State Mapping of the Public Health Development Index in Aceh Province using K-Medoids method

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Abstract. Health level mapping is necessary to obtain information on the state of public health in Aceh Province. The study analyzed the clustering of districts/cities in Aceh Province using the Aceh Province Public Health Development Index (PHDI) in 2013 and 2018, which was sourced from the Aceh Health Office. The analytical method used is the K-Medoids grouping method. The results of this study indicate that 4 clusters are consisting of 3 conditions, namely the district/city cluster with a good health level, the district/city cluster with a medium health level, the district/city cluster with a low health level. Districts/cities that experienced significant changes in health levels in 2013 and 2018 are Aceh Besar, Lhokseumawe, Aceh Jaya, Pidie Jaya, Aceh Timur, Gayo Lues, and Simeulue. Meanwhile, Banda Aceh, Sabang, and Langsa city always occupy a cluster position with a high level of health.

1. Introduction

Health is an indicator that is very influential in life. Improvement and maintenance of health levels carried out by the Government of Indonesia in the fifth program of Nawa Cita. The Indonesian community health improvement program is a collaboration of various sectors who are members of the Healthy Indonesia Program. Many program is not only fulfilling the need for medical devices, but also for health services as smart city services [1]. The healthy Indonesia, the main program in health development, is planned for the Ministry of Health's programs of the Republic of Indonesia [2]. There are three pillars of the healthy Indonesia program, namely the application of a healthy paradigm, strengthening health services and implementing the national health insurance. The output expected from this program includes increasing access to health services, cutting referral channels, improving health quality.

The government hopes through the program to control quality and minimize health costs that must be incurred by the community so that the realization of a healthy family. There are twelve main indicators of family health following the family planning (FP) program; mothers give birth in health
facilities, babies receive complete primary immunization, babies receive exclusive breast milk, toddlers receive growth monitoring, pulmonary tuberculosis sufferers receive treatment according to standards, people with hypertension receive regular medication, people with mental disorders receive treatment and not neglected, no family members smoke, the family is a member of the national health insurance, the family has access to clean water, and the family has access or uses a healthy latrine. These indicators are contained in Indonesia's health development strategy.

The Ministry of Health as an extension of the Central Government in carrying out health affairs measures the quality of health services and facilities through PHDI by assessing the main indicators of family health in each region. This index shows the success or failure of health services provided to the community, as well as measuring community participation in treating their disease. Through Law number 23 Regarding Regional Government, it is the authority to establish norms, standards, procedures and criteria in the framework of administering government affairs, carry out guidance and supervision of the administration of government affairs which fall under regional authority, as well as resource development, coordination and guidance, as well as monitoring and evaluation.

The Government of Aceh, the authority of regional health administrators, continues to make improvements for each health indicator that is included in the Aceh development strategy. The special autonomy granted by the national government to the Aceh government have focused development on improving health, education and improving community welfare [3]. Through the "Aceh Teuga" program which adopts the Healthy Indonesia program, the Aceh Government in collaboration with the Aceh Health Office allocates a sizeable special autonomy fund for health. The use of Aceh's special autonomy funds which is the income of the Aceh Government which is allocated for development (construction and maintenance of infrastructure which is the main target), improving the community's economy, reducing poverty and improving education, social and health [4]. Throughout 2020, the Aceh government transferred the Aceh Special Autonomy Fund for handling Covid-19. Revised Aceh Qanun No. 2 of 2008 contained in the Aceh Qanun No. 2 of 2013 allowed to district/city governments to manage autonomy funds independently. This opportunity demands good quality output from the district/city government in providing benefits to the community [5].

This study aims to analyze the mapping of district / municipal health levels in Aceh based on Aceh Health Development Indicators which describe the distribution of health services, health facilities and public health participation in improving and maintaining health levels. This research is expected to contribute thoughts and information to the government in evaluating health programs that have been carried out for future improvements, immensely to improve the quality of health services.

2. Materials and Methods
2.1. K-Medoids
K-Medoids or Partitioning Around Medoid (PAM) is a grouping algorithm similar to K-Means. The difference between these two algorithms is that K-Medoids uses data in the middle of the cluster while K-Means uses the average value as the center of the cluster so that K-Medoids has the advantage of overcoming the weaknesses of K-Means, which are sensitive to outlier [6]. The K-Medoids algorithm is as follows:
1) Initialize k cluster centers (number of clusters)
2) Allocate each data (object) to the nearest cluster using the euclidean distance with the equation:

\[ d_{ik} = d(x_{ij} - v_{kj}) = \sqrt{(x_{i1} - v_{k1})^2 + (x_{i2} - v_{k2})^2 + \ldots + (x_{ij} - v_{kj})^2} \]

where \( d_{ik} \) is the distance between the \( x_{ij} \) data and group center \( v_{kj} \), \( x_{ij} \) is \( j^{th} \) data in variable \( j^{th} \), and \( v_{kj} \) is the group center value of \( k^{th} \) in variable \( j^{th} \).
3) Randomly select objects in each cluster as candidates for the new medoid.
4) Calculate the distance of each object in each cluster with the new medoid candidate.
5) Calculate the total deviation (S) by calculating the new total distance's value - the old total distance. If \( S < 0 \), then replace the old medoid with the new medoid.
6) Repeat steps 3 to 5 until there is no change in medoid, so we get the cluster and each cluster member.
2.2. Data
This study uses secondary data, namely PHDI, which consists of indicators of the availability of health care facilities for children under five, indicators of public health complaint service facilities, and services indicators according to treatment characteristics. The research data was sourced from [7] Aceh Health Office in 2013 and 2018.

Table 1. Research variable

| Variable                                      | Abbreviations | Variable                                      | Abbreviations |
|-----------------------------------------------|---------------|-----------------------------------------------|---------------|
| Prevalence of children with poor nutrition    | X1            | Prevalence of Hypertension                    | X20           |
| Prevalence of very short and short children   | X2            | Prevalence of injury                          | X21           |
| Prevalence of fat toddler                     | X3            | Prevalence of Diabetes Mellitus               | X22           |
| Toddler weighing coverage                     | X4            | Prevalence of mental disorders                | X23           |
| Neonatal visit coverage (KN1)                 | X5            | Prevalence of mental disorders                | X24           |
| Complete basic immunization coverage         | X6            | Oral dental health prevalence                 | X25           |
| Proportion of FP users (MKJP)                 | X7            | Prevalence of Pneumonia                       | X26           |
| Pregnancy check-up coverage (K4)              | X8            | Prevalence of diarrhea (Toddler)              | X27           |
| Prevalence of KEK in WUS                      | X9            | Prevalence of ARI (Toddlers)                  | X28           |
| Coverage of delivery by health workers in health facilities | X10       | Coverage of access and clean water sources   | X29           |
| Proportion of sub-districts that have sufficient doctors per population | X11        | Access to sanitation coverage                 | X30           |
| Proportion of villages that have sufficient Posyandu | X12        | Sub-index for toddler health                  | X31           |
| Proportion of villages with sufficient population midwives | X13        | Reproductive health sub index                 | X32           |
| JPK ownership coverage                        | X14           | Health service sub index                      | X33           |
| Proportion of smoking behavior                | X15           | Health behavior sub index                     | X34           |
| Proportion of proper hand washing behavior    | X16           | Sub-index of non-communicable diseases        | X35           |
| Proportion of defecating behavior in the latrine | X17        | Sub-index of infectious diseases               | X36           |
| Proportion of enough physical activity        | X18           | Environmental health sub-index                | X37           |
| Proportion of correct toothbrush behavior     | X19           |                                               |               |
3. Results and Discussions

3.1. Overview of the health services index of Aceh

Health service is an effort carried out individually or collectively to maintain the quality of health, prevent and cure disease, and restore individuals, families, groups, and communities. An area's health level is assessed by the high or low service index of the area's health services. Aceh is one of the areas with the lowest level of health in Indonesia. The average health service level index in Aceh from 2013 to 2018 is shown in Figure 1.

![Figure 1. Aceh health service index](image)

**Source:** Aceh Health Office 2020 (processed)

Figure 1 shows the average percentage of health service levels in Aceh from 2013 to 2018. Aceh Utara is a district with the lowest average health service index of 0.394. It is due to the lack of availability of health infrastructure and reliable health personnel. Banda Aceh City occupied the highest health service index in Aceh, with an index value of 0.719. The higher the level of education and community welfare in a district/city, the higher the level of public health services. There are nine districts/cities in Aceh with health service index scores above the Aceh average from 2013 to 2018, namely Aceh Tengah, Aceh Jaya, Bireuen, andPidie Jaya, Aceh Besar, Lhokseumawe, Langsa, Sabang, and Banda Aceh.

3.2. Overview of the Aceh environmental health index

The environment is one of the factors that significantly affect humans, especially human health. From an ecological perspective, there are three ecological triad factors: disease agents, humans, and the environment. There needs to be a balance between these three components [8]. Environmental health measures are measured using an index called the Environmental Health Index (EHI). The following is an overview of the EHI Aceh from 2013 to 2018.

Figure 2 shows the average EHI in Aceh from 2013 to 2018. Aceh has an environmental health index of 0.6. Banda Aceh, Sabang, Langsa, Aceh Tengah, and Lhokseumawe are ranked in the top five districts/cities in Aceh with an excellent health index period 2013 to 2018. This environmental health index is strongly influenced by several factors, including the availability of space facilities: green open space, facilities for breastfeeding mothers in public areas, clean water facilities, and areas without smoke. There are several districts in Aceh that have a low EHI, including Pidie, Subulussalam, and Aceh Barat Daya. The low level of environmental health can lead to susceptibility to illness, disability, and even a high mortality rate [9].
Aceh health level mapping

The health level of an area is influenced by the ecological system in the area [10]. So that health is vital, in accordance with the vision and mission of development, namely improving the welfare of the community [11]. Automatically when development is carried out evenly throughout Indonesia, especially Aceh, health will improve. It is because health and education are the main aspects of development. Figures 3 and 4 show a visualization of Aceh's health level in 2013 and the health level of Aceh in 2018.

The results of the district/city clusters in Aceh Province based on PHDI 2013 are as follows:
1. Members of the district/city group in Aceh Province with a high level of public health, namely Banda Aceh, Sabang, Lhokseumawe, Langsa, and Aceh Besar.
2. Members of district/city groups in Aceh Province with moderate public health, namely Aceh Jaya, Pidie Jaya, Bireuen, Bener Meriah, Aceh Tengah, Aceh Timur, Gayo Lues, Aceh Tamiang, Subulussalam, Aceh Singkil, and Simeulue.
3. Members of district/city groups in Aceh Province with a low level of community, namely Pidie, Aceh Barat, Aceh Utara, Aceh Barat Daya, Aceh Selatan, Aceh Tenggara, and Nagan Raya.

The results of the district/city clusters in Aceh Province based on PHDI 2018 are as follows:
1. Members of the district/city group in Aceh Province with a high level of public health, namely Kota Banda Aceh, Sabang, and Kota Langsa.
2. Members of the district/city group in Aceh Province with a moderate public health level, namely Bireuen, Bener Meriah, Aceh Tengah, Aceh Tamiang, and Aceh Singkil.
3. Members of district/city groups in Aceh Province with a low level of community, namely Aceh Besar, Aceh Jaya, Pidie Jaya, Pidie, Aceh Barat, Nagan Raya, Aceh Barat Daya, Aceh Utara, Lhokseumawe, Simeulue, Aceh Timur, Gayo Lues, Aceh Selatan, Aceh Tenggara, and Sublussalam.
The clustering of districts/cities in Aceh Province based on the Aceh PHDI shows that the geographic location and governance structure of the districts/cities greatly influence the results of the clustering produced using the K-Medoids method. The causes of high and low health levels of cluster members include the geographical location of the district/city, socio-cultural conditions, human resources, natural resources, progress from regional development that includes government structures, and health facilities [12].

4. Conclusion
Districts/cities in Aceh Province have low levels of health. It is evident from the analysis of the public health development index data from 2013 to 2018, which resulted in the average percentage of district/city clusters with moderate welfare levels greater than 50% of the total percentage of all districts/cities in Aceh Province. There have been changes to the district/city clusters in Aceh Province from 2013 to 2018 based on public health. The districts/cities that experienced these changes are Aceh Besar, Lhokseumawe, Aceh Jaya, Pidie Jaya, Aceh Timur, Gayo Lues, Simeulue. Meanwhile, Banda Aceh, Sabang, and Langsa always occupy cluster positions with high health levels. It is due to the particular government structure in the form of municipalities.

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