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# Assessing service availability and accessibility of healthcare facilities in Indonesia: A spatially-informed correspondence analysis with visual approach

**Restu Arisanti[a*], Resa Septiani Pontoh[a], Sri Winarni[a], Silvani Dewi Nura Aini[a]**

[a]*Department of Statistics, Padjadjaran University, Indonesia*

**C H R O N I C L E**

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**A B S T R A C T**

A nation's health status can be determined by the availability of healthcare services, which is a crucial part of human life. Since 2011, health facilities in Indonesia have been acknowledged as an important health indicator. This study uses correspondence analysis and spatial visualization to look at the primary healthcare facilities in each region of Indonesia. The analysis makes use of information from Indonesia's province-level data on the number of Regions with health facilities in 2021, along with six different types of medical facilities: hospitals, maternity hospitals, polyclinics, health centers, sub-district health centers, and pharmacies. To show the spread of medical facilities in Indonesia, a spatial representation is also produced. In comparison to provinces on other islands, the analysis reveals that the provinces on Java Island have a more varied and adequate distribution of healthcare facilities. Health facilities on other islands' provinces, however, are only focused on public health and sub-district public health. The spatial representation gives a clear picture of the distribution of medical services and draws attention to the distinctions across Indonesia's regions and islands. The geographical visualization offers a thorough perspective of the distribution of health care facilities, and this study delivers insightful information about how health care facilities are distributed in Indonesia. Future research and policy decisions targeted at enhancing Indonesia's healthcare system can be informed by these findings.



## 1. Introduction

Healthcare facilities in Indonesia include a range of different types of institutions, including hospitals, clinics, health centers, and community health posts. The healthcare system in Indonesia is decentralized, with a mix of public and private providers offering healthcare services. Hospitals in Indonesia can be classified into three categories: general hospitals, specialized hospitals, and teaching hospitals. General hospitals provide a range of healthcare services, while specialized hospitals focus on specific areas such as pediatrics, mental health, or cancer treatment. Teaching hospitals are associated with medical schools and offer training for healthcare professionals. Smaller healthcare institutions like clinics and health centers offer primary care services like treatment, diagnosis, and preventive care. They serve underserved communities and are frequently found in rural locations. Even more compact institutions, community health posts offer fundamental medical care and health information to isolated people. Indonesia also has a developing telemedicine sector, which makes use of technology to deliver healthcare services remotely, in addition to these conventional healthcare facilities. For patients who live in remote locations and do not have easy access to medical facilities, this includes teleconsultation, telemonitoring, and telemedicine services. Overall, healthcare facilities in Indonesia face significant challenges, including limited resources, disparities in healthcare access and outcomes, and a shortage of healthcare workers. However, there are ongoing efforts to improve the

* Corresponding author.
E-mail address: r.arisanti@unpad.ac.id (R. Arisanti)


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healthcare system, including expanding access to healthcare services, improving the quality of care, and investing in healthcare infrastructure.

Like many developing countries, Indonesia has a difficult time ensuring that its citizens have access to healthcare. The country's healthcare system is marked by discrepancies in healthcare outcomes based on elements including poverty and location, as well as a lack of healthcare facilities, particularly in rural areas. Understanding the accessibility and availability of healthcare services in various parts of the nation is crucial for addressing these issues. Indonesia has conducted a number of studies on public health. Spatial analysis is used by Setyawan et al. (2018) to evaluate the distribution of healthcare facilities in Indonesia and identify regions with insufficient access to healthcare services. The utilization of healthcare facilities in Indonesia is then examined by Suparmi et al. (2019), who list the factors that influence facility use, such as socioeconomic status, location, and kind of institution. The same year, Van der Grijp et al. looked at the government's efforts to achieve universal healthcare coverage and gave an overview of Indonesia's healthcare system, including its advantages and disadvantages. In order to evaluate the service accessibility and availability of healthcare facilities in Indonesia, correspondence analysis (Sączewska-Piotrowska, 2021) was employed in this study. Correspondence Analysis is a statistical method that allows us to analyze relationships between categorical variables, such as the types of healthcare facilities available and their geographic locations. Other relevant variables, such population density, demography, or health outcomes, can also be related using correspondence analysis. By examining these relationships, we can gain a better understanding of the factors that drive the distribution and availability of healthcare services in Indonesia, and identify areas where additional investment or policy interventions may be needed to improve access to care. Moreover, correspondence analysis can be utilized to investigate the connection between location and facility type. This can assist us in locating geographically contiguous groups of healthcare facilities as well as patterns of variation in the kinds of facilities that are offered in various geographic locations. We used statistics from the Central Bureau of Statistics and the Indonesian Ministry of Health to map the distribution of healthcare facilities across the nation's regions and look for trends in service accessibility and availability.

The goal of this study is to map the distribution of healthcare facilities, such as hospitals, clinics, and other healthcare facilities, across the various regions of the nation; to identify trends in service accessibility and availability based on variables like geographic location and population density; and to compare the distribution of healthcare facilities across the various regions of the country. Identify regions where healthcare services are weak or unavailable, and offer suggestions for enhancing healthcare access and quality. Evaluate the relationship between the types of healthcare facilities that are offered and their geographic locations.

Our findings can help inform efforts to increase all Indonesians' access to high-quality healthcare services and shed light on the system's advantages and disadvantages. Policymakers can more effectively spend resources and create initiatives to enhance healthcare outcomes by identifying places where healthcare services are limited or inaccessible. Overall, this study helps to understand the accessibility and availability of healthcare services in Indonesia and can provide guidance for attempts to increase healthcare access and quality in other developing nations that face comparable difficulties.

## 2. Literature Review

In order to categorize the Indonesian provinces into categories depending on the number of healthcare facilities in 2021, correspondence analysis was used in this study. To minimize the dimension of variables and characterize the row and column vector profiles of a data matrix from a contingency table, correspondence analysis is used. In correspondence analysis, which is a subset of multivariate analysis, rows and columns from a two-way contingency table are combined into a low-dimensional vector space to study the relationship between two or more variables (Greenacre, 2007). In order to explain the row and column vector profiles of a data matrix derived from a contingency table and to reduce the dimension of variables, correspondence analysis is utilized. To ascertain the interdependence or dependence links among the variables in the data, the observation units are then mapped onto a two-dimensional map based on the attributes evaluated against these units (Beh, 2004).

Correspondence Analysis offers tools for examining the relationships between contingency tables' rows and columns. The basic goal of correspondence analysis is to create straightforward indices that display the relationships between the categories in the rows and columns (Nascimento, 2007). These indices could display simultaneously which row category's column categories have higher "weight" and conversely. A data table is converted by Correspondence Analysis into two sets of factor scores, which can then be shown as maps to show the data in the original table. Rows and columns can conveniently be represented in a single map because the factor scores for both have the same variance (Abdi, 2014). Whereas the data structure in correspondence analysis is a table of frequencies, the data structure in multidimensional scaling is either metric or non-metric and the outcome of measurement. Each variable/unit of analysis is located as a point in a low-dimensional space using correspondence analysis, which aids in the distinct geometrical description of patterns of correlations (Ayele, 2014). Multidimensional scaling, despite their similarities, has a limitation in that it only maps objects based on one set of variables measured against objects; however, the variables are not visible on the map. In contrast,

correspondence analysis also produces a map or a set of observation units, as well as a map for the variables measured on each object.

The outcomes of correspondence analysis typically reveal the optimum dimensions to portray the data, which become the coordinate points and an indicator of how much information is contained in each dimension known as inertia (Johnson, 2007). Moreover, correspondence analysis can reveal the connections between variables (Zhao, 2013). In other words, correspondence analysis finds an initial picture of the links among variables by describing the patterns of the associations between categorical variables in the form of a graph (Mota, 2008).

Simple Correspondence Analysis is a method used to analyze contingency tables with two classifications, while the method used to analyze contingency tables with more than two classifications is called Multiple Correspondence Analysis. Correspondence analysis also has several basic characteristics that need to be considered, namely:

1. Used for non-metric data with nominal and ordinal measurement scales;
2. Can be used for non-linear relationships;
3. There is no assumption about the distribution;
4. There is no hypothesized model;
5. As one of the methods in data exploration, the end result can be a hypothesis that needs to be further tested;
6. One of the grouping structure techniques or data reduction techniques.

Simple Correspondence Analysis is a technique used to evaluate contingency tables with two classes, whereas Multiple Correspondence Analysis is a technique used to study contingency tables with more than two classifications. As one of the methods in data exploration, the end result can be a hypothesis that needs to be further tested. As one of the grouping structure techniques or data reduction techniques. It is important to emphasize that this method is only intended to be used for exploratory reasons (Glynn, 2014). To put it another way, it is a tool for finding things rather than determining their worth or relevance. Relevantly, this descriptive approach does not call for any data-related assumptions (Chapman, 2007). Additionally, there are a few fundamental aspects of correspondence analysis that should be taken into account, including:

1. Used for non-metric data with nominal and ordinal measurement scales.
2. Can be used for non-linear relationships.
3. There is no assumption about the distribution.
4. There is no hypothesized model.
5. Can be used for non-linear relationships.
6. One of the data-reduction or grouping structure strategies

The following are the goals of two-way correspondence analysis: Determine the relationship between one row variable and one column variable; compare the similarity of two categories from the first qualitative variable (row) based on a number of second qualitative variables (column); compare the similarity of two categories from the second qualitative variable (column) based on a number of first qualitative variables (row); and present each category of row and column variables from the contingency tab.

Since correspondence analysis is a data reduction and residual analysis that provides information about two or more dimensional graphs and categorical variables, it is preferred because it can explain in fewer dimensions the lack of homogeneity in row profiles or the dependence or interaction between the rows and columns of cross tables. In a contingency table with categorical variables, correspondence analysis is typically a graphical method for examining the relationship between two variables. In correspondence analysis, a two-dimensional graph is produced with points denoting each variable's categories (Süner, a., & Çelikoğlu, 2010). CA reduces the dimensionality of points by projecting them onto a two-dimensional plane and measuring distance in terms of chi-square distance (De Maesschalck et al., 2000; Greenacre, 2013).The following are factors to take into account when deciding whether to use correspondence analysis against other types of analyses.

**Table 1**
The advantages and disadvantages of correspondence analysis

| Advantages | Disadvantages |
|---|---|
| 1. Excellent for evaluating data including numerous categorical variables that are simple to cross-tabulate. | 1. While data exploration is a good use for this approach, hypothesis testing is not one. |
| 2. Describes the relationships between categories inside each row and column in addition to the relationships between rows and columns. | 2. It lacks a specific process for choosing or figuring out the right number of dimensions. |
| 3. Offers a single, evenly sized image with a combined graphical depiction of row and column categories. | |
| 4. Versatile enough to work with big matrix data. | |

The following processes or steps can be used to conduct correspondence analysis.

1. defining the problem
2. gathering and entering data

3. conducting correspondence analytic methods
4. Creating a clustering map
5. Determining inertia values.

## 3. Research Methods

Secondary data taken from the Indonesian Central Statistical Agency (BPS) website on the number of Regions/Kelurahan with health facilities per province (village) in Indonesia in 2021 was utilized in this study. The observation units in this data are Indonesia's 34 provinces. There are six factors in the form of health care institutions, namely:

- Hospital (RS)
  According to the Regulation of the Minister of Health of the Republic of Indonesia No. 4 of 2018, a hospital is a healthcare facility that provides comprehensive individual healthcare services that include inpatient, outpatient and emergency care.
- Maternity hospital (RSB)
  A maternity hospital is a hospital dedicated to the examination of pregnant women, mothers about to give birth and the health of children under five years old.
- Polyclinic (PK)
  The polyclinic is a general medical center (no treatment or residential area).
- Public Health Center (P)
  Public Health Center is a public health organization that organizes public health efforts and individual health efforts at the first level by prioritizing promotional and preventive efforts in its work areas.
- Sub-District Health Center (PP)
  Sub-District Health Center is a health center service network that provides ongoing health services at a location within the health center's work area.
- Pharmacy (A)
  The pharmacy is a pharmaceutical service facility where pharmacists practice pharmacy.

The data is presented in a table as follows.

**Table 2**
Number of Regions with Health Facilities by Province in Indonesia in 2021

| Province | Hospital | Maternity Hospital | Polyclinic | Public Health Center | Sub District Health Center | Pharmacy |
|---|---|---|---|---|---|---|
| ACEH | 64 | 50 | 210 | 353 | 981 | 239 |
| NORTH SUMATERA | 178 | 192 | 872 | 585 | 1858 | 573 |
| WEST SUMATERA | 48 | 63 | 98 | 274 | 691 | 201 |
| RIAU | 59 | 76 | 265 | 229 | 913 | 261 |
| JAMBI | 35 | 32 | 62 | 196 | 635 | 130 |
| SOUTH SUMATERA | 59 | 57 | 134 | 350 | 911 | 171 |
| BENGKULU | 18 | 8 | 30 | 177 | 444 | 97 |
| LAMPUNG | 46 | 100 | 312 | 320 | 833 | 226 |
| BANGKA BELITUNG | 16 | 60 | 33 | 62 | 163 | 55 |
| RIAU ISLAND | 25 | 21 | 64 | 77 | 224 | 77 |
| WEST JAVA | 244 | 341 | 1499 | 1074 | 1835 | 1356 |
| CENTRAL JAVA | 247 | 428 | 1035 | 881 | 1823 | 1553 |
| YOGYAKAR TA | 55 | 59 | 146 | 121 | 306 | 174 |
| EAST JAVA | 274 | 307 | 873 | 987 | 2327 | 1424 |
| BANTEN | 60 | 111 | 445 | 233 | 279 | 313 |
| BALI | 39 | 26 | 57 | 119 | 487 | 160 |
| NUSA TENGGARA | 22 | 11 | 55 | 165 | 532 | 147 |
| NUSA TENGGARA | 40 | 16 | 99 | 377 | 980 | 113 |
| WEST KALIMANT AN | 35 | 18 | 81 | 258 | 806 | 84 |
| CENTRAL | 17 | 7 | 74 | 200 | 993 | 59 |
| SOUTH | 27 | 12 | 94 | 234 | 505 | 118 |
| EAST KALIMANTAN | 31 | 31 | 113 | 193 | 684 | 147 |
| NORTH | 7 | 2 | 13 | 50 | 176 | 32 |
| NORTH SULAWESI | 35 | 27 | 53 | 212 | 508 | 111 |
| CENTRAL SULAWESI | 20 | 10 | 34 | 182 | 676 | 122 |
| SOUTH SULAWESI | 63 | 70 | 134 | 447 | 1324 | 323 |
| SOUTHEAST | 22 | 11 | 25 | 266 | 474 | 109 |
| GORONTALO | 12 | 1 | 9 | 96 | 224 | 66 |
| WEST SULAWESI | 8 | 1 | 12 | 93 | 239 | 28 |
| MALUKU | 27 | 6 | 31 | 188 | 438 | 51 |
| NORTH MALUKU | 17 | 1 | 14 | 130 | 263 | 62 |
| WEST PAPUA | 14 | 2 | 30 | 144 | 434 | 58 |
| PAPUA | 43 | 10 | 154 | 386 | 983 | 91 |

The data shown above is a data structure that can be utilized for correspondence analysis, which is non-metric data displayed in a contingency table with a frequency in each cell.

**Correspondence Analysis**

The correspondence analysis algorithm is used to identify the position or coordinates of variables and objects investigated are as follows:

1. Entering information from the contingency table into a contingency matrix.
2. Constructing a correspondence matrix with proportional elements
3. Creating a row diagonal matrix using the proportion values of the total rows (Dr) and a column diagonal matrix that contains the proportion values of the total columns (Dc)
4. Using the following formula, create a row profile matrix R and a column profile matrix C:

$$R = D_r^{-1}P$$

$$R = PD_c^{-1}$$

5. Determining the row center (c = $R'r$) and column center (c = $C'c$).
6. Calculating the inertia value.

**Spatial Visualization Approach**

The term "spatial regression" refers to data analysis that uses geography or geographical location, where data can be linked to actual places on a map or geographic coordinates. Spatial regression is used to investigate the relationship between certain variables and geographical data or data connected to geographic locations (Arisanti, 2010).

Choropleth maps are a type of geographical analysis that use color to show spatial data. Spatial analysis includes both the study of geographic information and the links between distinct geographical elements. Looking at data distribution patterns, discovering clusters of data points, and analyzing geographical relationships between various variables may be part of this.

A choropleth map is a type of spatial analysis that uses color to represent data values across different geographic locations. This allows users to identify places with high or low data concentrations and visualize data distribution trends.

Choropleth maps have a wide range of applications, including the examination of social, economic, and medical data. A choropleth map depicting the distribution of healthcare institutions in Indonesia, for example, might be used to identify places with a large demand for greater healthcare resources.

Choropleth maps are an effective tool for displaying and analyzing geographic data, making it easier to see patterns and linkages that may be missed by other data analysis approaches. This is the general link between spatial analysis and choropleth maps.

The following are the main processes for creating a choropleth map depicting the number of medical facilities in Indonesia:

1. Compile data Count the number of medical facilities in each administrative region or unit in Indonesia. This information can be gathered via government databases or public health tools.
2. Determine the administrative divisions: Choose the regions or administrative divisions to display on the choropleth map. In Indonesia, these could be cities, districts, or provinces.
3. Choose a mapping program: Choose a program that can generate choropleth maps. Internet map-making tools such as QGIS, ArcGIS, Tableau, and Google Maps are widely available and can be used for free or for a fee.
4. Save the data: Add data from the mapping tool on the number of healthcare facilities. The data should be organized by region or administrative division.
5. Choose a color scheme: Determine which color scheme best captures the data's range of values. You could, for example, use a red-to-green gradient, with red denoting a scarcity of healthcare services and green denoting an abundance of healthcare facilities.
6. Sort the data into categories: Split the data into groups based on the number of healthcare institutions. This will decide the shading of each administrative unit on the map. Classification procedures that are frequently employed include natural breaks, equal intervals, and quantiles.
7. Create the map: Using the mapping tool, create the choropleth map by assigning a different hue to each administrative unit based on the classified information. Provide a legend describing the color scheme and value range.
8. Make the map more informative and user-friendly by adding labels, headings, and other visual elements.

## 4. Result and Discussion

### *4.1 Data Input*

The data from Table 2 was entered. The data will then be analyzed using simple correspondence analysis to evaluate the similarity of provinces in Indonesia in 2021 based on the number of Regions/urban neighborhoods with health facilities per province (Regions/urban neighborhoods).

A mosaic plot can be used to visualize the disparities in Regions/urban neighborhoods with healthcare facilities by province in 2021.

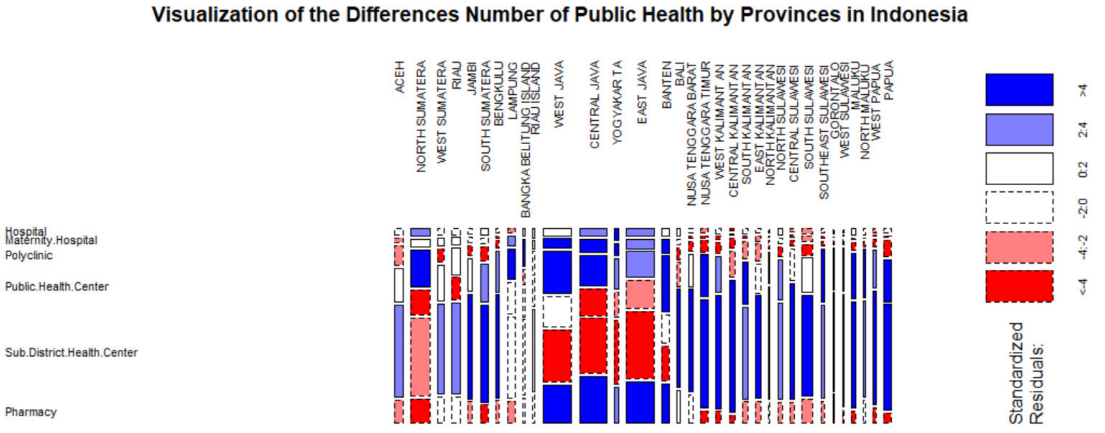


**Fig. 1**. Visualization of the differences in the number of healthcare facilities according to Province in Indonesia

According to the plot above, DKI Jakarta province has more complete amenities than other provinces. Following that, the longest line displayed in the plot for each province shows the province with the greatest number of healthcare institutions. Each province shows that the majority of the highest number of healthcare institutions in each province is a sub-district community health center. According to province, the following are the most common healthcare facilities:

1. Aceh: sub-district public health center
2. North Sumatra: sub-district public health center
3. West Sumatra: sub-district public health center
4. Riau: sub-district public health center
   ...
5. Papua: sub-district public health center

### *4.2 Creating Contingency Table*

The data structure utilized in correspondence analysis is presented in the form of a two-way contingency table, with each cell containing frequency.

**Table 3**
Two Way Contingency Table

| Province | RS | RSB | PK | P | PP | A |
|---|---|---|---|---|---|---|
| ACEH | 64 | 50 | 210 | 353 | 981 | 239 |
| NORTH SUMATERA | 178 | 192 | 872 | 585 | 1858 | 573 |
| WEST SUMATERA | 48 | 63 | 98 | 274 | 691 | 201 |
| RIAU | 59 | 76 | 265 | 229 | 913 | 261 |
| JAMBI | 35 | 32 | 62 | 196 | 635 | 130 |
| SOUTH SUMATERA | 59 | 57 | 134 | 350 | 911 | 171 |
| BENGKULU | 18 | 8 | 30 | 177 | 444 | 97 |
| LAMPUNG | 46 | 100 | 312 | 320 | 833 | 226 |
| BANGKA BELITUNG | 16 | 60 | 33 | 62 | 163 | 55 |
| RIAU ISLAND | 25 | 21 | 64 | 77 | 224 | 77 |
| WEST JAVA | 244 | 341 | 1499 | 1074 | 1835 | 1356 |
| CENTRAL JAVA | 247 | 428 | 1035 | 881 | 1823 | 1553 |
| YOGYAKAR TA | 55 | 59 | 146 | 121 | 306 | 174 |
| EAST JAVA | 274 | 307 | 873 | 987 | 2327 | 1424 |
| BANTEN | 60 | 111 | 445 | 233 | 279 | 313 |
| BALI | 39 | 26 | 57 | 119 | 487 | 160 |

**Table 3**
Two Way Contingency Table (Continued)

| Province | RS | RSB | PK | P | PP | A |
|---|---|---|---|---|---|---|
| NUSA TENGGARA BARAT | 22 | 11 | 55 | 165 | 532 | 147 |
| NUSA TENGGARA TIMUR | 40 | 16 | 99 | 377 | 980 | 113 |
| WEST KALIMANT AN | 35 | 18 | 81 | 258 | 806 | 84 |
| CENTRAL KALIMANTAN | 17 | 7 | 74 | 200 | 993 | 59 |
| SOUTH KALIMANTAN | 27 | 12 | 94 | 234 | 505 | 118 |
| EAST KALIMANTAN | 31 | 31 | 113 | 193 | 684 | 147 |
| NORTH KALIMANTAN | 7 | 2 | 13 | 50 | 176 | 32 |
| NORTH SULAWESI | 35 | 27 | 53 | 212 | 508 | 111 |
| CENTRAL SULAWESI | 20 | 10 | 34 | 182 | 676 | 122 |
| SOUTH SULAWESI | 63 | 70 | 134 | 447 | 1324 | 323 |
| SOUTHEAST SULAWESI | 22 | 11 | 25 | 266 | 474 | 109 |
| GORONTALO | 12 | 1 | 9 | 96 | 224 | 66 |
| WEST SULAWESI | 8 | 1 | 12 | 93 | 239 | 28 |
| MALUKU | 27 | 6 | 31 | 188 | 438 | 51 |
| NORTH MALUKU | 17 | 1 | 14 | 130 | 263 | 62 |
| WEST PAPUA | 14 | 2 | 30 | 144 | 434 | 58 |
| PAPUA | 43 | 10 | 154 | 386 | 983 | 91 |

### *4.3 Calculating Row and Column Proportions*

**Table 4**
Proportion of Row Total

| Province | RS | RSB | PK | P | PP | A |
|---|---|---|---|---|---|---|
| ACEH | 0.034 | 0.026 | 0.111 | 0.186 | 0.517 | 0.126 |
| NORTH SUMATERA | 0.042 | 0.045 | 0.205 | 0.137 | 0.436 | 0.135 |
| WEST SUMATERA | 0.035 | 0.046 | 0.071 | 0.199 | 0.503 | 0.146 |
| RIAU | 0.033 | 0.042 | 0.147 | 0.127 | 0.506 | 0.145 |
| JAMBI | 0.032 | 0.029 | 0.057 | 0.180 | 0.583 | 0.119 |
| SOUTH SUMATERA | 0.035 | 0.034 | 0.080 | 0.208 | 0.542 | 0.102 |
| BENGKULU | 0.023 | 0.010 | 0.039 | 0.229 | 0.574 | 0.125 |
| LAMPUNG | 0.025 | 0.054 | 0.170 | 0.174 | 0.453 | 0.123 |
| BANGKA BELITUNG | 0.041 | 0.154 | 0.085 | 0.159 | 0.419 | 0.141 |
| RIAU ISLAND | 0.051 | 0.043 | 0.131 | 0.158 | 0.459 | 0.158 |
| WEST JAVA | 0.038 | 0.054 | 0.236 | 0.169 | 0.289 | 0.214 |
| CENTRAL JAVA | 0.041 | 0.072 | 0.173 | 0.148 | 0.306 | 0.260 |
| YOGYAKARTA | 0.064 | 0.069 | 0.170 | 0.141 | 0.355 | 0.202 |
| EAST JAVA | 0.044 | 0.050 | 0.141 | 0.159 | 0.376 | 0.230 |
| BANTEN | 0.042 | 0.077 | 0.309 | 0.162 | 0.194 | 0.217 |
| BALI | 0.044 | 0.029 | 0.064 | 0.134 | 0.548 | 0.180 |
| NUSA TENGGARA BARAT | 0.024 | 0.012 | 0.059 | 0.177 | 0.571 | 0.158 |
| NUSA TENGGARA TIMUR | 0.025 | 0.010 | 0.061 | 0.232 | 0.603 | 0.070 |
| WEST KALIMANTAN | 0.027 | 0.014 | 0.063 | 0.201 | 0.629 | 0.066 |
| CENTRAL KALIMANTAN | 0.013 | 0.005 | 0.055 | 0.148 | 0.736 | 0.044 |
| SOUTH KALIMANTAN | 0.027 | 0.012 | 0.095 | 0.236 | 0.510 | 0.119 |
| EAST KALIMANTAN | 0.026 | 0.026 | 0.094 | 0.161 | 0.570 | 0.123 |
| NORTH KALIMANTAN | 0.025 | 0.007 | 0.046 | 0.179 | 0.629 | 0.114 |
| NORTH SULAWESI | 0.037 | 0.029 | 0.056 | 0.224 | 0.537 | 0.117 |
| CENTRAL SULAWESI | 0.019 | 0.010 | 0.033 | 0.174 | 0.648 | 0.117 |
| SOUTH SULAWESI | 0.027 | 0.030 | 0.057 | 0.189 | 0.561 | 0.137 |
| SOUTHEAST SULAWESI | 0.024 | 0.012 | 0.028 | 0.293 | 0.523 | 0.120 |
| GORONTALO | 0.029 | 0.002 | 0.022 | 0.235 | 0.549 | 0.162 |
| WEST SULAWESI | 0.021 | 0.003 | 0.031 | 0.244 | 0.627 | 0.073 |
| MALUKU | 0.036 | 0.008 | 0.042 | 0.254 | 0.591 | 0.069 |
| NORTH MALUKU | 0.035 | 0.002 | 0.029 | 0.267 | 0.540 | 0.127 |
| WEST PAPUA | 0.021 | 0.003 | 0.044 | 0.211 | 0.636 | 0.085 |
| PAPUA | 0.026 | 0.006 | 0.092 | 0.232 | 0.590 | 0.055 |

From the calculation of the proportion of each cell relative to the total rows (each province) that correspond, we can interpret the proportion of the most common types of health facilities as detailed below:

1. Aceh = Sub-district health center with a proportion of 51.71%
2. North Sumatera = Sub-district health center with a proportion of 43.64%
3. West Sumatera = Sub-district health center with a proportion of 50.26%
4. Riau = Sub-district health center with a proportion of 50.64%

…

30. West Sulawesi = Sub-district health center with a proportion of 62.73%
31. Maluku = Sub-district health center with a proportion of 59.11%
32. North Maluku = Sub-district health center with a proportion of 54%
33. West Papua = Sub-district health center with a proportion of 63.64%
34. Papua = Sub-district health center with a proportion of 58.97%

**Table 5**
Proportion of Column Total

| Province | RS | RSB | PK | P | PP | A |
|---|---|---|---|---|---|---|
| ACEH | 0.034 | 0.023 | 0.029 | 0.037 | 0.039 | 0.027 |
| NORTH SUMATERA | 0.093 | 0.089 | 0.122 | 0.061 | 0.074 | 0.066 |
| WEST SUMATERA | 0.025 | 0.029 | 0.014 | 0.028 | 0.028 | 0.023 |
| RIAU | 0.031 | 0.035 | 0.037 | 0.024 | 0.037 | 0.030 |
| JAMBI | 0.018 | 0.015 | 0.009 | 0.020 | 0.025 | 0.015 |
| SOUTH SUMATERA | 0.031 | 0.026 | 0.019 | 0.036 | 0.037 | 0.020 |
| BENGKULU | 0.009 | 0.004 | 0.004 | 0.018 | 0.018 | 0.011 |
| LAMPUNG | 0.024 | 0.046 | 0.044 | 0.033 | 0.033 | 0.026 |
| BANGKA BELITUNG | 0.008 | 0.028 | 0.005 | 0.006 | 0.007 | 0.006 |
| RIAU ISLAND | 0.013 | 0.010 | 0.009 | 0.008 | 0.009 | 0.009 |
| WEST JAVA | 0.128 | 0.157 | 0.209 | 0.111 | 0.074 | 0.155 |
| CENTRAL JAVA | 0.130 | 0.198 | 0.145 | 0.091 | 0.073 | 0.178 |
| YOGYAKAR TA | 0.029 | 0.027 | 0.020 | 0.013 | 0.012 | 0.020 |
| EAST JAVA | 0.144 | 0.142 | 0.122 | 0.102 | 0.093 | 0.163 |
| BANTEN | 0.031 | 0.051 | 0.062 | 0.024 | 0.011 | 0.036 |
| BALI | 0.020 | 0.012 | 0.008 | 0.012 | 0.020 | 0.018 |
| NUSA TENGGARA BARAT | 0.012 | 0.005 | 0.008 | 0.017 | 0.021 | 0.017 |
| NUSA TENGGARA TIMUR | 0.021 | 0.007 | 0.014 | 0.039 | 0.039 | 0.013 |
| WEST KALIMANTAN | 0.018 | 0.008 | 0.011 | 0.027 | 0.032 | 0.010 |
| CENTRAL KALIMANTAN | 0.009 | 0.003 | 0.010 | 0.021 | 0.040 | 0.007 |
| SOUTH KALIMANTAN | 0.014 | 0.006 | 0.013 | 0.024 | 0.020 | 0.014 |
| EAST KALIMANTAN | 0.016 | 0.014 | 0.016 | 0.020 | 0.027 | 0.017 |
| NORTH KALIMANTAN | 0.004 | 0.001 | 0.002 | 0.005 | 0.007 | 0.004 |
| NORTH SULAWESI | 0.018 | 0.012 | 0.007 | 0.022 | 0.020 | 0.013 |
| CENTRAL SULAWESI | 0.010 | 0.005 | 0.005 | 0.019 | 0.027 | 0.014 |
| SOUTH SULAWESI | 0.033 | 0.032 | 0.019 | 0.046 | 0.053 | 0.037 |
| SOUTHEAST SULAWESI | 0.012 | 0.005 | 0.003 | 0.028 | 0.019 | 0.012 |
| GORONTALO | 0.006 | 0.000 | 0.001 | 0.010 | 0.009 | 0.008 |
| WEST SULAWESI | 0.004 | 0.000 | 0.002 | 0.010 | 0.010 | 0.003 |
| MALUKU | 0.014 | 0.003 | 0.004 | 0.019 | 0.018 | 0.006 |
| NORTH MALUKU | 0.009 | 0.000 | 0.002 | 0.013 | 0.011 | 0.007 |
| WEST PAPUA | 0.007 | 0.001 | 0.004 | 0.015 | 0.017 | 0.007 |
| PAPUA | 0.023 | 0.005 | 0.022 | 0.040 | 0.039 | 0.010 |

The fraction of each cell in relation to the associated column has been computed using the equations above (each type of health facility). It can be considered that the proportion of the largest facility type in each province in Indonesia can be specified as follows for each type of health institution:

1. Hospital = East Java province with a proportion of 13.66%
2. Maternity hospital = Central Java province with a proportion of 18.55%
3. Clinic = West Java province with a proportion of 20.27%
4. Public health center = West Java province with a proportion of 10.84%
5. Sub-district health center = East Java province with a proportion of 9.33%
6. Pharmacy = Central Java province with a proportion of 17.23%

*4.4 Correspondence Analysis*

**Table 6**
Principal Inertias (eigenvalues)

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Value | 0.112201 | 0.012094 | 0.007975 | 0.004897 | 0.001273 |
| Percentage | 81.05% | 8.74% | 5.76% | 3.54% | 0.92% |

The following information can be gathered from Table 6: a. Dimension 1 may explain 81% of the variation with an eigenvalue of 0.112. b. Dimension 2 has an eigenvalue of 0.0121 and can explain 8.7% of the variation, for a total explained variance of 89.8%. c. Dimension 3 has an eigenvalue of 0.007975 and can explain 5.8% of the variation, for a total explained variance of 95.5%. d. Dimension 4 has an eigenvalue of 0.004897 and can explain 3.5% of the variation, for a total explained variance of 99.1%. e. Dimension 5 has an eigenvalue of 0.001273 and can explain 0.9% of the variation, for a total explained variance of 100%. Hence, the two-dimensional cumulative inertia proportion is already 89.8%. As a result, if the data on

the number of healthcare facilities in Indonesia in 2021 is mapped into two dimensions, the data diversity or features that can be explained account for 89.8% of the overall data diversity. The two-dimensional mapping loses 10.2% of its information. The province of West Java has the highest row mass value of 0.114308. This suggests that West Java will have the most healthcare facilities in 2021, followed by the Special Area of Yogyakarta, which has a population of 0.111481. Meanwhile, North Kalimantan province has the smallest mass value of 0.005041, indicating that North Kalimantan will have the fewest healthcare facilities in 2021. The healthcare institution puskesmas pembantu has the highest column mass value of 0.449184. This indicates that in 2021, the sub-district healthcare facility will be the most commonly available in every province in Indonesia. Meanwhile, the smallest mass value is 0.036116 for hospitals. This suggests that hospitals are the least available healthcare institution in Indonesian provinces when compared to other healthcare facilities.

### *4.5 Creating Mapping Graphs*

Correspondence analysis tries to discover the link between one categorical variable in the rows with one categorical variable in the columns using non-metric data in the form of a contingency table that comprises frequencies. Based on the qualities assessed against the objects or observation units, it maps the observation units into a two-dimensional map. It also seeks to determine the interdependence or interrelationships between the variables in the data. A correspondence map of all 34 provinces in Indonesia against the number of health facilities in Indonesia in 2021 was also obtained after obtaining the coordinate points from the previous calculation of the correspondence analysis, with the dimension for the coordinate formation being two dimensions. In the R software output, you can see the correspondence map.

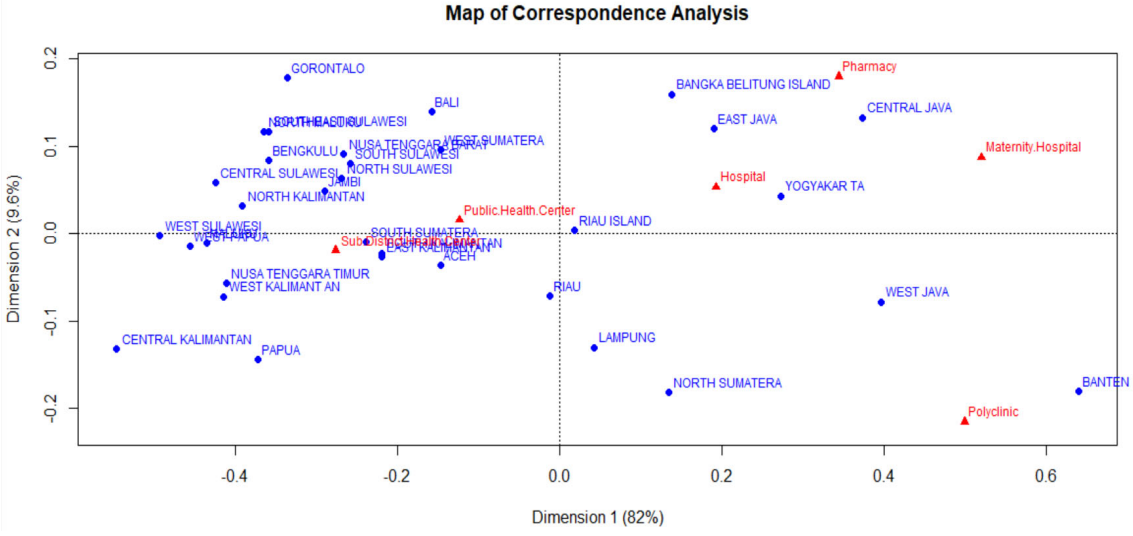


**Fig. 2**. Map of Correspondence Analysis

Based on the data "Number of Region/Cities that Have Health Facilities by Province (Village) in Indonesia in 2021," the correspondence analysis plot illustrates the positions of 34 provinces in Indonesia and 6 variables of health facilities. If the coordinate point in the two-dimensional graph above is (0,0), the graph is divided into four quadrants. In 2018, each quadrant is generated based on the six health facility characteristics in Indonesia. The constructed quadrants represent the similarity of each province to its health-care facilities, as explained below:

- Quadrant I (pharmacy, hospital, and maternity hospital) includes DKI Jakarta, Bangka Belitung Islands, Central Java Province, DI Yogyakarta, and West Java;
- Quadrant II (community health center) the average province in Indonesia is concentrated in quadrant II;
- Quadrant III (sub-district health center) includes West Kalimantan Province, Central Kalimantan, Papua, and Riau, as well as several other provinces;
- Quadrant IV (polyclinic) includes West Java, Banten, North Sumatra, and Lampung.

Unfortunately, quadrant mapping cannot be used as a reference for mapping provinces in Indonesia based on the Number of Regions/Cities with Health Facilities by Province in 2021, namely hospitals, maternity hospitals, polyclinics, community health centers, sub-district health centers, and pharmacies, because certain provinces are in different quadrants but have close distances or high similarities.

The overall graph shows that based on the distance between provinces, it almost suggests their similarity, hence they can be categorized as follows:

- Group 1: in Central Java Province there is a dominant health facility in the form of a pharmacy;

- Group 2: on average, provinces in Indonesia have a dominant health facility in the form of community health centers;
- Group 3: in Papua, there is a dominant health facility in the form of sub-district health centers; Group 4: in Banten, there is a dominant health facility in the form of polyclinics;

Meanwhile, numerous provinces are not featured in the above groups, indicating that particular health facilities do not dominate in certain areas. In addition to the location (blue dots), the kind of health institution shows that polyclinics and maternity hospitals have similarities, whereas other health facilities do not.

Overall, the two-dimensional map above clearly demonstrates that provinces on the island of Java have more diverse and adequate health-care services. Meanwhile, community health clinics and sub-district health centers predominate in provinces on other islands.

### *4.6 Visualizing Spatial Approach*

A choropleth is a themed map that uses color to display spatial information. This information could be provided through a choropleth map depicting the distribution of healthcare facilities across Indonesia's main regions. This can be used to locate locations with a lot of medical facilities as well as locations with limited access to healthcare. Fig. 3 to Fig. 8 show a representation of the number of healthcare facilities in Indonesia.

On a choropleth map, each region or administrative unit is colored based on the number of healthcare facilities present. A color gradient is typically employed for shading, with darker shades representing a greater number of healthcare institutions and lighter hues denoting less.

By looking at the choropleth map, policymakers and healthcare professionals can identify places with a high need for more healthcare facilities and allocate resources accordingly. Academics and public health officials can use the map to investigate patterns in healthcare accessibility and identify places that are particularly vulnerable to health disparities.

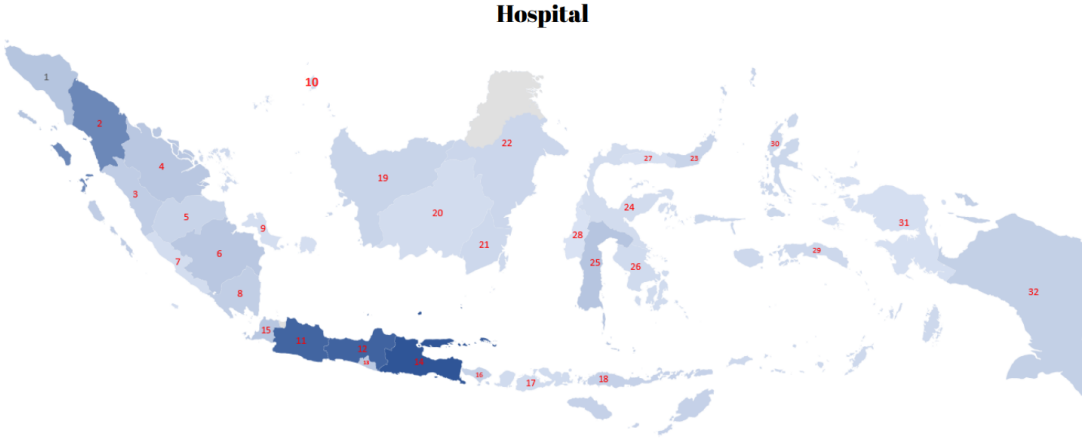


**Fig. 3**. Visualization of the number of Hospital in Indonesia

Note:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1: Aceh | 5: Jambi | 9: Bangka Belitung | 13: Yogyakarta | 17: Nusa Tenggara Barat | 21: South Kalimantan | 25: South Sulawesi | 29: Maluku |
| 2: North Sumatera | 6: South Sumatera | 10: Kepulauan Riau | 14: East Java | 18: Nusa Tenggara Timur | 22: East Kalimantan | 26: Southeast Sulawesi | 30: North Maluku |
| 3: West Sumatera | 7: Bengkulu | 11: West Java | 15: Banten | 19: West Kalimantan | 23: North Sulawesi | 27: Gorontalo | 31: West Papua |
| 4: Riau | 8: Lampung | 12: Central Java | 16: Bali | 20: East Kalimantan | 24: Central Sulawesi | 28: West Sulawesi | 32: Papua |

A choropleth map is a form of thematic map that employs color to indicate varying values of a certain variable throughout time and space. In this scenario, the variable being represented is the number of hospitals in various Indonesian provinces.

The brightest colors, signifying the greatest number of hospitals, are concentrated in certain provinces, including Aceh, Jambi, North Kalimantan, West Kalimantan, South Kalimantan, Banten, East Java, South Sulawesi, and Central Sulawesi, as seen in Figure 3. In comparison to other locations in Indonesia, these provinces appear to have a higher concentration of hospitals.

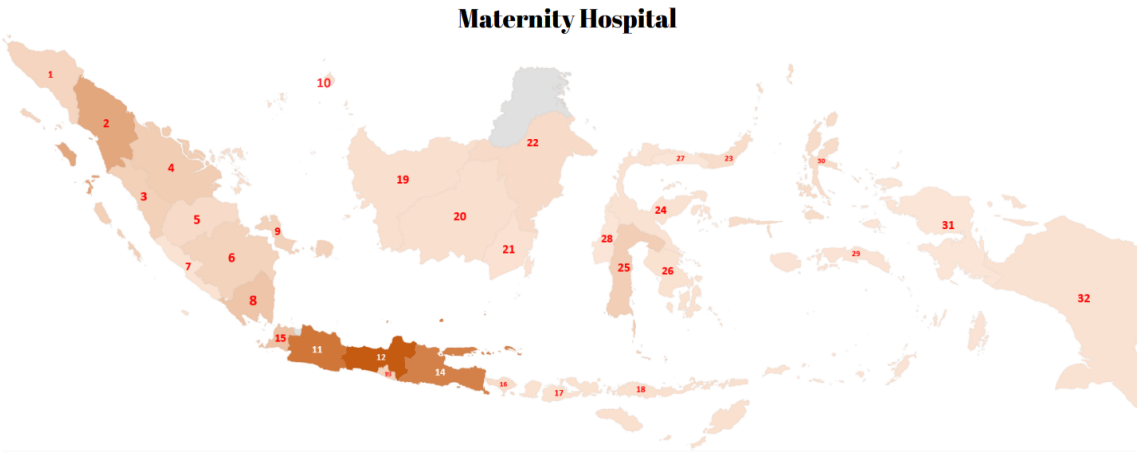


**Fig.4**. Visualization of the number of Maternity Hospital in Indonesia

The brightest colors, signifying the greatest number of maternity hospitals, are concentrated in numerous provinces, notably Jambi, Bangka Belitung, North Kalimantan, and Central Sulawesi, as seen in **Figure 4**. When compared to other locations in Indonesia, these provinces tend to have a higher concentration of maternity hospitals.

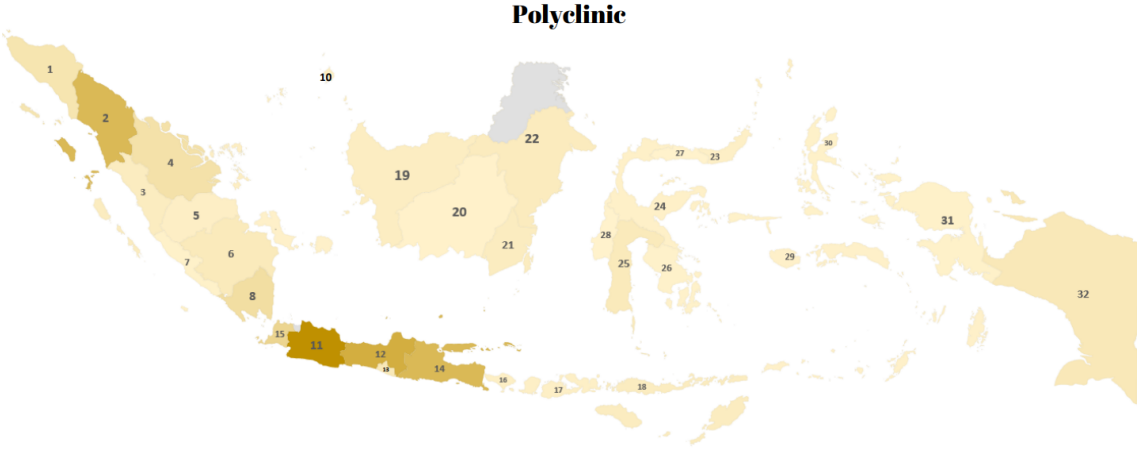


**Fig.5**. Visualization of the number of Polyclinic in Indonesia

The choropleth map depicts the spread of clinics across Indonesia's various provinces. The map is color-coded, with the provinces of North Kalimantan, West Kalimantan, East Java, and South-East Sulawesi having the fewest clinics depicted by shades of brown. In contrast, the most clinics are represented by brown tones in the regions of Central Kalimantan and Bali.

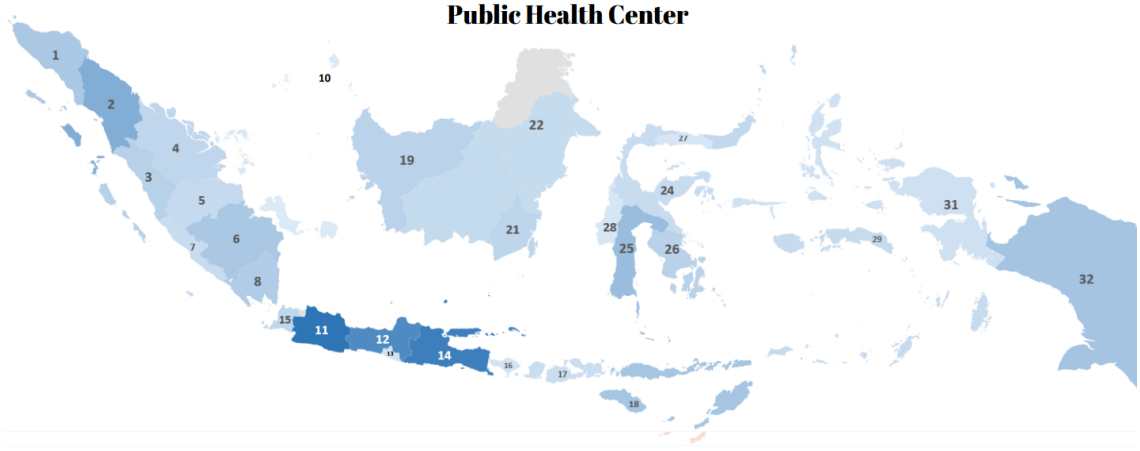


**Fig.6**. Visualization of the number of Public Health Center in Indonesia

According to the figure in **Figure 6**, the provinces of Aceh, East Java, Central Sulawesi, Maluku, and West Papua have the fewest public health facilities, as indicated by the lighter hues on the map. Provinces with darker colors, such as Jakarta and West Java, on the other hand, have a higher frequency of public health problems.

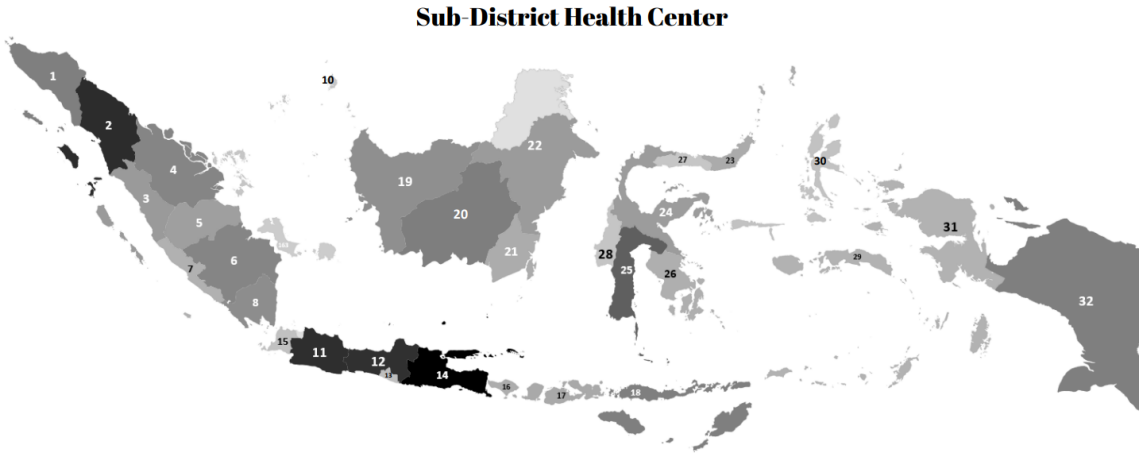


**Fig.7**. Visualization of the number of Sub-District Health Center in Indonesia

The provinces of Jambi, Banten, West Java, Central Kalimantan, Central Sulawesi, and North Maluku, which are depicted on the map in Figure 7, are those with the least Sub-District health Centers, as seen by the lighter hues on the map. Contrarily, provinces with deeper hues, including Riau, West Sulawesi, and West Sumatra, have more Sub-District health Centers.

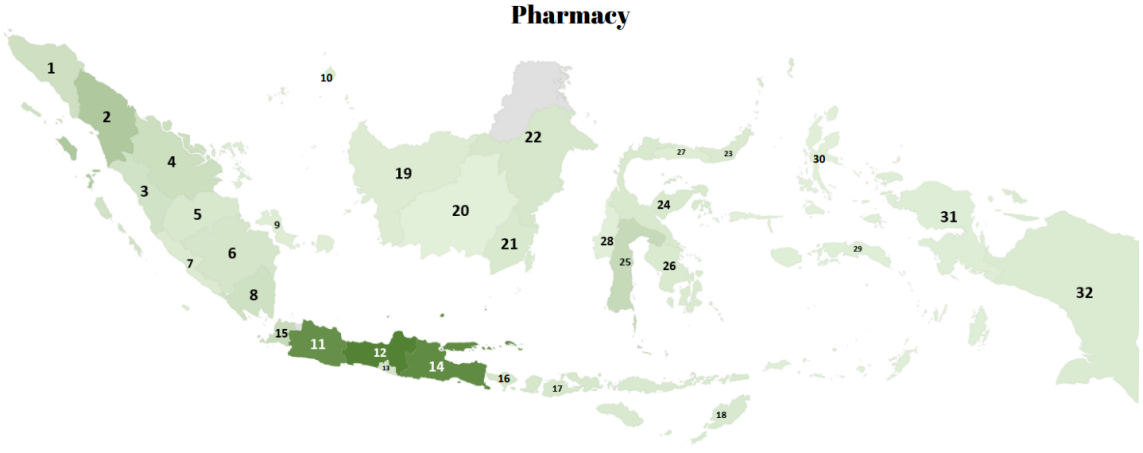


**Fig.8**. Visualization of the number of Pharmacy in Indonesia

The provinces of West Kalimantan and North Sumawesi have the fewest Sub-District health Centers, according to the map in Fig. 8, which is shown by the lighter hues. The number of Sub-District health Centers is larger in provinces with darker colors, such as North Kalimantan, Central Kalimantan, and East Java.

Overall, the choropleth map gives a visual picture of how public health cases are distributed throughout Indonesia, with lighter colors denoting regions with lower frequency and darker colors denoting regions with higher incidence.

## 5. Conclusion and Future Research

### *5.1 Conclusion*

Based on the analysis's findings using the correspondence analysis method on the data "Number of Regions/Sub-Districts that Have Health Facilities by Province in Indonesia in 2021" with observation units made up of 34 provinces in Indonesia and 6 variables, including hospitals (RS), maternity hospitals (RSB), polyclinic health facilities (PK), community health centers (P), sub-district health centers (PP), and pharmacies (A), it is believed that there will be an increase in the number of regions and However, because some provinces are spread over multiple quadrants yet are close by or otherwise rather comparable, four groups were created based on the distance from each health facility variable. This classification is based

on the correspondence analysis findings, which also contain the proportion, mass, chi-square, inertia, and standard coordinate points values. As a result, the correspondence map shows how Indonesia's 34 provinces will be mapped in 2021 depending on the health facilities available in each village and sub-district.

The dominant health facilities in each province can be identified based on the research findings. In order to better ensure public health in these regions, healthcare professionals can use this as an evaluation tool to construct and upgrade the standard of the health facilities that are still underutilized in each province.

### *5.2 Future Research*

Based on the findings of the aforementioned study, the author suggests expanding and deepening the study of the variables connected to different types of healthcare facilities. It is possible to conduct a more thorough examination of the observation unit under consideration so that the construction of healthcare facilities can be better targeted, for instance by employing Indonesian cities and districts as the observation unit.

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