The goal of this policy is to improve the quality, availability, affordability, relevance, equality, and certainty of obtaining educational services in Indonesia. Despite the difficulty of providing educational services to all regions in Indonesia, education must be a national obligation to fulfill. Mapping the quality of education is crucial to determine whether the education quality in a particular area meets the established standards. This mapping is done based on the government's standards through legislation, aiming to monitor the distribution of education quality in each mapped area.

Currently, mapping is still done using conventional methods. Therefore, there is a need for a method that can process data for rapid, effective, and efficient mapping. Geographic Information System (GIS) has recently developed significantly in line with information technology progress. GIS is a computer-based information system that combines map elements (geographic) and information designed to acquire, process, manipulate, analyze, illustrate, and display processed data results. GIS has broad applications in various fields, especially those requiring mapping-based information systems, not only displaying but also analyzing data based on geographical elements. GIS is a computer-based system used to store and manipulate geographic information in general. Geographic information systems can be an essential tool for storing, manipulating, analyzing, and displaying natural conditions using attribute and spatial data. In its development, GIS has been widely used to map specific conditions in an area, considering the data and geographical conditions of that area. GIS can also be used to display school data distribution, the availability of teachers in an area, and the excellence facilities of those schools. In the process of improving education quality, GIS can also map indicators of education quality standards, making it easier for users to search for quality educational institutions based on name, address, facilities, and educational concentration. With this system, users can access information presented in the form of a web-based information system and mapping. GIS can also be used to display school data distribution, the availability of teachers in an area, and the excellence facilities of those schools. In the process of improving education quality,

Geographic Information System is also capable of mapping indicators of education quality standards, making it easier for users to search for quality educational institutions based on name, address, facilities, and educational concentration. The research aims to map the quality of education in East Kalimantan based on the Geographic Information System (GIS), with the hope of providing a foundation for improving education quality in various regions.

B. Literature Review

1. Quality & National Education Standards

From its definition, quality is a process that occurs through standards or criteria that have been established, covering the input processes to the resulting output. For educational service institutions, quality is the most important task to achieve the expected output standards. In response to the government's focus on education, efforts are made to improve quality standards and equalize educational services throughout Indonesia, based on Government Regulation No. 19 of 2005, Chapter 1, Article 1, Paragraph 1, which contains the National Education Standards (SNP). These standards set the minimum criteria for the education system throughout Indonesia, obligating each educational institution to meet the established standards. Thus, the goal of improving education quality in Indonesia can be achieved according to expectations. In the current era of globalization, the enhancement of education quality in Indonesia is crucial to catch up with other ASEAN countries that have better quality education standards, allowing Indonesian education quality to compete globally. According to Government Regulation No. 19 of 2005, there are eight National Education Standards:

a. Graduates' Competence Standards (SKL): Graduates must have competencies and knowledge corresponding to their respective expertise, referring to assessment standards and graduation requirements.
b. Content Standards: Content standards must have sufficient material to support the learning process, including materials provided in the learning process and standards that align with the minimum graduate competencies at the targeted education level.
c. Process Standards: The learning process in an educational institution should be interactive, inspiring, enjoyable to prevent students from feeling bored quickly, motivating them to participate and providing enough space for self-development based on their interests and talents.
d. Educator and Education Personnel Standards: Educators must meet academic and competency standards as instructors, be physically and mentally healthy, and possess the ability to achieve national standard education goals.
e. Facility and Infrastructure Standards: Educational service units must have facilities to support the teaching and learning process, including educational media, furniture, books, and other learning resources, as well as other necessary equipment for continuous and sustainable learning processes.
f. Education Management Standards: Education management standards cover three aspects: management standards by educational units, management standards by local governments, and management standards by the government.
g. Education Financing Standards: Education incurs various costs, including investment, operational, and personnel costs, necessary for sustaining an educational institution.

h. Education Assessment Standards: Education assessment at the elementary and secondary education levels includes assessment by educators, assessment by educational institutions, and assessment by the government. Higher education assessment comprises assessment by educators and assessment by higher education units.

2. Geographic Information System (GIS)

GIS or Geographic Information System is used to analyze geographic data in the form of spatial data by processing it visually for easier comprehension. Spatial analysis or processing uses geographic features to identify patterns and data trends, and GIS is also used for forecasting scenarios. In its development, GIS has many effective data analysis features. GIS focuses on processing and storing data in spatial and visual forms. Therefore, GIS-based software requires facilities for spatial analysis and uses a database for storage.

3. Spatial Data Analysis

Spatial data analysis describes a population of data, including the location, position, and information about objects in a specific area. Spatial data has topography in the form of location, distance, and information. Geographic Information System (GIS) is a technology that provides tools to collect and use geographic data to assist in developing geographically based data provision, and digital maps are generally much larger than printed maps because digital versions can be combined with other data sources to analyze information with graphic presentations.

4. Clustering Mapping

Clustering is a data analysis method often included as one of the Data Mining methods, aiming to group data with similar characteristics in the same area and data with different characteristics in other areas.

C. Method

The research method used in this study is a quantitative data analysis method by conducting spatial analysis on the distribution of schools in several districts/cities in East Kalimantan. To achieve the previously stated objectives, tools and materials used to support the process and completion of this research are outlined as follows. This research uses tools in the form of statistical computer software, namely OpenJump GIS 1.15, GEODA 1.8, and MS Excel 2010.

1. Data Sources

The data used in this research are primary data obtained through observations at predetermined locations and interviews using instruments related to the eight indicators of education quality standards covering the eight national standards in seven sample regions/districts in East Kalimantan.

2. Data Analysis Procedure

In line with the research objectives, the steps of the data analysis procedure consist of eight parts, as outlined below:

a. Verify the acquired data by cross-checking to ensure its conformity with the geographical conditions in that area.
b. Perform clustering or grouping of data using MS Excel and OpenJUMP for GIS. This involves two stages: 1). Grouping data based on the quality standards achieved in each area using the specified quality standards for each region or

sample. 2). Grouping data based on the region and geographical conditions of that area.

c. Describe the results of clustering on the grouped data, including the geographical conditions in the area and the quality achieved for each region.
d. Evaluate the results to ensure that the processed data is accurate and consistent with the conditions present during data collection.
e. Draw conclusions from the analysis results.

D. Findings and Discussion

1. Data Input Preparation

The input data consists of 8 parameters of the National Education Standards (SNP): graduate competency standards, content standards, process standards, assessment standards, teacher and educational staff standards, facilities and infrastructure standards, and education financing standards. The mapping process of regions in this study includes 36 sub-districts from 7 regencies and cities in East Kalimantan. The mapping represents both peripheral and urban areas based on the national education quality standards, and it is transformed for the analysis needs in this study, as shown in Table 1.

Table 1. Transformed SNP Standards

Indicator	ATRIBUTE	
	Color Code	RANGE
Not Meeting SNP	Red	0.0 - 0.40
Expected	Orange	0.41 - 0.60
Meeting	Blue	0.61 - 0.80
According to SNP	Green	0.81 - 1.00

The next step involves using Table 1.1 as a reference for analyzing the distribution of regions to be mapped. The base mapping of East Kalimantan is shown in Figure 1, where the distribution of regions is represented by different colors.

Figure 1. Distribution of school mapping per sub-district for each regency/city in East Kalimantan

The figure above explains the distribution of sample data taken from each sub-district representing the East Kalimantan region, analyzed through observation and interviews.

2. Clustering Process

The clustering process in this study is conducted in two stages. First, data clustering is based on the achieved quality standards in each region. Second, data clustering is based on regions, utilizing OpenJUMP for GIS and Ms. Excel 2010 for visualizing clustering for each standard in each region, relying on the base map shown in Figure 1.

a. Quality Distribution with Graduate Competency Standards (SKL)

Parameter From the Graduate Competency Standards (SKL) parameter in 36 sub-districts across 7 regencies/cities, the visualization results, presented in Figure 2, indicate that 1 area falls into the category of not meeting SNP, 7 areas are expected, 20 areas are meeting expectations, and 8 areas are in accordance with SNP.

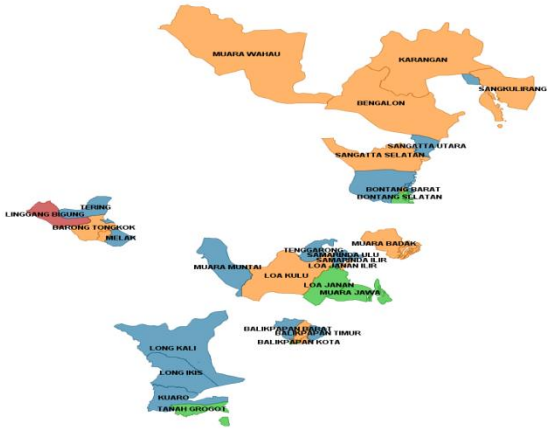


Figure 2. Graduation Standards (SKL) for each sub-district in regencies/cities

The mapping pattern in Figure 2 reveals the distribution of graduation competency standards (SKL) based on colors. The pattern does not evenly spread across some regions based on their geographical locations. For instance, in Loajanan and Loakulu sub-districts, Loajanan has a score range of SKL 0.81 – 1.00, according to SNP, while Loakulu falls into the category of 0.41 – 0.60, indicating an expected level. The geographical proximity of these two areas is apparent, while Linggang Bigung, which does not meet SNP for graduation competency standards (SKL), is geographically distant from areas that comply with SNP.

b. Quality Distribution with Content Standards Parameter

From the Content Standards parameter in 36 sub-districts across 7 regencies/cities, the visualization results, presented in Figure 3, indicate that 1 area falls into the category of not meeting SNP, no area is expected, 9 areas are expected, and 26 areas are in accordance with SNP.

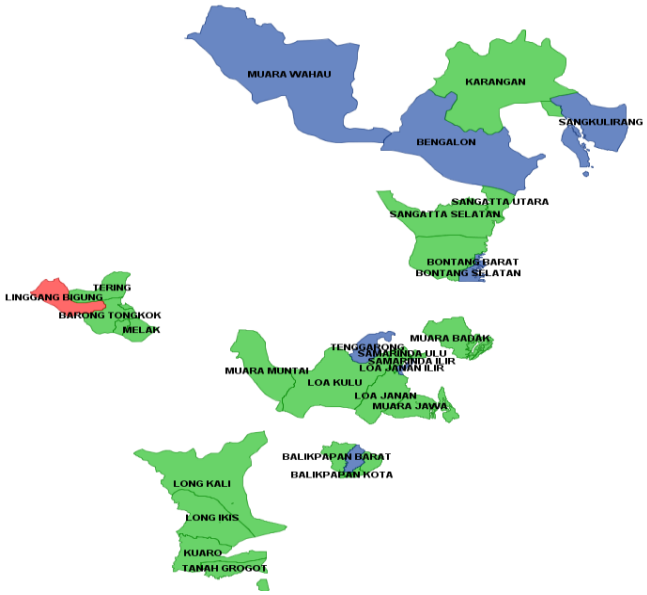


Figure 3. Content Standards for each sub-district in regencies/cities

The mapping pattern in Figure 3 shows the distribution of content standards based on colors. The pattern does not evenly spread across one area based on its geographical location. For instance, in Linggang Bigung and Barong Tongkok sub-districts, Barong Tongkok has a score range of content standards 0.81 – 1.00, according to SNP, while Linggang Bigung falls into the category of 0.41 – 0.60, indicating not meeting SNP. This suggests that the distribution of content standards in accordance with SNP is not influenced by the geographical location of an area.

c. Clustering of Process Standards Parameter

From the Process Standards parameter in 36 sub-districts across 7 regencies/cities, the visualization results, presented in Figure 4, indicate that 6 areas fall into the category of not meeting SNP, 3 areas are expected, 3 areas meet expectations, and 24 areas are in accordance with SNP.

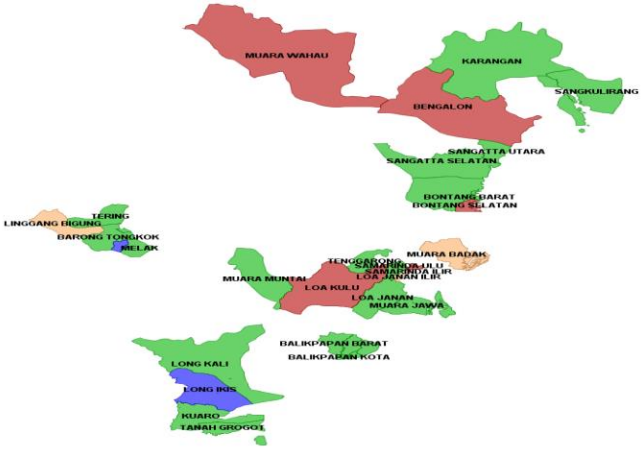


Figure 4. Process Standards for each sub-district in regencies/cities

The mapping pattern in Figure 4 shows the distribution of process standards based on colors, which is not evenly spread across each region based on its geographical location. This can be observed in several sub-districts in each regency, where the score range of process standards 0.81 – 1.00, according to SNP, and the score range of 0.0 – 0.40 are within the same regency. The geographical proximity between sub-districts that comply with SNP and those that do not meet SNP in the same regency suggests that the distribution of process standards in accordance with SNP is not influenced by the geographical location of an area.

d. Clustering of Assessment Standards Parameter

From the Assessment Standards parameter in 36 sub-districts across 7 regencies/cities, the visualization results, presented in Figure 5, indicate no areas fall into the category of not meeting SNP, 7 areas are expected, 3 areas meet expectations, and 26 areas are in accordance with SNP.

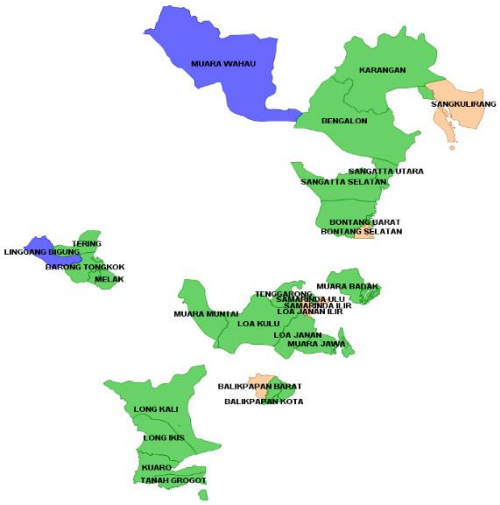


Figure 5. Assessment Standards for each sub-district in regencies/cities

The mapping pattern in Figure 5 shows the distribution of assessment standards based on colors, which is almost evenly spread across each region based on its geographical location. This can be observed in several sub-districts in each regency, where there are no areas falling into the category of not meeting SNP. The areas with score ranges of 0.81 – 1.00, according to SNP, and 0.61 – 0.80 are almost evenly distributed in each regency. This suggests that the distribution of assessment standards in accordance with SNP can be influenced by the geographical location of an area.

e. Clustering of Teacher and Educational Staff Standards Parameter

From the Teacher and Educational Staff Standards parameter in 36 sub-districts across 7 regencies/cities, the visualization results, presented in Figure 6, indicate 3 areas fall into the category of not meeting SNP, 25 areas are expected, 8 areas meet expectations, and no areas are in accordance with SNP.

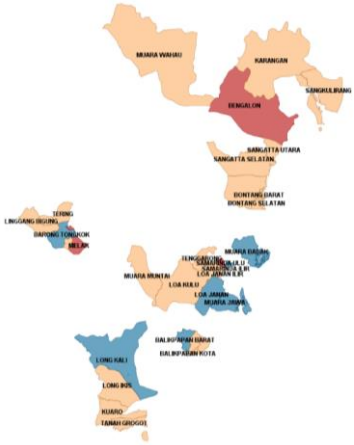


Figure 6. Teacher and Educational Staff Standards for each sub-district in regencies/cities

From the mapping patterns in Figure 6, it can be observed that the distribution pattern of Educators and Education Personnel Standards based on color is not evenly spread across each region based on its geographical location. This can be seen in several districts in each regency where there is no area classified as meeting the National Education Standards (SNP). This indicates that the Standards for Educators and Education Personnel in the sampled areas mapped are still relatively low, with areas having a score range of 0.41 – 0.60 falling under the expected category reaching 25 districts, including regency and city districts. Thus, it can be concluded that the distribution of Standards for Educators and Education Personnel in accordance with the SNP is not influenced by the geographical location in a certain area.

f. Grouping of Infrastructure Standards Parameters

From the parameters of Infrastructure Standards in 36 districts, in 7 Regencies/Cities, it is known that the visualization results are presented in the form of maps and frequency graphs, by grouping based on Infrastructure Standards parameters in Figure 7. There are 5 areas classified as not meeting the SNP, 16 areas classified as expected, 10 areas classified as meeting, and 2 areas classified as already in accordance with the SNP.

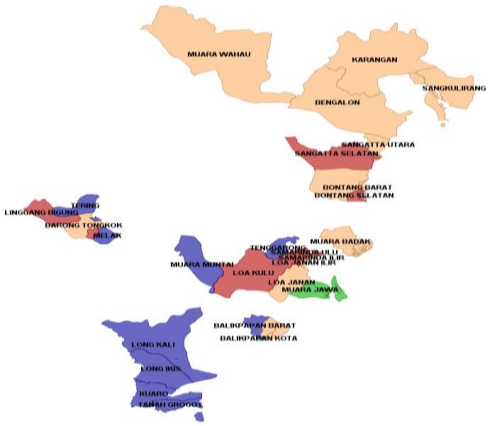


Figure 7. Infrastructure Standards for each district in Regency/City

From the mapping pattern in Figure 7, it can be seen that the distribution pattern of Infrastructure Standards based on color is not evenly spread across each region based on its geographical location. This can be observed in several districts in each regency where only 2 areas have a score range of 0.81 – 1.00 classified as meeting the SNP, and 8 areas have a score range of 0.0 – 0.4 classified as not meeting the SNP. Thus, it can be concluded that the distribution of Infrastructure Standards in accordance with the SNP is not influenced by the geographical location in a certain area.

g. Grouping of Management Standards Parameters

From the parameters of Management Standards in 36 districts, in 7 Regencies/Cities, it is known that the visualization results are presented in the form of maps and frequency graphs, by grouping based on Management Standards parameters in Figure 8. There is 1 area classified as not meeting the SNP, 2 areas classified as expected, 3 areas classified as meeting, and 30 areas classified as already in accordance with the SNP.

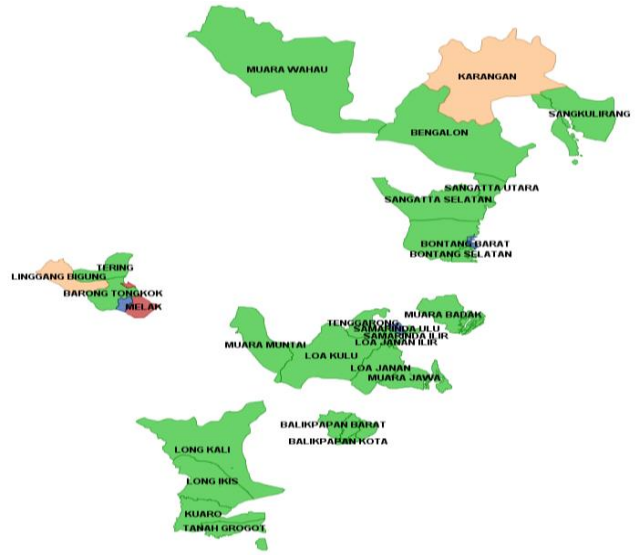


Figure 8. Management Standards for each district in Regency/City

From the mapping pattern in Figure 8, it can be seen that the distribution pattern of Management Standards based on color is not evenly spread across each region based on its geographical location. This can be observed in several districts in each regency where there is 1 area with a score range of 0.0 – 0.04 classified as meeting the SNP, and 30 areas with a score range of 0.81 – 1.0 meeting the SNP. Thus, it can be concluded that the distribution of Management Standards in accordance with the SNP is influenced by the geographical location in a certain area.

h. Grouping of Financing Standards Parameters

From the parameters of Financing Standards in 36 districts, in 7 Regencies/Cities, it is known that the visualization results are presented in the form of maps and frequency graphs, by grouping based on Financing Standards

parameters in Figure 9. There is 1 area classified as not meeting the SNP, 8 areas classified as expected, 15 areas classified as meeting, and 12 areas classified as already in accordance with the SNP.

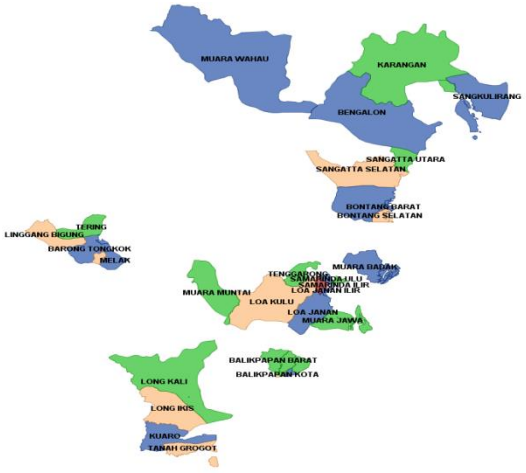


Figure 9. Financing Standards for each district in Regency/City

From the mapping pattern in Figure 9, it can be seen that the distribution pattern of Financing Standards based on color is not evenly spread across each region based on its geographical location. This can be observed in several districts in each regency where there is 1 area with a score range of 0.0 – 0.04 classified as meeting the SNP, and 30 areas with a score range of 0.81 – 1.0 meeting the SNP. Thus, it can be concluded that the distribution of Financing Standards in accordance with the SNP is influenced by the geographical location in a certain area.

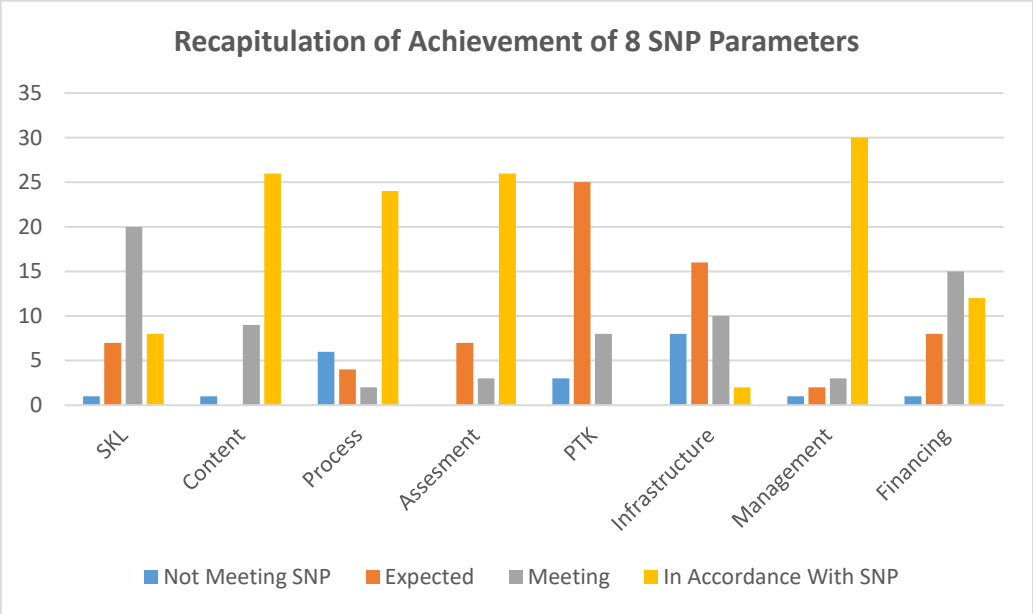
3. Grouping Based on SNP

The process of grouping (clustering) data based on the quality standards achieved in all sampled areas mapped, where the recapitulation results of grouping from the 8 parameters of national education standards convey information through tables and graphs using Ms. Excel 2010, can be seen in Table 2, and Graph 1.

Table 2. Recapitulation of Achievement of 8 SNP Parameters

	Recapitulation			
Indicator	**Not Meeting SNP**	**Expected**	**Meeting**	**In Accordance With SNP**
Range	0.0 - 0.40	0.40 - 0.60	0.61 - 0.80	0.81 - 1.00
SKL	1	7	20	8
Content	1	0	9	26
Process	6	4	2	24
Assesment	0	7	3	26
PTK	3	25	8	0
Infrastructure	8	16	10	2

Management	1	2	3	30
Financing	1	8	15	12
Percentage	7%	24%	24%	44%



Graph 1. Recapitulation of 8 SNP Parameter Achievements

From the results of data grouping based on 8 SNP parameters, it is known that the distribution of education quality in each region is not evenly spread, where from Graph 1, it can be seen that the infrastructure parameter has 8 districts that still do not meet the SNP out of 36 sampled districts studied, and only 2 districts that have met the SNP.

E. Conclusion

Quality Education Mapping in East Kalimantan based on Geographic Information System (GIS) is capable and effective in identifying the spatial distribution of education quality in the 7 Regencies/Cities in East Kalimantan. From the analysis results of mapping the distribution of education quality grouped in each region, it can be concluded that the geographical location in each region does not significantly influence the improvement of quality in accordance with the National Education Standards (SNP). This can be seen from several analysis results, indicating that regions with adjacent topography do not necessarily have the same SNP score range or are one level below in each mapped area. The results of grouping based on the 8 parameters of the National Education Standards in the mapped areas can be concluded that there are several parameters with the most categories of "Not Meeting SNP" in each mapped area, namely Infrastructure Standards and Process Standards. This indicates that each parameter of the National Education Standards is still not uniformly implemented. From the conclusions of the education quality mapping results, a joint evaluation is needed as a follow-up action to improve education quality uniformly and generate recommendations for appropriate and beneficial quality improvement programs for local governments, relevant agencies, and schools in the future.

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