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DISTRIBUTION PATTERNS AND ACCESSIBILITY OF HEALTH FACILITIES ANALYSIS USING GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN BADUNG DISTRICT, INDONESIA

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ABSTRACT

Badung District is located in Bali Island, a famous and most-visited island tourists destination in Indonesia. Tourists generally understand that health is one of the important things in their lives, as well as the need for travel. The problem found is that the public does not fully comprehend the details regarding the location of the health centre, both the address and reliable contact person. In an emergency, people find it difficult to know the location of the nearest health centre so they can get treatment and service quickly. In this research, qualitative descriptive research was used, based on secondary data. The Average Nearest Neighbor method was used as the data analysis method to analyze the distribution pattern of health facilities in Badung Regency, aimed to determine the distribution pattern of health facilities in Badung Regency. The results of the calculation revealed the Nearest Neighbor Ratio value of 1.055839 or T= 1.055839. It showed that the distribution pattern of health facilities in Badung Regency was random. The accessibility of health centre health facilities to settlement areas was highest in the Abiansemal sub-district with a coverage area of 22.33 km², of which the settlement area was 65.52 km² or 34%, while the lowest coverage was in the Petang sub-district with 1.75 km² and an area settlements of 91.98 km² or 2.67%. The highest accessibility of hospital health facilities was in the Kuta District area with a coverage area of 21.16 km² with a settlement area of 8.8 km² or 32.25%.

Keywords: Badung regency, Health care accessibility, Health facility, Spatial analysis.

INTRODUCTION

Bali Island is one of the islands in Indonesia which is a very famous and most-visited tourist destination in Indonesia. The island of Bali consists of 9 districts/cities. Badung Regency is one of the districts in Bali with many tourist attractions such as beaches, places of worship, cultural performances, culinary tourism, beach clubs and many other tourist attractions. This makes Badung Regency visited by many domestic and foreign tourists. Based on data retrieved from the Ministry of Tourism, shows that there will be more than 280,000 foreign tourists coming to Bali in 2023.

In general, tourists understand that health is one of the important things in their lives, as well

as the need for travelling. According to data from the Badung District Health Service, there are 13 health centres (puskesmas), 9 hospitals, 2 special hospitals, 3 Inpatient Health Centres, 10 Non-Inpatient Health Centres, 71 clinics, 564 Posyandu, and 0 Polindes spread across various regions in the Badung Regency area. The community can take advantage of the health facilities provided for treatment and other health checks. The obstacle found is that the community does not fully know the details regarding the location of the health centre, both the address and the reliable contact person. In an emergency, people have difficulty knowing the location of the nearest health centre to get immediate treatment and service. The location and accessibility of health service facilities are the main components in the presentation of health service facilities' visits or utilizations. The proper location of health service facilities will make it easier for people to access these health service facilities.

Table 1. Number of Health Facilities According to Subdistricts in Badung Regency in 2022

Subdistricts	Hospital	Special Hospital	Inpatient Health Centre	Non-Inpatient Health Centre	Clinics	*Posyandu*	*Polindes*
South Kuta	3	1	0	1	13	65	0
Kuta	3	1	1	1	25	39	0
Abiansem	1	0	1	3	3	130	0
Mengwi	1	0	1	2	9	199	0
Petang	0	0	0	2	1	51	0
Badung	9	2	3	10	71	564	0

Source: Badung District Health Service, 2023.

The development of technology and information in the form of Geographic Information Systems (GIS) in various sectors (Mustikaningrum et al., 2023; Warganegaraet et al., 2023). It has been utilized not only in the field of geography but it has been also in various fields including the health sector. The use of GIS in the health sector is to analyze gaps in accessing health services, analyze extraordinary events (KLB) of a disease, and assess priorities for using limited resources to improve the level of public health (Riner et al., 2004). Apart from that, GIS also has a spatial analyst feature that can be used for spatial analysis.

Under the government's commitment, increasing access to and quality of health services has become one of the priorities for health development in Indonesia (KEMENKES RI, 2020). To realize this, a good understanding of the distribution and accessibility of Health facilities is needed (Morrone et al, 2021). One method used to analyze the accessibility of health facilities is spatial analysis using a health geography approach (Ramadhan, 2020). In the study of health geography, the spatial analysis of health facility accessibility has become an important and growing research topic. Previous research has shown that this analysis can contribute significantly to identify health facility distribution problems and providing solutions to increase community accessibility to health services. According to (Syaadah, 2014), the growth of the population is an additional burden for the government in the form of increasing the provision of facilities and infrastructure, specifically health facilities that are expected to serve the needs of the community. In addition, the rapid population growth in large cities requires special attention for the government to be able to provide adequate and quality health facilities continuously for the community. With the increasing percentage of areas covered by health services, it also contributes greatly to the level of public health improvement in the area.

Based on the explained phenomenon, following Government Regulation No. 47 of 2016 (Indonesia, 2016) concerning health service facilities intended for the whole community including the health equipment contained therein and health workers, whether they work in hospitals, health centres (puskesmas), polyclinics, posyandu, and other health service facilities for the common good. Spatial distribution patterns are useful in making decisions about the appropriate method for estimating the density or abundance of a population. It refers to the presence of many populations living in a certain area which means that the location of health services in that area covers the entire population or vice versa. This distribution pattern can be a problem for urban

areas because people experience problems accessing health facilities (Dewantara, & Urufi, 2021). These difficulties can be caused by the unequal distribution of health service facilities or the lack of easy accessibility to these health facilities. Therefore, this analysis is very important to be carried out in Badung Regency, especially by implementing the Health Geography approach.

RESEARCH METHODS

In this research, qualitative descriptive research was used, based on secondary data. Apart from being based on field research, the researchers also reviewed legal regulations, settlement decrees, and reference books related to health facility service issues in Badung Regency. The data analysis method used to analyze the distribution pattern of health facilities in Badung Regency by employing the Average Nearest Neighbor method to determine the distribution pattern of health facilities in Badung Regency.

This analysis has the final result in the form of an index (T). The nearest neighbor distribution index value itself is obtained through as Equation 1:

$$T = \frac{Ju}{Jh} \tag{1}$$

T = Nearest neighbor distribution index

Ju = The average distance measured between one point and its nearest neighbor.

Jh = Average distance obtained if all points have a random pattern

The formula used to determine the value of Jh as Equation 2:

$$Jh = \frac{1}{2\sqrt{p}} \tag{2}$$

Jh = Average distance obtained if all points had a random pattern

p = Population density or point density in square kilometers

Meanwhile, P value can be determined as Equation 3:

$$P = \frac{n}{a} \tag{3}$$

P = Population density or point in square kilometers

N = Number of points

A = Area in square kilometers

After analyzing using the Average Nearest Neighbor method, the next step is analyzing the accessibility of health facilities using spatial and quantitative analysis. Analysis of the Accessibility of health facility services using GIS modelling in the form of buffering the service coverage of each health facility in Badung Regency.
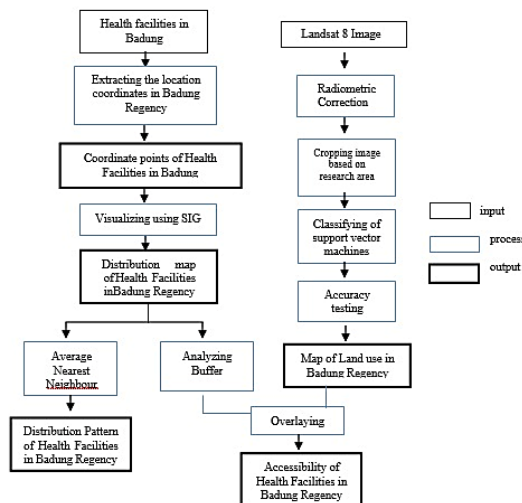

Figure 1. Research Flow

RESULTS AND DISCUSSION

This research revealed two results, the first result was the distribution pattern of Health Facility locations in Badung Regency which was processed using nearest-neighbor analysis.

The second result was the accessibility of the location of Health Facilities in Badung Regency which was processed using the Buffer method from the coordinates of the map distribution of Health Facilities in Badung Regency.
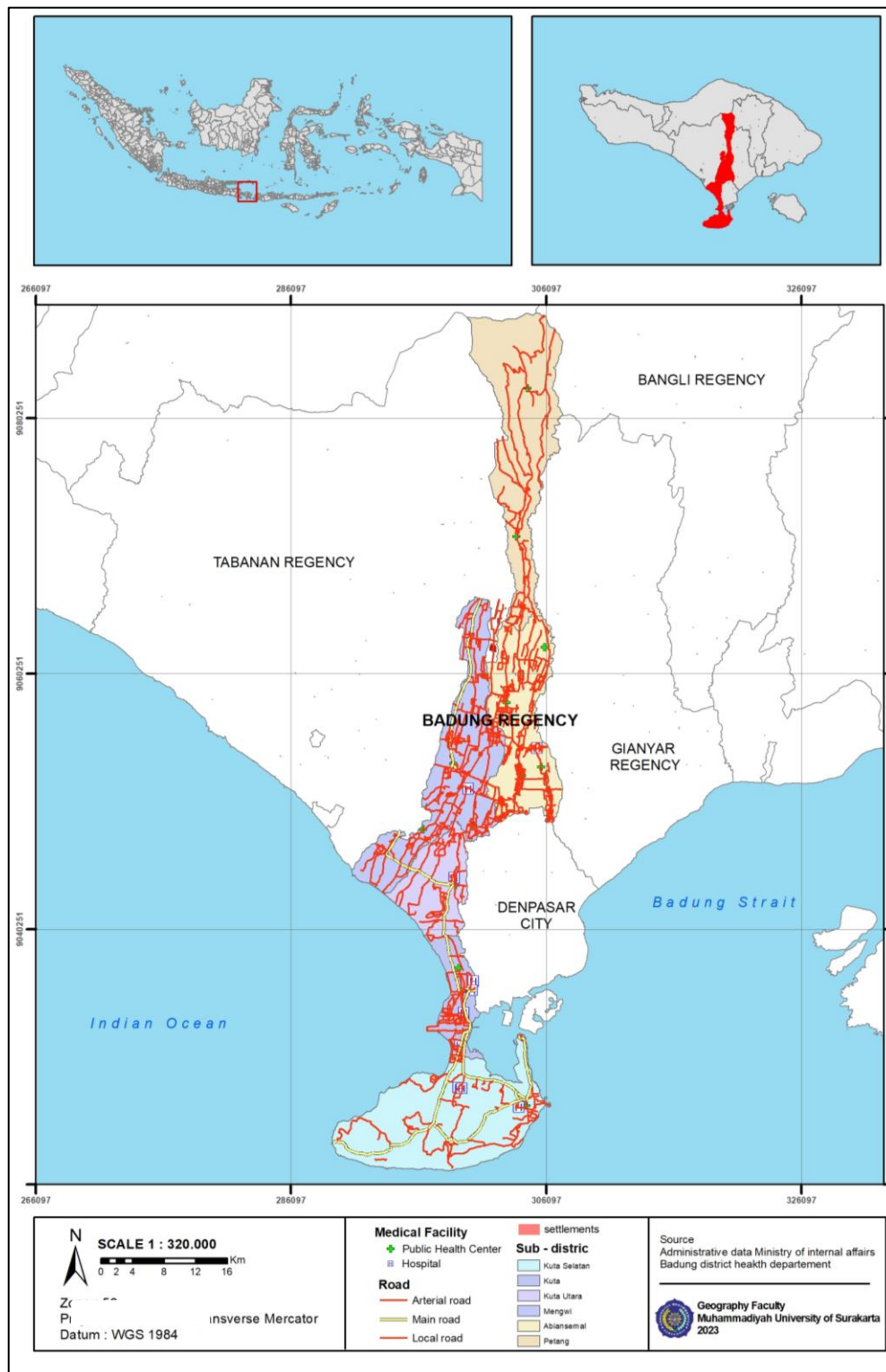
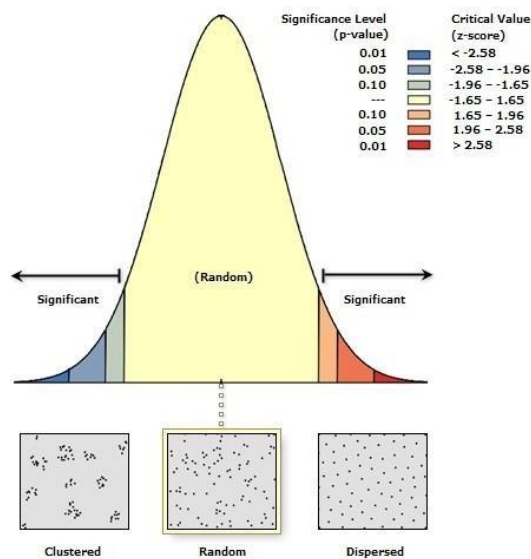**Figure 2. Distribution Map of Health Facilities in Badung Regency**

The distribution of health facilities in Badung Regency covered 6 sub-districts, namely Abiansemal, Kuta, South Kuta, North Kuta, Mengwi, and Petang. Based on the distribution of the map, it could be seen that South Kuta District provided 3 General Hospitals, 1 Special Hospital, and 1 Non-Inpatient Health Centre. Kuta District provides 3 General Hospitals, 1 Special Hospital, 1 Inpatient Health Centre, 1 Non-Inpatient Health Centre. North Kuta District provided 1 General Hospital, 1 Non-Inpatient Health Centre.

Abiansemal District provides 1 General Hospital, 1 Inpatient Health Centre, 3 Non-Inpatient Health centres (puskesmas). Mengwi District provided 1 General Hospital, 1 Inpatient Health Centre, 2 Non-Inpatient Health centres (puskesmas). Meanwhile, Petang District only provided 2 Non-Inpatient Health centres (puskesmas). Based on the distribution map attached above, the placement of health facilities that had a big role such as hospitals were in strategic locations, which means they are easy to access by the public and vehicles including ambulances to carry out their functions. The placement of other health facilities was also influenced by accessibility. High accessibility affected health facility services so that they could be reached easily by the community (Bamba, 2018).

Distribution Patterns of Health Facilities Using Nearest Neighbor Area

The distribution pattern of health facilities was grouped into 3 types, namely clustered, random and scattered distribution patterns. To find out distribution patterns, the ArcGis application was used and supported by the Nearest Neighbor Analysis (NNA) method or in Indonesian, it can be called Analisis Tetangga Terdekat (ATT). The distribution pattern was calculated by measuring the distance between health facilities in Badung Regency and the settlements in the research area. Based on the integration of location points of health facilities such as hospitals and health centres (puskesmas) which were considered to have the same status as health service facilities by looking at the distance between each of the closest units, without looking at the type of existing health service facilities, the following distribution pattern was obtained.

Average Nearest Neighbor Summary

Observed Mean Distance:	2481,9440 Meters
Expected Mean Distance:	2350,6833 Meters
Nearest Neighbor Ratio:	1,055839
z-score:	0,512313
p-value:	0,608432

Figure 3. Distribution Pattern of Health Facilities in Badung Regency

The results above showed the value of the Nearest Neighbor Ratio or T value, which determined the type of distribution pattern produced. The T value was used with certain interval parameters. There were 3 intervals, namely if T <0.7 then the settlement had a clustered pattern; If $0.7 \leq T \leq 1.4$ then the settlement pattern was random; If T $\geq$1.4 then the settlement pattern was uniform. The result of the calculation above showed Nearest Neighbor Ratio value of 1.055839 or T= 1.055839. It presented that the distribution pattern of health facilities in Badung Regency was random. The pattern of distribution of health facility locations in Badung Regency was due to the location of health facilities tending to be less evenly distributed throughout the region and concentrated in areas with dense settlement areas. The location of health facilities close to dense settlement areas was not a complete measure of the success of the health facilities distribution. In this case, a uniform and even location also determined the level of community accessibility of health facilities. The problem of random distribution patterns can be overcome by selecting strategic and distributed

health facility locations so that they can facilitate the community as a whole and evenly throughout all areas in the Badung Regency. The random distribution pattern in the distribution of health facilities in Badung Regency was caused by good accessibility, which caused the construction of health facilities to spread randomly and not in groups or clusters. This showed that development was likely to be in strategic areas (Dian, 2021).

Health Facilities Accessibility Analysis Using Buffering Analysis

To determine the use of land in Badung Regency, a process of interpreting Landsat 8 satellite images in 2022 was carried out. Landsat 8 satellite images were medium-

resolution images, the Landsat 8 image sensor provided a spatial resolution of 30 meters. To determine the appearance of the earth's surface, it was necessary to carry out radiometric correction and atmospheric correction processes. These two processes needed to be carried out to sharpen the image and reduce noise due to the presence of clouds. The results of land use processing using Landsat 8 imagery can be seen in the following figure 4.

The classification of land cover classes in Indonesia was prepared based on the Regulation of the Director General of Forestry Planning and Environmental Management No: 01/Juknis/IPSDH/2015 concerning the Interpretation of Medium Resolution Imagery to Produce Land Cover Data (KLHK, 2015).
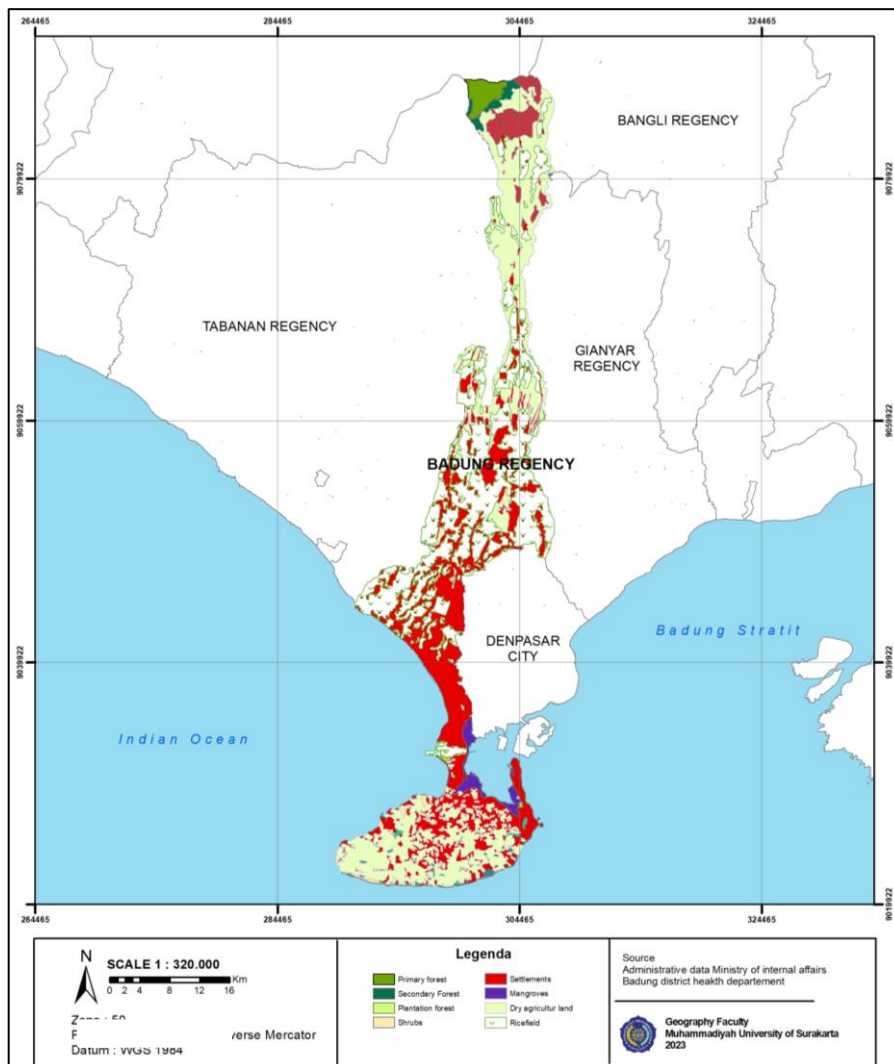

Figure 4. Land Cover Map of Badung Regency 2023

The results of processing with ENVI displayed that there are 8 classifications, namely Primary Forest, Secondary Forest, Plantation Forest,

Shrubs, Settlements, Mangroves, Mixed Shrub Rice Fields and Rice Fields. The land use map showed that the types of land use in Badung

Regency were dominated by rice fields and gardens. The land use map still needed further processing to reveal the actual appearance of the field. To find out the actual appearance, secondary data was used, namely from Google Earth Pro. It was needed to test the accuracy with a confusion matrix (kappa). The sample used was a random sampling of 80 samples spread across Badung Regency. The following are the results of the accuracy test with the confusion matrix (kappa).

Table 2. Confusion Matrix of Land Use

Land	Types of Land Use	Primary Forest	Secondary Forest	Plantation Forest	Shrubs	Settlements	Mangrove	Mixed Shrub Rice Fields	Rice Fields	Total
	Field Appearances and Google Earth									
	Primary Forest	8			1		1			10
	Secondary Forest		8	1	1					10
	Plantation Forest		1	9						10
	Shrubs				8			1	1	10
	Settlements					10				10
	Mangrove						10			10
	Mixed Shrub Rice Fields				1			7	2	10
	Rice Fields							2	8	10
	Total	8	9	10	11	10	11	10	11	80

Table 2 shows the confusion matrix table for land use in Badung Regency in 2022. The total number of sample points used was 80 sample points spread throughout Badung Regency. These samples were obtained from the results of digitization processing with ArcGIS. This table can be used to calculate accurate kappa as follows.

Cross-multiplication. According to calculations using Kappa accuracy, the results were 85%. The meaning of 85% was that the results of Landsat 8 image processing with field appearances have a very good level of accuracy, namely 85%. So the results of land use processing with Landsat 8 imagery can be used in conducting research.

The accessibility of health facility locations to settlement areas in Badung Regency was the result of processed data from intersect buffering the reach of health facilities available in Badung Regency. Buffers were carried out at each type of health facility, including hospitals and health centres (puskesmas). The level of accessibility of health facilities in Badung Regency was used to determine the spatial layers of an area that could be served or facilitated for housing.

Accessibility of health facilities was carried out using buffer analysis in GIS software. Buffer analysis was used to identify geographically surrounding areas. The results of this buffer analysis showed polygon shape around the object. In the standardized regulations that were applied in the community, there were rules regarding the optimal distance or radius for services of 3000 meters. The distance between health centre health facilities with a radius of 3 km showed that the accessibility of health centre services in Badung Regency was evenly distributed. The largest distribution of health centres (puskesmas) was in Abiansemal District, where one sub-district has been reached by 4 community health centres (puskesmas). However, there were still several villages/sub-districts that were less accessible.
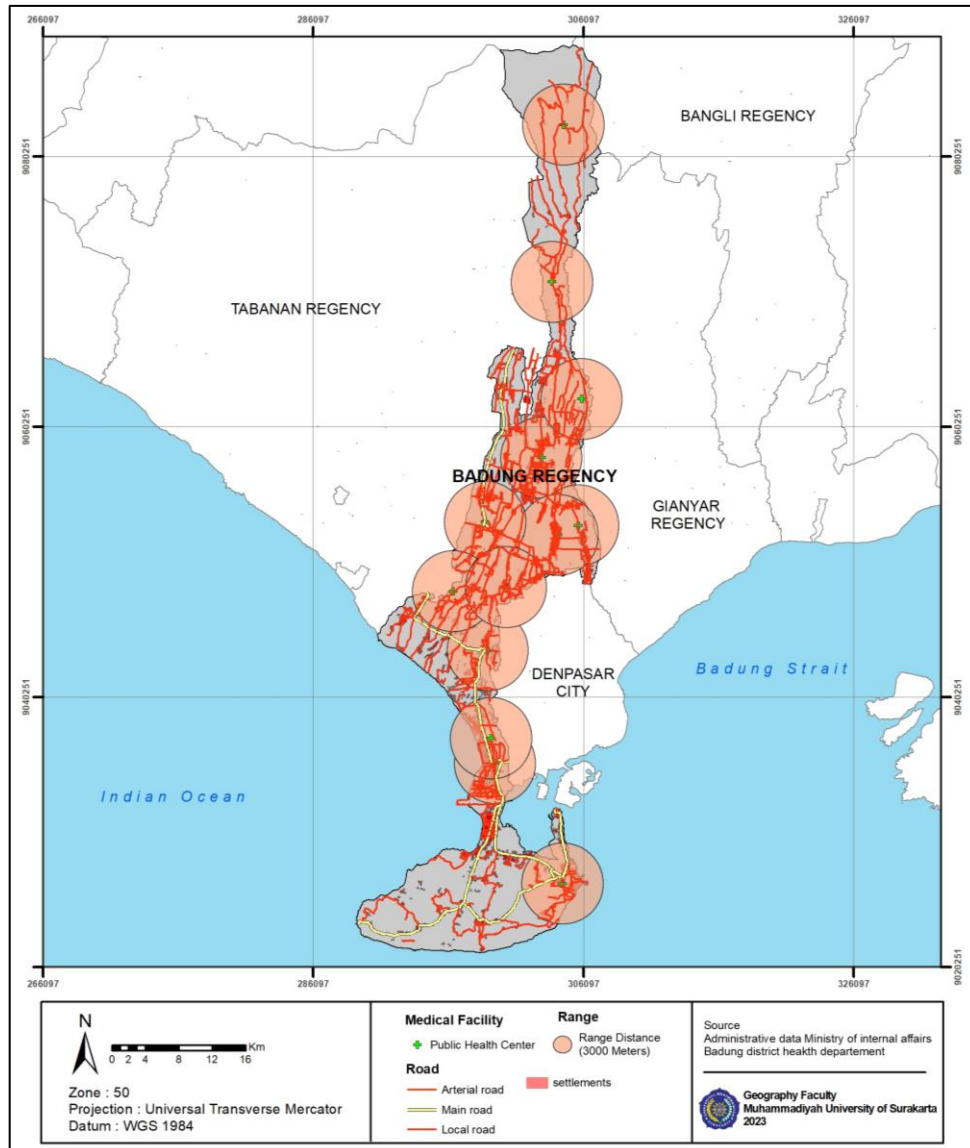
Figure 5. Health Centres (Puskesmas) Accessibility Map in Badung Regency 2023

Table 3. Accessibility of Health Centres (Puskesmas) as Health Facility

Sub-districts	Area ofSub-districts(km^2)	Area of Settlements (km^2)	Accessibility of Health centres (*puskesmas*) (*Puskesmas*)	Percentage
Abiansemal	65.52	16.51	22.33	34.03
Kuta	21.77	8.8	10.87	16.57
South Kuta	101.03	11	3.8	5.79
North Kuta	34.89	7.7	4.4	6.71
Mengwi	83.07	18.1	16.01	24.40
Petang	91.98	3.5	1.75	2.67

The accessibility of health centre health facilities to settlement areas with the highest accessibility was in the Abiansemal sub-district area with a coverage area of 22.33 km^2, the area of settlement areas was 65.52 km^2, this covered 34% of the coverage area, while the lowest coverage was in the Petang sub-district with a coverage of 1.75 km^2 and a settlement area of 91.98 km^2 or 2.67% coverage.

Accessibility of community health centre services was evenly distributed throughout all sub-districts in Badung Regency, however,

there were still areas that were not accessed due to the accessibility of community health centre health services. The district that was most accessible to community health centre services was in Abiansemal District because it was the centre of population activity and dense settlement areas in the area.

The condition of distribution patterns could be a problem for urban areas because people experience obstacles in accessing health facilities. These difficulties could be caused by the unequal distribution of health service facilities or the lack of accessibility to these health facilities easily. The buffer analysis technique (Proximity Analysis) (Kolcsár et al., 2021) was used to carry out this analysis.
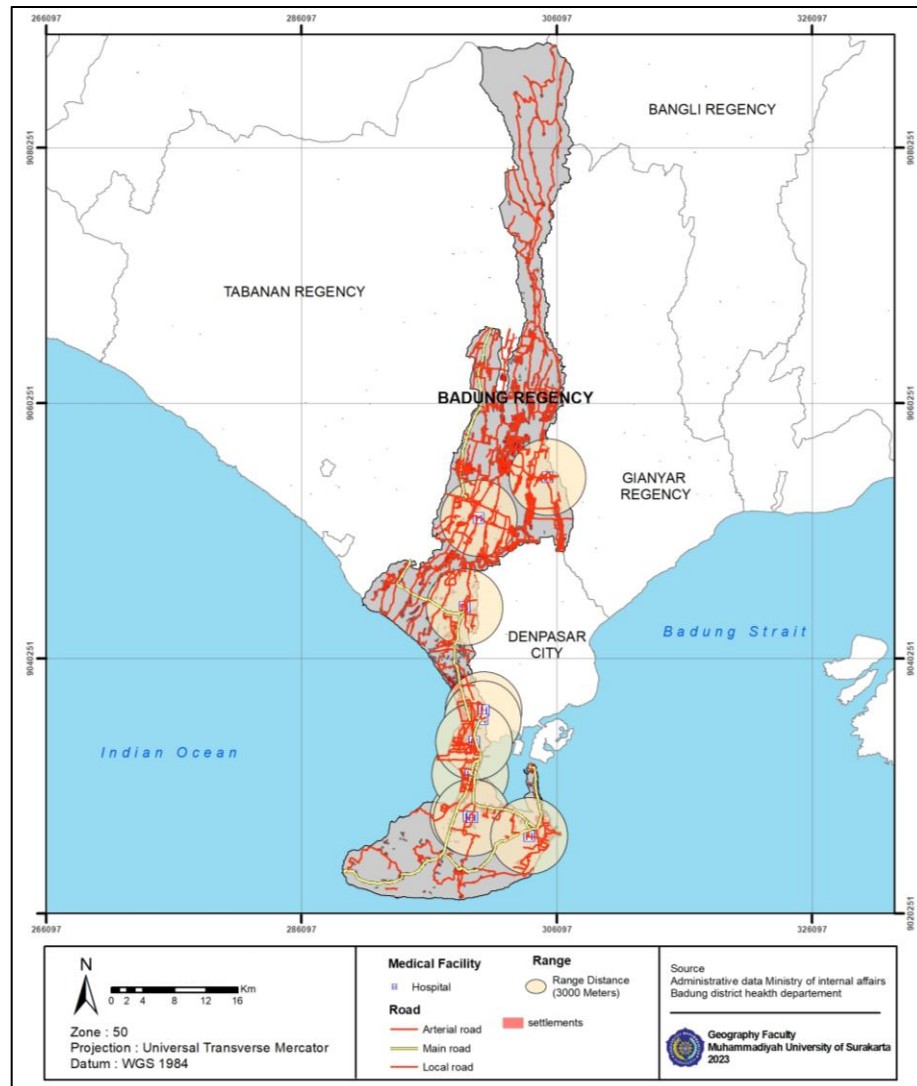

Figure 6. Accessibility Map of Hospitals in Badung Regency 2023

The distribution of hospitals was greatest in Kuta District, where 4 hospitals were provided in one district and those were close to each other. However, in contrast to the northern region, Petang District did not have hospital health facilities. The lack of accessibility of hospital health facilities in Badung Regency could be seen from the number of facilities available in the area. Settlement areas that were within the reach of health facilities indicated that the area has been served, whereas if the area in question was not included in the reach of health facilities then the area has not been served or the availability of health facilities is still lacking (Gaol et al., 2019).

Table 4. Health Facility Accessibility of Hospital

Sub-districts	Area ofSub-districts (km^2)	Area of Settlements (km^2)	Accessibility of Health centres (*puskesmas*)	Percentage
Abiansemal	65.52	16.51	4.58	6.98
Kuta	21.77	8.8	21.16	32.25
Kuta Selatan	101.03	11	13.08	19.94
Kuta Utara	34.89	7.7	4.72	7.19
Mengwi	83.07	18.1	6.37	9.71
Petang	91.98	3.5	0.00	0.00

Based on the results of Table 4, the accessibility of hospital health facilities to settlement areas, the area with high accessibility is in the Kuta District area with a coverage area of 21.16 km^2, of which the settlement area is 8.8 km^2 with a value of 32.25% accessibility. The great accessibility in Kuta District was because this area was the centre for tourism visits from tourists from various countries, so there were 4 hospitals with good facilities. Hospital health facilities in Badung Regency with a reachable service radius of 3 km showed that several areas were not covered by hospitals, these areas were far from crowds and accessibility was inadequate, resulting in a lack of hospital health facilities in these areas. The area was the Petang sub-district with a value of 0%. The availability of hospital health facilities, which was relatively small, was insufficient in the Badung Regency area. So far, health facilities have been centred in Kuta District, this was because the city's rapid development has made the need for health services high. Petang sub-district area did not have a hospital, so there was a need for access infrastructure to facilitate the accessibility of hospital services to community settlements.

CONCLUSIONS

The result of the calculation above was the Nearest Neighbor Ratio value of 1.055839 or T= 1.055839. It showed that the distribution pattern of health facilities in Badung Regency was random. The pattern of distribution of health facility locations in Badung Regency was due to the location of health facilities tending to be less evenly distributed throughout the region and concentrated in areas with dense settlement areas. The accessibility of health centre health facilities to settlement areas with the highest accessibility was in the Abiansemal sub-district area with a coverage area of 22.33 km^2, of

which the area of settlement areas was 65.52 km^2, this covered 34% of the total coverage, while the lowest coverage was in Petang sub-district with a coverage of 1.75 km^2 and the settlement area of 91.98 km^2 or 2.67%. Accessibility of hospital health facilities to settlement areas, areas with high accessibility were in the Kuta District area with a coverage area of 21.16 km^2, of which the area of settlement areas was 8.8 km^2 with a value of 32.25%, while the lowest coverage area was in the petang sub-district with a coverage of 0 km^2 and a settlement area of 3.5 km^2 or 0%. The lack of equal distribution of health facilities, especially hospitals, required further action to overcome this problem based on the results of analysis of accessibility and distribution patterns.

RECOMMENDATIONS

The location of health facilities in the form of hospitals was not yet accessible to all community settlements, so it was necessary to increase and distribute health facilities, especially hospitals, throughout the region to increase the reach of schools to community settlements. The problem of random distribution patterns could be overcome by selecting school locations that were strategic and spread out so that they were able to facilitate the community as a whole and evenly distributed throughout the region. There were other health facilities, such as dentists, health centres (puskesmas), and polyclinics. This aimed to expand the coverage of health facilities so that people could access optimal health service facilities.

REFERENCES

Bamba, G. 2018. Jangkauan Pelayanan Kesehatan Persalinan Rumah Sakit Swasta Bunda Margonda danTugu Ibu di Kota

Depok. *Prosiding Industrial Research Workshop and National Seminar*, 9, 506–517.

Dewantara, S. J. A., & Urufi, Z. 2021. Pola Persebaran Spasial, Aksesibilitas, dan Arahan Lokasi Sarana Pelayanan Umum (SPU) Rumah Sakit di Kawasan Perkotaan Jember. *In FTSP Series 2: Seminar Nasional dan Diseminasi Tugas Akhir 2021*, 948–959.

Dian Rizqi Khusnul Khotimah, S.Tr.Stat. 2021. Spatial Analysis: Pendekatan Metropolitan Statistical Area Untuk Perencanaan Pembangunan Manusia Di Provinsi Jawa Tengah. *Jurnal Litbang Provinsi Jawa Barat*, 19(1), 105-114.

Gaol, E. L., Fatimah, E., & Sugihartoyo, S. 2019. Kajian Penyediaan Sarana Kesehatan di KabupatenAsmat. *Prosiding Seminar Nasional Pembangunan Wilayah Dan Kota Berkelanjutan*, 1(1), 50–56.

Indonesia. 2016. *Peraturan Pemerintah Republik Indonesia Peraturan Pemerintah Republik Indonesia Nomor 47 Tahun 2016 Tentang Fasilitas Pelayanan Kesehatan*. In A. W. C. Pratama (Ed.), Lembaran Negara Republik Indonesia Tahun 2016 Nomor 229.

Kemenkes, R. I. 2020. *Pokok-pokok renstra kemenkes 2020-2024*. Kemenkes RI. https://farmalkes.kemkes.go.id/2021/03/rencana-strategis-kementerian-kesehatan-tahun-2020-2024/.

Kementerian Lingkungan Hidup dan Kehutanan (KLHK). 2015. *Peraturan Dirjen Planologi Kehutanan dan Tata Lingkungan No: 01/Juknis/IPSDH/2015 tentang Penafsiran Citra Resolusi Sedang untuk Menghasilkan Data Penutupan Lahan.* Indonesia.

Kolcsár, R. A., Csikós, N., & Szilassi, P. 2021. Testing the limitations of buffer zones and Urban atlas population data in urban green space provision analyses through the case study of Szeged, Hungary. Urban forestry & urban greening, 57, 126942.

Morrone, M., Cronin, C. E., Schuller, K., & Nicks, S. E. 2021. Access to Health Care i Appalachia: Perception and Reality. *Journal of Appalachian Health*, 3(4), 123–136.

Mustikaningrum, M., Widhatama, A.F., Widantara, K.W., Ibrohim, M., Hibatullah, M.F., Larasati, R.A.P., Utami, S., & Hadmoko, D.S. 2023. Multi-Hazard Analysis in Gunungkidul Regency Using the Spatial Multi-Criteria Evaluation. *Forum Geografi*, 37(1), 35-45.

Ramadhan, I. 2020. *Analisis Spasial Ketersediaan dan Keterjangkauan Fasilitas Pelayanan Kesehatan pada Wilayah Rawan dan Terdampak Bencana Erupsi Gunung Semeru*. https://repository.uinjkt.ac.id/dspace/handle/123456789/67175

Riner, M. E., Cunningham, C., & Johnson, A. 2004. Public health education and practice using geographic information system technology. *Public health nursing*, 21(1), 57-65.

Syaadah, N. 2014. Analisis Dampak Pertambahan Penduduk terhadap Penyerapan Angkatan Kerja. *Jurnal Ilmiah Pendidikan Geografi*, 2(1), 61–70.

Warganegara, A., Darmastuti, A., Hertanto, H., Krisbintoro, R.S., Febriansyah, M., & Pramono W.T. (2023). Friends and Neighbours: Electoral Geography in 2020 Local Election of Met-ro City, Lampung, Indonesia. 37(2), 191-201.