Accessibility, Distribution, and Fulfillment of Hospital Needs in Metro City, Lampung with 2SFCA Method

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Abstract. Health is one of the basic needs needed by everyone. Therefore, the government and community development should prioritize improving public health services. Hospitals in an area have an important role in community social services, especially health services. This research was conducted to assess hospitals' distribution and availability and analyze the quality and health services in Metro City. The 2SFCA method was used to determine the level of accessibility in Metro City. The accessibility value could assess the distribution and fulfillment of existing hospitals in Metro City and analyze the quality and health services there. The distribution of hospitals in Metro City showed that, on average, the hospitals are spread over areas with a high population density. The level of need and fulfillment of hospital facilities in Metro City is appropriate because hospitals are directly proportional to the number of residents. The 2SFCA results also showed a tendency for accessibility between hospitals and cities where accessibility is high in areas around hospitals, such as the Central Metro Area. However, in some cases, an area that has a good level of accessibility does not necessarily get good health services. Inadequate accessibility indicated that the fulfillment of hospitals in Metro City has not been fulfilled and is spread evenly in each region. With high accessibility and fulfillment, people can access health services better.

Keywords: Health · Accessibility · Hospital · Metro City · 2SFCA

1 Introduction

Health is an important aspect of life (Fikriyah et al., 2022). Medical and health services have been an important part of social public service facilities for a long time, and the rationality and accessibility of the layout of medical facilities is one of the key factors of public services (Wang et al., 2021). The trade-off between equity and efficiency is a key issue in the spatial distribution of health services. Regarding equity, the WHO initiated a strategy for universal coverage of health services (S. Zhang et al., 2021). Since health is part of the basic needs needed by everyone, therefore, health services are one of the main pillars the government is trying to provide, finance, and manage to maintain public

health (Khashoggi & Murad, 2021). Many environmental characteristics are believed to be one factor that accelerates the spread of various diseases (Ghazali et al., 2021). Therefore, health services are improved with various policies, including procuring health facilities such as hospitals. Hospitals in an area have an important role in community social services, especially health services. Hospitals are health service institutions that provide complete individual health services that provide inpatient, outpatient, and emergency services (Farlinda et al., 2019).Please note that the first paragraph of a section or subsection is not indented.

One of the main goals of health service facility planning is to achieve geographic equity of health service resources (Yang et al., 2006). However, it is acceptable that each region sometimes only has a hospital in its area. The unavailability of hospitals in an area indicates an imbalance in the distribution and availability of health facilities. Unlimited access to health services for the entire population remains the government's and society's main objective. To ensure adequate access to primary care, healthcare planners and policymakers need accurate and reliable accessibility measures so that areas with a true shortage of doctors can be accurately identified and allocated resources to address the problem (Ni et al., 2019).

Community health service facilities are essential for all communities, and their location has long been an important issue in urban planning (Song et al., 2021). Nowadays, Geographic Information System (GIS) technology has been widely applied in various fields of earth studies to optimize the analysis and presentation of spatial data (Sigit, 2011). Using Geographic Information Systems (GIS) promises to make resource management and model making, especially quantitative models, easier and simpler (Fauzi et al., 2009). One of the steps that can be used to assess the distribution and fulfillment of hospitals in an area is the 2SFCA method. Through the 2SFCA method, it is also possible to assess the quality and service of health facilities obtained by the community. Spatial accessibility provides a summary measure of two important and related access components. First, the volume of services provided relative to population size. Second, the proximity of the services provided relative to the location of the population (McGrail, 2012).

Based on previous research, accessibility is the ease with which a location can be reached from other locations (Husna & Tarigan, 2021). So, the 2SFCA method only assesses how accessible it is in an area. The basis of the 2SFCA method is to assess the level of accessibility of a facility in an area. However, this method can make other aspects known, such as the quality of existing health services and how accessible and acceptable they are to the community. This method also shows how the distribution of health facilities follows the condition of a region.

The description above shows that it is necessary to conduct research using the 2SFCA method by considering aspects other than accessibility. Another aspect that can be seen is the distribution and fulfillment of hospital areas, especially Metro City. In addition, this method can also see the quality and service of existing health facilities in Metro City. Especially in assessing whether the health facility is following regional conditions in Metro City.
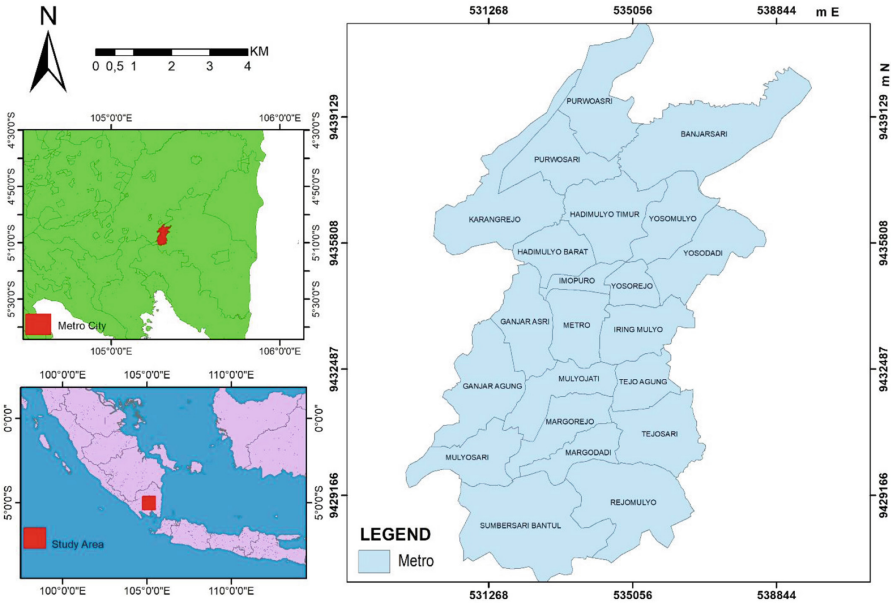
Fig. 1. Study area map

2 Method

2.1 Study Area and Data

Figure 1 illustrates the research was conducted in Metro City, Lampung. Metro City is one of the two cities in Lampung Province. Geographically, Metro City is located at 105.170–105.190 East Longitude and 5.60–5.80 South Latitude. Metro City consists of 5 sub-districts, 22 sub-districts/villages, and an area of around 68.74 km^2.

2.2 Data Collection and Processing

The data collection technique used in this research was secondary data analysis. Secondary data is data on the distribution of hospitals obtained online through the Google Earth application. Population data and data on the number of health facilities for Metro City were obtained through the Central Bureau of Statistics for Metro City, which can be accessed online through the official BPS Kota Metro website, BPS.go.id, and bed capacity data for each hospital in Metro City were obtained through the Dinas Metro City Health which can be accessed online through the official website of the Metro City Health Service, dinkes.metrokota.go.id. The Metro City shapefile data was obtained through a third party which can be accessed via the Indonesia-geospatial.com page. The data is then processed using the ArcGIS Application. Data illustrates in Tables 1, 2, 3, 4 and Figs. 2 and 3.

Table 1. Research data

Data	Source	Function
Metro City population data	Statistics Indonesia, 2022	Knowing many residents in Metro City
Data on the number of hospitals in Metro City	Statistics Indonesia, 2022	Finding out the number of hospitals in Metro City
Hospital distribution data in Metro City	Google Earth	Plotting the location of the hospital in Metro City
Bed capacity data for each hospital in Metro City	Metro City Health Agency, 2021	Completing hospital data
Metro City Shapefile	Indonesia geospatial, 2020	Administrative boundaries of the Metro City area

**Table 2.** Metro City health facilities in 2021(BPS Kota Metro, 2022)

Subdistrict	Hospital	Community health centers	Auxiliary health centers	Clinic	Pharmacy
South Metro	1	1	1	3	3
West Metro	2	2	1	3	2
East Metro	3	3	1	3	4
Central Metro	2	2	–	4	5
North Metro	-	3	1	1	3
Amount	8	11	4	14	17

Table 3. Distribution of hospitals in metro city in 2021(Dinas Kesehatan Kota Metro, 2022)

X	Y	Hospital	Beds Available
534314.07	9435186.43	Azizah Hospital	54
534758.95	9434686.32	Permata Hati Metro Hospital	71
534373.20	9434530.41	General Ahmad Yani General Hospital	250
534446.77	9434215.69	IMC Metro Hospital	62
532866.15	9434268.26	Mardi Waluyo Hospital	178
532112.05	9432403.10	Muhammadiyah Metro Hospital	165
536931.81	9435633.93	Islamic Metro Hospital	86
532697.06	9429401.14	Sumbersari General Hospital	33

Table 4. Population of Metro City residents in 2021(BPS Kota Metro, 2022)

No.	Subdistrict	Population	Area (km^2)	Population density
1	South Metro	17499	15.01	1516
2	West Metro	28610	11.54	2468
3	East Metro	38404	12.88	2557
4	Central Metro	52980	11.59	4113
5	North Metro	32288	22.14	1458
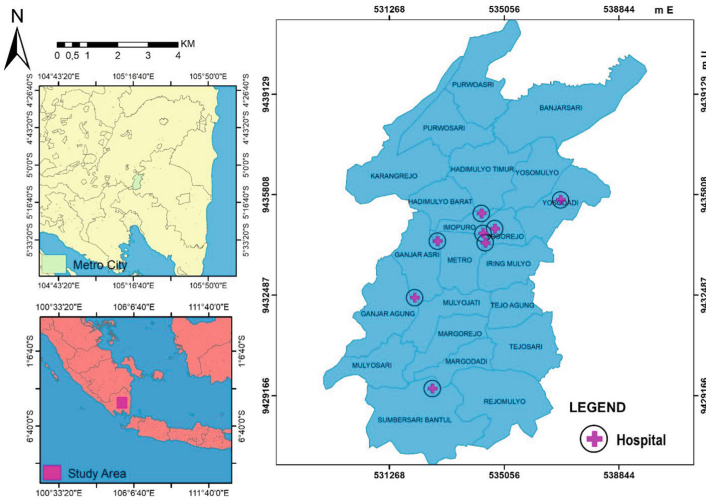
Fig. 2. Metro City hospital distribution map for 2021

2.3 Data Analysis

In the first data processing stage, for each location of the health center j, find all populations or residential locations (k) that are within the threshold distance (d0) from a certain location j and calculate the ratio of health care to the population, Rj, in the catchment area. The second is the population accessibility index. In the first step, a health facility's influence or service area will be determined in terms of distance using the existing road network. It also helps determine the proportion of the total population served by each health center. However, a village can be under the service area of more than one puskesmas or public health center. Thus, the consequences of overlapping service areas are considered in the second step. The accessibility level of each village is then determined in the second step by adding up the initial ratios within acceptable or perceived distances for the villagers. A larger value indicates that certain populations have better access to health care and are in a more advantageous position than other populations. In addition, it helps identify individuals and groups of villages who do not have or have
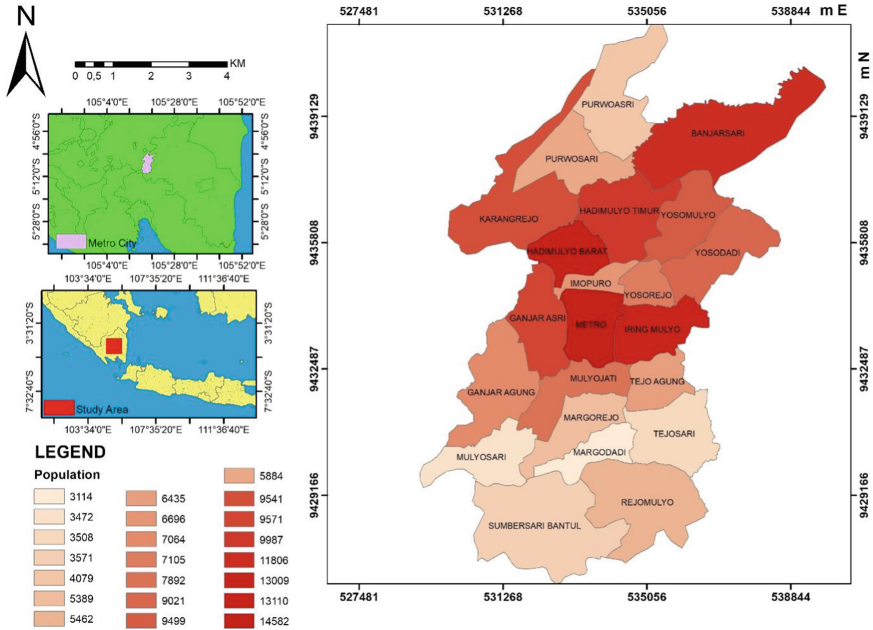
Fig. 3. Population map of Metro City residents in 2021

poor access to healthcare facilities (Kanuganti et al., 2016).

$$R_j = \frac{HC_j}{\underset{k\epsilon\{d_{kj} \leq d_0\}}{\Sigma} P_k} \tag{1}$$

Description:

P_k : the population at location k whose centroids are within the range ($dkj \leq d0$).
HC_j : the number of doctors in the area
d_{kj} : the distance between k and j

$$A_i^F = \underset{j\epsilon}{\Sigma}\{d_{kj} \leq d_0\}R_j \tag{2}$$

Description:

AFi : Accessibility of the population in certain locations to health services based on the floating two-step water catchment area. The superscript F represents the calculation formula based on the 2SFCA method.
R_j : ratio of health facilities to the population where the centroid is within the coverage area ($d_{kj} \leq d_0$)
d_{ij} : the distance between i and j

2.4 Research Framework

The research began by collecting data on the distribution of hospitals obtained online through Google Earth, population data, and data on the number of health facilities for Metro City obtained through Metro City BPS, which could be accessed online through the official website metrokota.bps.go.id and data. The bed capacity of each hospital in Metro City obtained through the Metro City Health Office could be accessed online via the official website dinkes.metrokota.go.id. Meanwhile, the Metro City shapefile data was obtained through a third party which can be accessed via the Indonesia-geospasial.com page. Hospital distribution data, bed capacity, and population were converted using the ArcGIS application to obtain hospital Shapefiles and population numbers.

The ArcGIS application was reused to create Centroid data based on the Metro City Shapefile. Hospital data and Centroids are analyzed by Buffer to obtain Buffer data that will be used for the Spatial Join program. Hospital Buffer data with Centroid Buffer were combined in the Spatial Join program to produce the first test data. The first test data was then calculated to obtain comparative data between hospitals and beds. The results of comparison calculations between hospitals and beds were combined with the hospital Shapefile again to get a full hospital Shapefile.

The Spatial Join program returned more complete hospital Shapefile data with Centroid Buffer to generate the second test data. The second test data was combined with the Metro City Shapefile to get the 2SFCA result-assessing 2SFCA results to suit the circumstances. The 2SFCA results were demonstrated using the Symbology program to obtain a map of the 2SFCA results for the Metro City area. Research flow illustrates in Fig. 4
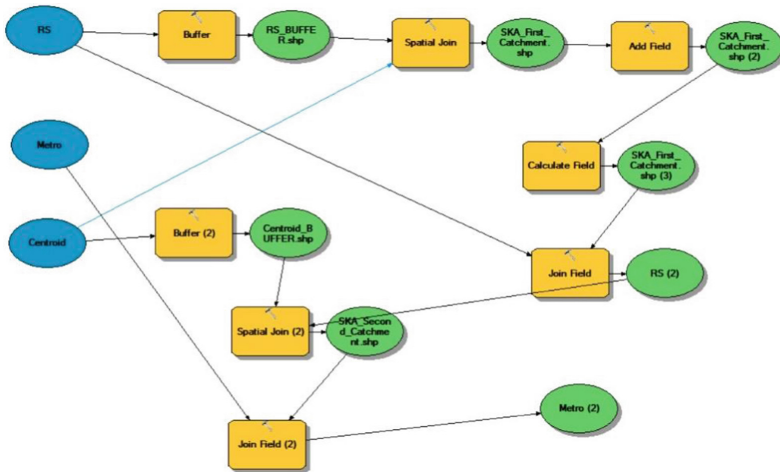

Fig. 4. Research flow

3   Results

3.1   Hospital Distribution and Needs Based on Population in Metro City, Lampung

Hospitals in Metro City are scattered in almost all areas. The distribution of hospitals in an area shows the quality and accessibility of the community to get health services, especially the accessibility and quality of health services. Based on data collection, the distribution of hospitals in Metro City is one hospital in South Metro District with one hospital in Sumbersari Village, two hospitals in West Metro District with hospitals in Ganjar Agung and Ganjar Asri Villages, three hospitals in East Metro District with hospitals in Yosodadi, Yosorejo, and Iring Mulyo Villages, two hospitals in Central Metro District with hospitals in Impuro and Metro Villages. The data showed that the distribution of hospitals in Metro City tends to be clustered and close to one another. The unequal distribution of health services is usually considered a cause of inequality in health outcomes (Tao et al., 2018). The data also showed that group distribution in one house would cause spatial disparities in health services.

Spatial disparities in health services are a common problem in urban areas examined in other large cities such as Beijing and Seoul. One of the reasons is the centralization of health services, where large hospitals have developed in city centers (Jumadi et al., 2022). Metro Utara District needs a hospital in its administrative area. It causes gaps in people's rights to get health services. Communities in Metro Utara District tend to need help receiving health services more than in other Districts. There is a trend in the distribution of health facility groups, such as hospitals in Metro City which are only found around the Central Metro Area. Areas such as East Metro District and West Metro District are increasingly making disparities in obtaining health service facilities more visible, where the three sub-districts tend to get more access to health services compared to other regions.

The disparity in obtaining health services is also evident from comparing the distribution of hospitals with the number of residents in Metro City. The data showed that the population of Metro City differs significantly from one area to another. The population distribution includes Metro Selatan District, with a population of 17499 people divided into four villages or sub-districts, namely Margodadi, Margorejo, Rejomulyo, and Sumbersari Bantul Villages. The largest population is in Rejomulyo Village, West Metro District, with 28,610 people divided into four villages or sub-districts, such as Ganjar Agung, Ganjar Asri, Mulyojati, and Mulyosari Villages. The largest population is in Ganjar Asri Village, East Metro District, with 38,404 people, divided into five villages or sub-districts: Iringmulyo, Tejo Agung, Tejosari, Yosodadi, and Yosorejo Villages. The largest population is in Iringmulyo Village, Central Metro District, with 52980 people divided into five villages or sub-districts: West Hadimulyo, Hadimulyo, Impuro, Metro, and East Yosomulyo Villages. The largest population is in Metro Village, North Metro District, with 32,288 people divided into four villages or sub-districts, namely Banjarsari, Karangrejo, Purwoasri, and Purwosari. The largest population is in Banjarsari Village.

Population data also showed that the population distribution in Metro City itself has random distribution. Sub-districts with a high population based on the number in one

sub-district are not necessarily spread evenly in every village but are spread randomly, as proved by villages with a small population in areas with a large population combined in one district. On the other hand, there are villages with a large population in areas with a small populations combined in one sub-district. Random distribution makes health services such as hospitals critical in the Metro City area, especially in terms of equity in each region. However, with the distribution of hospitals that tend to be clustered like those in Metro City, it is difficult for people from various regions, especially those with large populations, such as Banjarsari Village, to access healthcare facilities such as hospitals. Poor access to medical clinics can result in people with simple health problems not consulting health professionals and developing more complex conditions with irreversible consequences (Ngui, 2019).

The population's need for this hospital has also been regulated in the Decree of the Minister of Health of the Republic of Indonesia No. 228 of 2002, concerning that the ratio between the number of hospital inpatient beds and the population is 1: 1,500 to achieve the ideal ratio (Stella Purnomo, Sawitri Subiyanto, 2017). Based on the average distribution of health facilities in areas with a relatively high population, such as Central Metro District, East Metro District, and West Metro District. The existence of health service facilities such as hospitals in these areas also shows that the needs of hospitals in Metro City have been fulfilled quite well, where the presence of hospitals has fulfilled the number of residents. However, only some areas in Metro City have their hospital needs met. Areas such as North Metro Sub-District need hospitals. Of course, their need for health facilities needs to be met properly, causing many people in North Metro Sub-District to need access to health facilities in other areas. For this reason, an assessment of the level of accessibility in an area is very important to note.

High spatial accessibility usually appears in urban and near-urban areas where hospitals are located (L. Zhang, 2015). However, given the random population distribution, not all regions with high populations, when summed up in one district, have high populations in each region and vice versa, so the spread of healthcare facilities, such as hospitals in districts with high population numbers, when combined Being one sub-district will create gaps, especially in the distribution of health services in Metro City. In several areas, such as Banjarsari Village, Metro Utara District has a fairly high population of 11,806 people. However, there are no hospitals in the area. Therefore, communities there need help meeting public health needs. This gap shows the need for health facilities, especially hospitals, are needed in every region. It is necessary to consider whether the area has a high population. Health facilities are critical in fulfilling the community's right to get guaranteed health services. Equitable distribution may indicate that the fulfillment of existing houses in Metro City has yet to be fully fulfilled.

Various gaps in the distribution and supply of hospitals in Metro City cannot be separated from various factors that affect the distribution and supply of hospitals. One of them is the level of accessibility. Access to quality and affordable health facilities is the goal of government development and the right of every citizen without exception (Siagian et al., 2021). In addition, the level of accessibility can also determine the quality of hospital services in Metro City. In general, if the accessibility of hospitals to an area is good, then the level of health services that the community will obtain will also be good.

Table 5. 2SFCA results

No.	2SFCA Result
1	0.00109295532114
2	0.00167131267725
3	0.00289992413923
4	0.00318807779769
5	0.00485513997286
6	0.00537954775064
7	0.0057768078597
8	0.00612919254104
9	0.00652645265011

3.2 Hospital Accessibility Level in Metro City

The level of accessibility between the hospital and its area is low, so the level of health facility services that the community will receive will also be lower. The results of the 2SFCA method in this study indicate that the level of accessibility of hospitals in Metro City is quite diverse, with a value between 0.001–0.006. The results can be seen in Table 5 and Fig. 5.
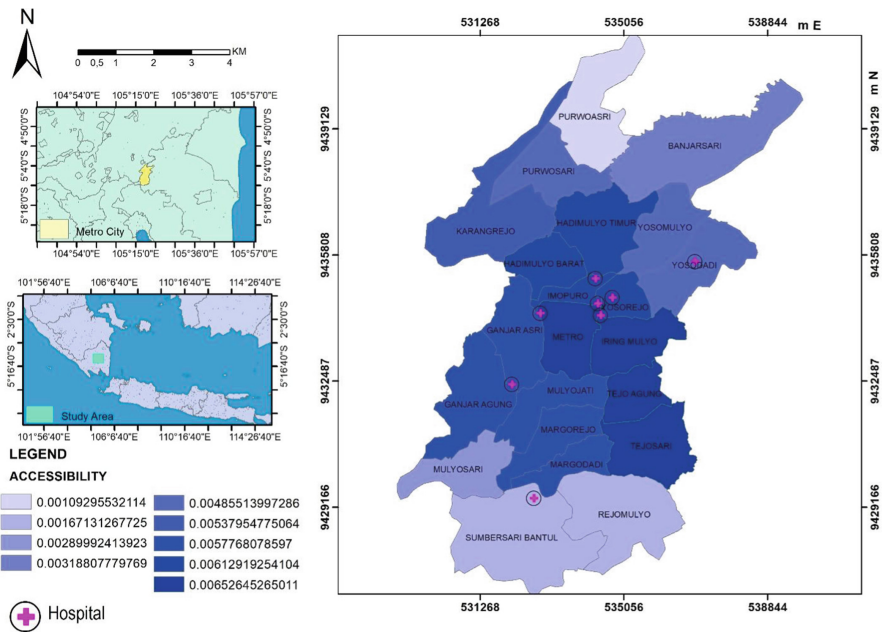
Fig. 5. Hospital accessibility level with 2SFCA

4 Discussion

The results of the accessibility of these sub-districts show that in certain cases, even if an area has a good level of accessibility, it will not necessarily get good health services. Based on (Husna & Tarigan, 2021), two regional clusters have good accessibility to health facilities, Pagelaran District and Cipanas District. Interestingly, the central region of Cianjur Regency has a low accessibility score compared to the two sub-districts. However, this high level of accessibility means that people in Tejo Agung and Tejosari, East Metro District, have better opportunities to access health services because, with a high level of accessibility, the people of Metro Timur, to be precise in Tejo Agung and Tejosari can easily access health facilities in other sub-districts that have health facilities such as hospitals, such as in Yosorejo Village, East Metro Regency. The level of accessibility also shows that a low level of accessibility does not necessarily mean that the area has a poor level of health services and is difficult to access, such as in Sumbersari Bantul Village, Metro Selatan District. Even though it has a fairly low level of accessibility, it is not difficult to get health facility services. A high level of accessibility does not necessarily provide an adequate level of health services and vice versa. Conversely, a low level of accessibility does not necessarily make it difficult for them to get services from inadequate health facilities and poor access to health services for the community's needs. Whether or not the level of health services is good can be obtained from policies in terms of equity and fulfillment of hospitals, especially in terms of building hospitals that must have the right place with a high level of accessibility.

High accessibility in these areas also shows that through a high level of accessibility, the need for hospital services in an area can still be fulfilled. Even though fulfilling their needs will not be optimal because the number of patients will increase, the number of hospitals will remain the same. For this reason, in future research, apart from assessing accessibility, the 2SFCA method can also assess the quality and service of each health facility development in an area. In addition, this assessment can link research with other factors that influence each other. Factors that can be linked to accessibility are social and economic. Further research should discuss the community's social and economic conditions, especially in Metro City. Assessing geographic access through detailed spatial analysis and visualization can provide valuable information for local communities and governments (Susilo & Harini, 2018).

5 Conclusions

The distribution of hospitals in an area showed the quality and accessibility of the community to get health services, especially the accessibility and quality of health services in Metro City. The 2SFCA results showed a trend of accessibility between hospitals and urban areas where accessibility was high in areas with many hospitals, precisely in the Districts of Central Metro, East Metro, and West Metro. A high level of accessibility indicated that these areas had adequate health services. However, the accessibility of these sub-districts showed that in certain cases, even though an area had a good level of accessibility, it did not mean that it would get good health services. However, with this high level of accessibility, people in Tejo Agung and Tejosari, East Metro District, would have better opportunities to access health services.

The level of accessibility also showed that a low level of accessibility did not guarantee accessible health services, for example, in Sumbersari Village, Bantul, Metro Selatan District. Hospitals around the area proved it. Finally, a good level of health services came with policies regarding hospitals' distribution and fulfillment, especially in building hospitals, which must have the right location with a high level of accessibility.

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