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SPATIAL STUDY OF THE DISTRIBUTION OF HEALTH CENTER WORK AREAS IN IMPROVING HUMAN HEALTH DEVELOPMENT IN BENGKULU CITY

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ABSTRACT

The objectives of this study are as follows: 1. To find out the area of work of health centres in Bengkulu City. 2. To find the ideal service distance between health centers in Bengkulu City using the buffer and network analyst methods. 3. To find out the policy direction of the influence of the distribution of health centre work areas on increasing the Human Development Index. The research method used is a descriptive quantitative method using a geographic information system in buffer analysis techniques, network analyst service areas, and AHP Expert Choice. The results of this study indicate 1. The area of work of Health Centers is spread across nine sub-districts, where each sub-district has 2 to 3 Health Centers that can reach and serve the entire community in Bengkulu City. 2. The facilities of Health Centers in Bengkulu City show that 13 health centers meet the ideal service distance of 2 km, and seven health centers do not meet the ideal service distance. The health center has served the entire community, as seen from the average number of residents served in each health center of 19,555. This reach can serve up to 9 work areas that health centers can accommodate. 3. Policy directions for determining the influence of the distribution of health center work areas in increasing the HDI have three policy criteria, namely accessibility, quality of health services and contribution to increasing the HDI.

Keywords: *Health Center; Buffer; Network Analyst; Distance; AHP*

INTRODUCTION

According to the law, health is a physical, mental, spiritual, and social condition enabling every individual to live productively socially and economically. Everyone has the right to health (Agustina et al., 2023; Lindberg et al., 2024). Health services in Bengkulu City are currently good and sufficient in serving public health problems by continuing to re-accredit each existing health centre as part of efforts to realise welfare. Although the Human Development Index of Bengkulu City is high, this is inseparable from each health centre's equality of access. Differences in services between health centers in each

sub-district can affect the quality of life, which will cause inequality. Therefore, this study was conducted to ensure that improving human development goes hand in hand with distributing fair and equitable health services, especially at the basic service level, such as Health Centers. In improving services, the related agency continues to review health center management, starting from planning, development, implementation and supervision of control and assessment by making 20 health centres in Bengkulu City a regional public service agency in improving the quality of health centre environmental services. The Health Center serves around 30,000 residents (Almeida et al., 2024; Klootwijk et al., 2024).

The Human Development Index (HDI) is an indicator used to measure the success or performance of human development in a country or region. There are three components of the HDI: health, knowledge, and decent living standards (Azzah Miladia, 2024; Langiran & Setiawan, 2023). The Human Development Index of Bengkulu City has consistently increased from 78.82 in 2017 to 80.54 in 2021. This value places the Human Development Index of Bengkulu City in the very high category and the highest among the Human Development Index of Regencies/Cities in Bengkulu Province. Health services in Bengkulu City continue to be supported by health centres, which, based on the Decree of the Minister of Health Number 47 of 2021, are spread across 20 locations. Of these, 17 health centres are non-treatment health centres, which means they provide health services without providing inpatient facilities (Annisa & Indraswanti, 2024).

Meanwhile, the other three health centers are treatment health centers (inpatient) which function as referral centers for emergency patients before being referred to the hospital (Deviasari & Hermanto, 2023; Sela & Ekaputri, 2023). The Human Development Index itself is a measure of success in the health aspect. Inequality in the distribution of health services can cause significant differences in health status between regions, ultimately impacting the differences in HDI between sub-districts.

Based on the background presented, this study aims to analyse how the spatial distribution of the work area covered by each health center influences and to see the contribution of each health center to human development, especially public health. The study was conducted descriptively by utilising policy analysis

to determine the solutions to be provided. Similar research was also conducted by Edgard et al. (2024), showing the use of nearest neighbour analysis in developing health centre locations with the results of an even distribution pattern so that the entire community can reach it. While this study descriptively utilises geographically based spatial analysis, which shows the reach of health center services evenly spread across nine sub-districts in the city of Bengkulu, obtained through spatial network analysis, this analysis is a novelty of this study.

MATERIALS AND METHODS

This study adopted a quantitative approach using primary and secondary data sources (Hariani et al., 2024; Vidiani et al., 2023). Primary data were obtained through direct observation at the health center to see the conditions in the field. In contrast, secondary data were collected from various sources, such as Google Earth, the official website of the Bengkulu City Health Office, and the Data and Information Technology Center of the Ministry of Health of the Republic of Indonesia (Abdullah et al., 2024; Mahfudah et al., 2024). The data analysis method used in this study is spatial analysis with the help of ArcGIS software, while to determine the direction of policy, this study utilises AHP Expert Choice (Agustin & Anggraini, 2021; Berenbrok et al., 2022; Sreekumar & Mishra, 2024).

Data analysis techniques in this study are as follows (Isnaini Salsabilah et al., 2023; Latupeirissa & Papilaya, 2023). The variety of policy indicators taken depends on the primary purpose of decision-making. AHP is a multi-criteria decision-making method, so the indicators are usually arranged as criteria and sub-criteria in a hierarchical structure. Policy analysis can be in the form of economic, social, environmental, political, regulatory, technical, and operational analysis. These indicators are flexible and can be adjusted to the objectives and stakeholders undergoing the decision-making process. Policy direction in determining the influence of the distribution of health centers in increasing the HDI is carried out using the AHP (Analytical Hierarchy Process) method, where the formulation of priority directions is carried out so that the distribution of health center work areas is appropriate; this aims to increase human development growth (Kriswardhana et al., 2025; Ksissou et al., 2024). The AHP method is very suitable for making the

right decision and providing clear thoughts or reasons (Caporale & Rinaldi, 2025). AHP determination is carried out in pairs to get the most important weights and priorities in determining decision-making policies.

RESULTS AND DISCUSSION

Area Region Work Health Center Based on the Regulation of the Minister of Health

The working area of the Health Center is regulated based on the Regulation of the Minister of Health Number 43 of 2016, which states that the working area covers one sub-district or part of a sub-district. The results of this study show the coverage of the area served by each Health Center. The working area with the most significant area is the Padang Serai Health Center, which has an area of 34,712 km² and covers three sub-districts, namely Padang Serai Village, Sumber Jaya Village, and Teluk Sepang Village. In contrast, the smallest working area is owned by the Anggut Atas Health Center, with an area of 0.890 km², which covers five sub-districts: Anggut Atas Village, Anggut Dalam Village, Kebun Geran Village, Kebun Dahri Village, and Pengantungan Village. Overall, the working area of the Health Center is spread across nine sub-districts in Bengkulu City, with each sub-district having 2 to 3 Health Center ready to reach and serve the entire community in Bengkulu City. According to BPS, the total number of health workers in Bengkulu City is 2,171 people, with health facilities consisting of 8 hospitals, 20 health centers, and 53 clinics.

The Farthest Service Distance of the Health Center Based on Permenpera

The service distance of the Health Center reflects the extent to which the community can easily reach health facilities. Based on the Regulation of the Minister of State for Public Housing Number 32 of 2006 concerning the Ideal Distance Standard for health service facilities, the ideal distance for a Health Center is 2 km. Therefore, most Health Center in Bengkulu City meet the ideal service distance standards. This service distance also considers the population coverage in each work area. For example, Pasar Ikan Health Center has a work area that covers nine sub-districts, namely Pasar Jitra Sub-district, Pasar Melintang Sub-district, Berkas Sub-district, Pasar Baru Sub-district, Pondok Besi Sub-district, Malabero Sub-district, Sumur Meleleh Sub-district, Kebun Keling Sub-

district, and Kebun Ros Sub-district, with a service distance ranging from 80 meters to 1,000 meters.

Meanwhile, the Sukamerindu Health Center has the furthest service distance, 6 km, with a work area in Surabaya Sub-district. The Padang Serai Health Center also has the furthest service distance of 3 km, with a working area in Teluk Sepang Village. The results of the work area (**Figure 1**), buffering area, and ideal service area are shown in **Table 1**.

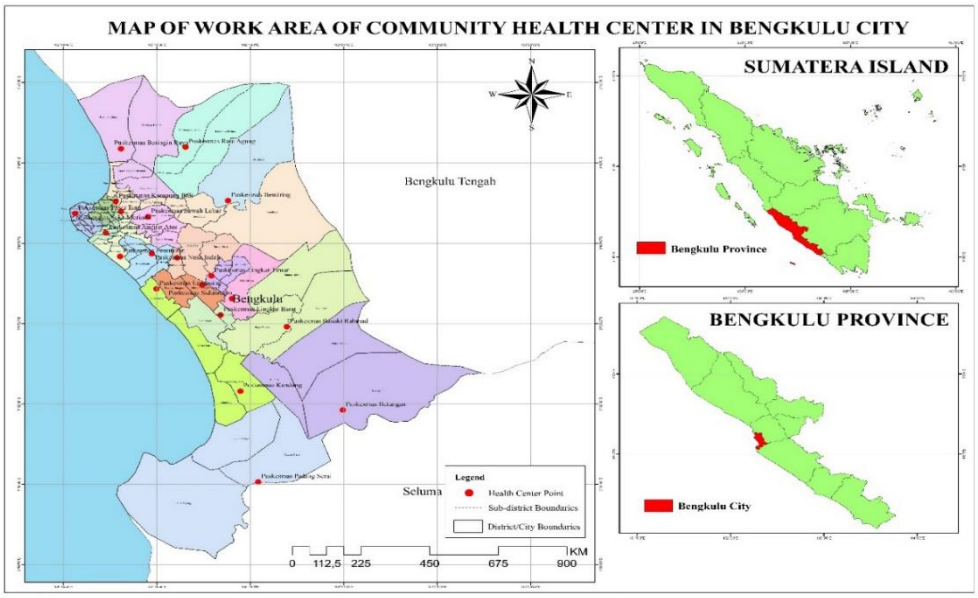

Figure 1. Result Map of Puskesmas Working Area

Based on the results of the buffer (**Figure 2**) and service area analysis (**Figure 3**), it can be seen that most of the working areas of the Health Centers in Bengkulu City overlap. This can be seen from comparing the working and the buffer areas, which are significantly different. The ideal service area shows that 13 out of 20 health centers meet the ideal service distance standard of 2 km. Meanwhile, seven other health centers do not meet this standard, namely Jalan Gedang Health Center, Jembatan Kecil Health Center, Lingkar Timur Health Center, Sidomulyo Health Center, Bentiring Health Center, Muara Bangkahulu Health Center, and Telaga Dewa Health Center. Factors such as population density, area, geographical conditions, and other infrastructure are considered in determining the working area of the Health Center. The service target of each Health Center is to serve an average of 30,000 residents. Thus, it can be concluded that all Health Center in Bengkulu City mostly meet the ideal and

effective service distance of 2 km, with an average number of residents served of 19,555 people and covering up to 9 work areas. This will make it easier for the community to access health services within and outside the coverage area.

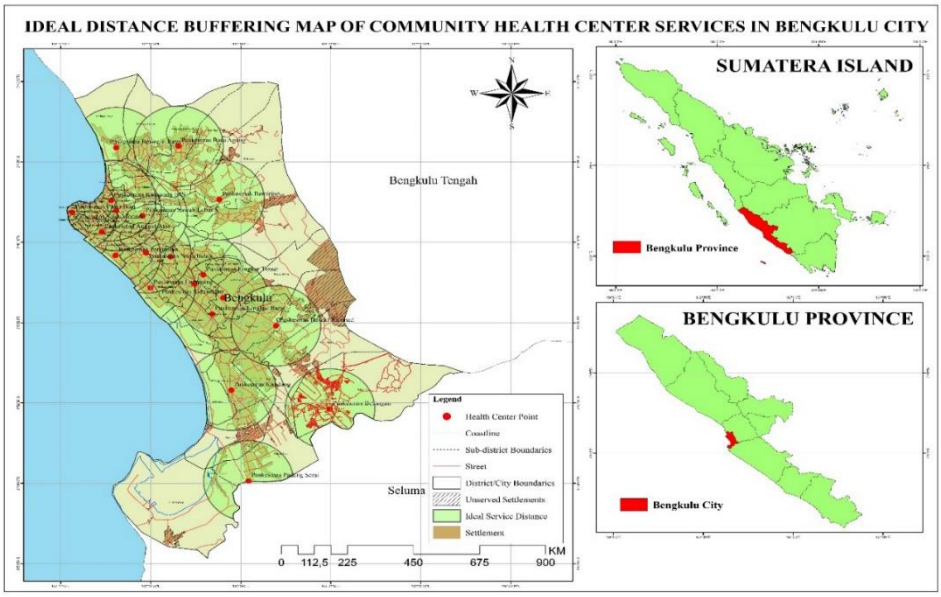

Figure 2. Ideal Distance Buffering Map of Community Health Center

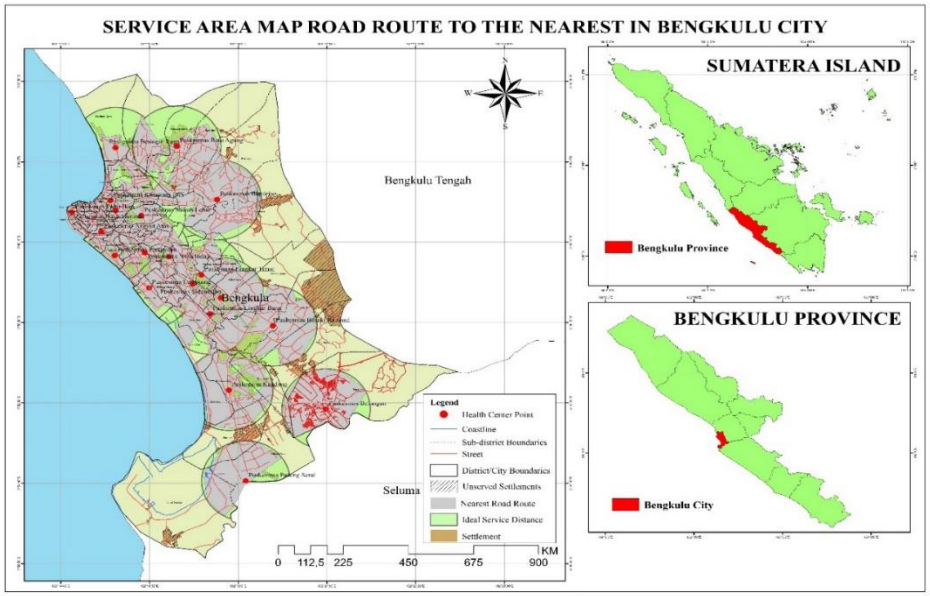

Figure 3. Service Area Map Road Route To The Nearest

Table 1. Result of Work Area, Buffering Area and Ideal Service Area

Name of Health Center	Working Area (Km²)	Buffer Area (Km²)	Ideal Service Area (Km²)
Health Center Jalan Gedang	3.149	12,576	2,001
Health Center Jembatan Kecil	5.426	12,576	2,001
Health Center Lingkar Timur	3.137	12,576	2,001
Health Center Lingkar Barat	1.927	12,467	1,993
Health Center Sidomulyo	4.142	12,576	2,001
Health Center Kandang	8.656	8,300	1,626
Health Center Padang Serai	34.712	10,970	1,869
Health Center Bentiring	11.231	12,576	2,001
Health Center Beringin Raya	16.357	9,277	1,719
Health Center Muara Bangkahulu	14.608	12,573	2,001
Health Center Lempuing	1.544	8,426	1,638
Health Center Nusa Indah	3.331	11,549	1,918
Health Center Sawah Lebar	3.254	12,577	2,001
Health Center Anggut Atas	0.890	8,598	1,655
Health Center Penururan	2.187	7,779	1,574
Health Center Telaga Dewa	20.080	12,575	2,001
Health Center Betungan	27.490	9,799	1,767
Health Center Suka Merindu	18.400	11,136	1,883
Health Center Kampung Bali	1.165	9,916	1,777
Health Center Pasar Ikan	1.647	4,000	1,129

Policy Directions on the Influence of the Distribution of Health Center Work Areas in Increasing IPM

Based on the results of determining the sub-criteria based on the whole (Combined), it can be seen that the criteria that are the main priority in the policy direction of the influence of the distribution of the work areas of health centers in increasing the HDI are the accessibility criteria which have a value of 0.474. In contrast, the second priority is the health service quality criteria, with a result of 0.370; finally, for the third priority, namely the contribution to increasing the HDI, the result is 0.156. analysis by utilising the Expert Choice software that has been done, then the CI value is obtained for each criterion according to the standard, namely with a value of <0.1, which can prove that the assessment given by each respondent is consistent. If you look at the results of the accessibility criteria analysis with the

most important priority, namely transportation to the health center which has a value of 0.0 468, then on the health service quality criteria where the main priority is satisfaction with health services by obtaining a value of 0.0390, finally for the contribution criteria to increasing the HDI with the most important priority, namely maternal and child mortality rates with a value of 0.0449. For more details, it can be seen in **Figure 4** below:

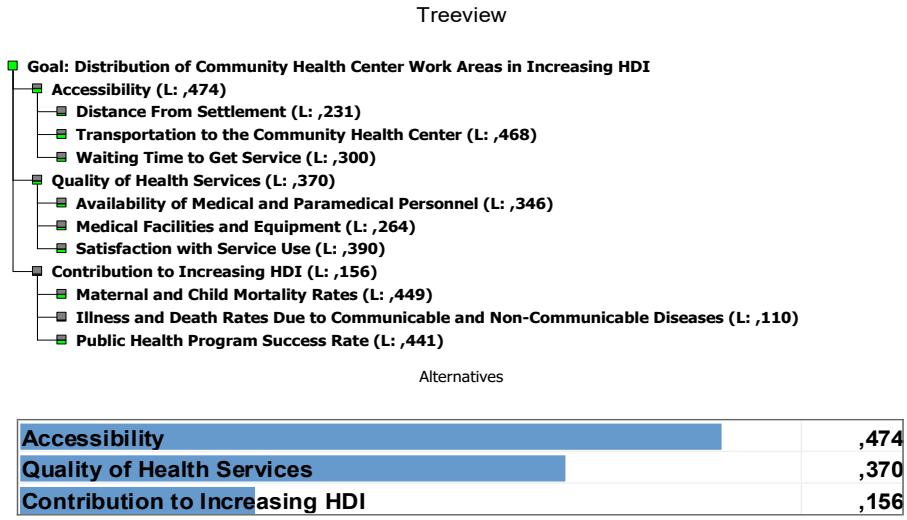

Figure 4. Consistency Value of Priority Policy Directions Influence of Distribution of Health Center Work Areas in Increasing Human Development Index

Based on the **Figure 4** shows the overall results (Combined) obtained from the calculation of the three criteria and sub-criteria related to the Priority of Policy Directions for the Influence of the Distribution of Health Center Work Areas in Increasing the Human Development Index, showing that there are alternative strategies that can be used, namely as follows:

Transportation is important in ensuring people can access health services effectively and efficiently. Patient satisfaction is influenced by consistent service standards and following applicable clinical guidelines. The need for medical personnel is determined based on the number of patients and the type of service to ensure timely and quality care. Waiting time affects service efficiency; a queuing system is needed based on the case's urgency. Complete medical facilities and equipment ensure safe and quality services, adjusted to the number of patients and current medical

standards. The distance to health facilities determines accessibility, especially for emergency services requiring short travel time. Improving maternal and child health services and education during pregnancy is important to reduce mortality rates. The program's success is assessed by its effectiveness in improving public health. The policy focuses on handling infectious and non-infectious diseases through routine immunisation and prevention.

DISCUSSION

Area of Work of Health Centers in Bengkulu City

The working area of the Health Center covers one sub-district or part of a sub-district. Considerations in determining the working area of the Health Center include population density, area, geographical conditions and other infrastructure conditions. The division of the working area of the Health Center is determined by the Regent and Mayor, with technical advice from the head of the district/city health office. The working area in Bengkulu City, from the study results, can be said to cover all areas in Bengkulu City, which are divided into nine sub-districts that cover 67 villages within them. The working area of the Health Center is located between 2 and 3 units in one sub-district area. This follows government standards, where each region must have a health service unit that can accommodate a different number of residents, depending on the area's conditions in each Health Center.

A Community Health Center is supported by simpler health service units called auxiliary Community Health Centers and peripheral Community Health Centers to expand the reach of health services. The distance of the Community Health Center service shows the distance that the community can easily reach to obtain health facilities. Health Centers are important in providing basic health services to the community. Therefore, the division of the health center's work area is adjusted to the health center's ability to reach people who need health services. Smaller work areas, such as some sub-districts, may be applied in areas with high population density or difficult access.

In comparison, wider work areas can be applied in areas with lower population density and are easier to reach. Meanwhile, this is also following research conducted by Fitri et al. (2024) and Rani et al. (2023), which states that in determining the work of the health center,

it can be seen based on the area, geographical conditions, adequate infrastructure, facilities, and others. Therefore, it is important to know this so that the health center's work area can fulfill the services of the work area in a place. The community will feel better served if it can be fulfilled, and their health needs can be met more efficiently. The fulfilment of optimal health services in the health center's work area will support the creation of a healthier society, improve the quality of life, and reduce morbidity and mortality due to disease. Conducted by Fitri et al. (2024) and Rani et al. (2023), which states that determining the work of the health center can be seen based on the area, geographical conditions, adequate infrastructure, facilities, and others. Therefore, it is important to know this so that the health center's work area can fulfill the services of the work area in a place. The community will feel better served if it can be fulfilled, and their health needs can be met more efficiently. The fulfilment of optimal health services in the health center's work area will support the creation of a healthier society, improve the quality of life, and reduce morbidity and mortality due to disease.

Buffer and Network Analysis Service Area is utilised in analysing research data where the buffer describes a closed area or polygon at a certain distance on a specific appearance span. Meanwhile, the Network Analysis GIS Service Area can create datasets and perform network analyses. A Network Analyst is useful for studying coverage issues, where the network analyst identifies a node's location. The target population served by the Health Center is an average of 30,000 residents per Health Center. To expand the reach of health services, a Health Center is supported by a simpler health service unit called a sub-health center and a peripheral Health Center. The distance of the Health Center service shows the distance the community can easily reach to get health facilities. Based on the regulations, namely the Regulation of the Minister of State for Public Housing Number 32 of 2006 concerning the Ideal Distance Standard for health center health service facilities, is 2 km. Table 14 above shows that seven health centers have the furthest ideal service distance, namely Kandang Health Center, Padang Serai Health Center, Bentiring Health Center, Beringin Raya Health Center, Telaga Dewa Health Center, Betungan Health Center and Suka Merindu Health Center,

which reach a range of up to 6 km from the health center point. Furthermore, 13 health centers are said to serve the people of Bengkulu City, with a target number of residents accommodated in each health center, namely 19,555 people spread throughout the area of Bengkulu City. Moreover, this is what causes several health centers to be close to each other regarding service coverage or the closest road route to the health center, which is caused by the density and geographical conditions in the city center, which usually has a high population density.

Similar research has also been conducted by Pratama & Muthia (2024); Pratiwi et al. (2024); Yasinta & Hidayah (2024) in the use of ArcGIS tools, utilising Buffer and Network Analysis Service Areas, which can be applied to spatial distribution and its influence on society or specific areas. Analyse the spatial distribution, accessibility, and influence of facilities or infrastructure on society, and help design policies and planning that are more effective and efficient in facing various challenges and community needs.

Meanwhile, according to the regulation of the Minister of State for Public Housing Number 32 of 2006 (Bolton et al., 2024; Fajar et al., 2024), the ideal distance in health services for a Health Center can be reached by 2 km. The ideal distance considered reasonable for the community to access health services is around 2 km. This distance is optimal because it allows the community to reach the Health Center easily, either by walking, cycling, or using public transportation, depending on the area's geographical conditions and existing transportation infrastructure. This distance also reflects the basic principle in public health planning that focuses on equitable and sustainable access, and can help reduce disparities in health services in different regions.

Policy Direction for Determining the Effect of the Distribution of Health Center Working Areas in Improving HDI

Policy Direction for Determining the Effect of the Distribution of Health Center Working Areas in Improving HDI has three policy criteria, namely accessibility, quality of health services and contribution to increasing HDI. Regarding accessibility criteria, it can be interpreted as an activity that enables access to and utilisation of health facilities. In order to increase public awareness about the importance of getting good and adequate health services. Furthermore, the criteria for the quality of health services are closely

related to the sense of community satisfaction in getting the services provided by the Health Center, the availability of medical equipment and medical staff who are fulfilled and adequate can improve the quality of health, which encourages population growth in an area. As well as on the criteria for contributing to increasing HDI, where this activity aims to reduce the mortality rate of both mothers and children or due to infectious and non-communicable diseases, which will then be arranged for programs to reduce the impact caused in the future.

Based on the results of the analysis of policy priorities that have been obtained based on interviews and discussions according to their fields of expertise, then processed into Expert Choise software, it is found that there are five main priorities including transportation to the Health Center, service user satisfaction, availability of medical and paramedical personnel, waiting time to get services and medical facilities and equipment. Of these five priorities, the government and the Health Center have focused on the availability of medical personnel and paramedics, where each Health Center already has medical personnel according to the fields and needs in the types of services provided.

Similar research has also been conducted by Nugroho (2024) and Setiono et al. (2024), stating that the use of AHP to determine the distribution policy of health centers can provide a strong basis for evidence-based decision-making in order to improve the Human Development Index (HDI). By identifying and prioritising the most influential criteria, policies can be developed to provide equitable, efficient, and sustainable health services, ultimately improving quality of life and social equality.

The results of this study reveal that with the spatial method, the distribution of the working areas of health centers in Bengkulu City can be said to be quite even by adjusting the conditions of each sub-district. The direction of the solution needed with a more spatial data-based work area planning approach is expected to be able to plan the distribution of new health facilities, expand service areas, and allocate health workforce resources. The sustainable use of Geographic Information System (GIS) technology is also a strategic step in monitoring and evaluating the effectiveness of service distribution over time. By improving the

accuracy and evenness of the distribution of the working areas of health centers, basic health services can reach all levels of society more fairly and evenly, thus supporting sustainable human health development in Bengkulu City.

CONCLUSION

Based on the results of the research conducted, it can be concluded that 1) The largest working area is the Padang Serai Health Center with a working area of 34,712 km² covering three working area sub-districts, namely Padang Serai Village, Sumber Jaya Village and Teluk Sepang Village. Then, for the smallest working area is the Anggut Atas with a working area of 0.890 km² covering five working areas, namely Anggut Atas Village, Anggut Dalam Village, Kebun Geran Village, Kebun Dahri Village and Pengantungan Village. The working area of the Health Center is spread across nine sub-districts in Bengkulu City, where each sub-district has 2 to 3 Health Centers that can reach and serve the entire community in Bengkulu City. 2) The facilities of Health Centers in Bengkulu City show that 13 health centers meet the ideal service distance of 2 km, and seven health centers do not meet the ideal service distance. In other words, Health Centers in Bengkulu City have served the entire community when viewed from the average number of supporting residents of 19,555 people served in each health center. This reach can serve up to 9 work areas, which the Bengkulu City Health Centres can accommodate. 3) Policy Directions for Determining the Influence of the Distribution of Health Center Work Areas in Increasing the Human Development Index have three policy criteria, namely accessibility, quality of health services and contribution to increasing the Human Development Index. Which in the accessibility criteria has a value of 0.474, while for the second priority, namely the quality of health services, it obtained a result of 0.370, finally, for the third priority, namely the contribution to increasing the Human Development Index, the result was 0.156. Meanwhile, the priority value of the transportation sub-criteria is to the health center with a value of 0.205, user satisfaction with a value of 0.0160, availability of medical and paramedical personnel with a value of 0.142, waiting time to get service with a value of 0.132 and medical facilities and equipment with a value of 0.108. The limitations in this study are highly dependent on population

distribution data covering all existing health center work areas and indicators obtained from related health agencies, which are then described accurately to show the appropriate conditions in the field—the limitations of spatial methods that can measure more accurate and precise service coverage. Future research is expected to use the latest data obtained from secondary and primary data and direct perspectives by the community to develop the needs and challenges of public health development in the future. Moreover, it can use advanced spatial technology and methods, and involve related party instances.

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