Geospatial analysis of healthcare facilities in Surulere Local Government Area of Lagos state

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ABSTRACT

The study is an assessment of the geographical distribution of healthcare facilities in Surulere Local Government Area (LGA) of Lagos state, Nigeria. The study relates the distribution of the healthcare facilities with population, distance from waterbody, road, and elevation using Fuzzy Analytical Hierarchy Process (FAHP). The FAHP is a Multi-Criteria Decision Analysis (MCDA) that provides a multidimensional approach to essential decision-making, in this case, the optimal locations of primary healthcare centres in areas of deficits. The spatial distribution of healthcare facilities in Surulere LGA shows uneven and deficiencies in the distribution, especially in Baruwa, Bale, Irone, Obele Oniwala, Odo-Oluwa, Agunbiade, Shitta Bank Olemoh wards. While the majority of the 183 health facilities were located in - Adeniran Ogunsanya, Osho, Coker, Ipanrin and Nuru-Oniwo political wards respectively. 28 of these facilities are government owned which is a course of concern in an area dominated by middle-to-low-income earners who cannot afford treatment in private facilities, especially if we consider that only 24 Primary Healthcare facilities are available for an area with a population of almost 700,000. The FAHP shows that the optimal location of new primary healthcare centres to meet the observed deficiencies are areas within Iponri/Eric Moore, Savage, and Adeniran Ogunsanya political wards because of their proximity to the road waterbody to aid easy access, located within areas of densely populated regions compared to surrounding areas to ensure easy and effective access to primary healthcare facilities and aid the general wellbeing of the citizenry. For effective healthcare coverage to be achieved in Surulere LGA, the paper recommends the adoption of geospatial techniques in the location and distribution of healthcare facilities.

Keywords: Healthcare, Fuzzy Analytical Hierarchy Process (FAHP), Multi-Criteria Decision Analysis (MCDA), Water, Sanitation and Health (WaSH)

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INTRODUCTION

The geographical distribution of healthcare facilities is one of the key elements of the health system, ensuring that all people have access to the necessary services and that no one is left out of receiving them (Doyani et al., 2020). The quality of healthcare services has been hampered and lifesaving interventions have been absent, which adds to the burden of communicable and non-communicable disease mortality and morbidity in sub-Saharan Africa including Nigerian cities. It has also contributed to the failure to provide lifesaving interventions to dwellers. This is a problem that needs further examination, particularly in highly populated modern cities in developing nations (Adewoyin et al., 2018). Urbanisation is best described as the population moving from rural to urban regions and the proportion of people living in cities gradually rising (Okikiola, 2022). However, there are issues with the urbanisation process. The ability of urban residents to access healthcare services and facilities based on their socioeconomic status, site of residence within the city, and other factors is of major significance (Almeida et al., 2017; Adewoyin et al., 2018). Some sections of the population are either at a distinct advantage or a disadvantage depending on where they live within the urban region (Ikporukpo, 2002). This is important because urbanisation has a significant impact on the population's health and access to medical facilities and services.

Surulere LGA, like other LGAs in the Lagos metropolis, is densely populated (Ayeni, 2017) and plagued with an emerald of health problems including malaria-infected environment, air pollution from the exhaust of vehicles, residential electricity generating plants and other households' combustion (WHO, 2008); poor access to Water, Sanitation and Health (WaSH) facilities (Akoteyon and Otusanya, 2022); malnutrition (Ruel and Garrett, 2004) among others. Thus, the state of urban health is a cause for worry, especially as access to and distribution of healthcare services would significantly enhance the general welfare of people. The spatial analysis of the healthcare facilities in Surulere is a contemporary issue that requires attention because of the sparsity in the literature on the issue of urbanization and access to healthcare facilities in Surulere LGA. The spatial study of the healthcare facilities in Surulere is a current problem that warrants consideration. Given the aforementioned debate, it is clear that new hospitals must be built. However, choosing the right location is a challenging task that calls for the use of sophisticated decision-making tools and a geospatial approach (Tripathi et al., 2022). The majority of the studies conducted in Nigeria have been based in other cities, with little impact in Lagos and

Surulere LGA (Abbas et al., 2012), Yola (Bukhari and Muhammed, 2013), and Ibadan (Adewoyin et al., 2018).

In consideration of this, the study was designed to analyse the spatial distribution of healthcare facilities in the Surulere LGA. This was done by assessing the spatial distribution of the healthcare facilities in the LGA and identifying their spatial limitations to pinpoint areas that have deficiencies and/or are suitable to ensure adequate coverage using the Fuzzy Analytical Hierarchy Process (FAHP). The FAHP is a decision-making tool designed to address or provide assistance with a range of spatial reasoning issues, such as risk management (Peng et al., 2021); evaluating students' projects (Cebi and Karal, 2017); supplier selection issues (Ayhan, 2013); Assessment of human settlement (Zhang and Fan, 2020) among others. The technique was chosen since, according to several studies (Cetinkaya et al., 2016; Vahidnia et al., 2019; Tripathi et al., 2022), choosing the most suitable healthcare location is contingent upon a variety of factors, the majority of which are homogenous. As a result, it is necessary to employ an optimization method to assess these factors and how they interact. Therefore, Multi-Criteria Decision Analysis (MCDA) method can provide a multidimensional approach to essential decision-making (Ding et al., 2020). The FAHP methodology uses MCDA, a geospatial method that can help with optimal site selection—in this case, evaluating the most suitable healthcare location. This method aids decision-makers and policy planners (Tripathi et al., 2022).

AHP, Fussy TOPSIS, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), and Elimination and Choice Expressing Reality (ELECTRE) are some of the different Multi-Criteria Decision Analysis (MCDA) approaches (Vahidnia et al., 2009; Kumar et al., 2016; Senvar et al., 2016; Rajak and Shaw, 2019). The Fussy technique was chosen for the study because it facilitates the identification of deviations in criteria weight, criterion ranking, and suitability map, which must be done in extensive detail in the context of GIS-based MCDA and especially to decision makers (Tripathi et al., 2022). In light of this, the study thoroughly understands the geographic distribution of public healthcare facilities in Surulere LGA, Lagos State.

METHODOLOGY

Study Area

The Surulere Local Government Area (LGA) is located between latitudes 6° 28' and 6° 31' north of the equator and longitudes 3° 19' and 3° 23' east of the Greenwich Meridian. Mushin LGA borders it to the north, Mainland LGA to the east, Apapa and Ajeromi-Ifelodun LGA to the south, and Amuwo-Odofin and Osodi-Isolo LGA to the west, respectively (Figure 1). Like other LGAs in the Lagos metropolitan, Surulere LGA is an urban LGA with a mix of residential and commercial land uses. It is one of Nigeria's LGAs with the highest population densities. The area has a population density of 18,631 people per square kilometre with a land mass of approximately 27.05 Km^2 and 503,975 residents as per the 2006 National Population Census result (FGN, 2006, www.nigerianstat.gov.ng). The National Bureau of Statistics (NBS, 2012) lists 23 wards and 3 Local Council Development Areas (LCDA) for Surulere LGA. Surulere LGA is a highly dense area in Lagos Metropolis. Although Lagos State barely makes up 0.4 per cent of Nigeria's total geographical area, it has a long history of economic growth and development and is responsible for 60% of the country's industrial and commercial operations. The neighbourhood, which is less than 10 km from the hub of the Lagos Metropolis, is mostly a congested and overcrowded residential region where low- and middle-income inhabitants predominate (Oyelola and Balogun, 2008).

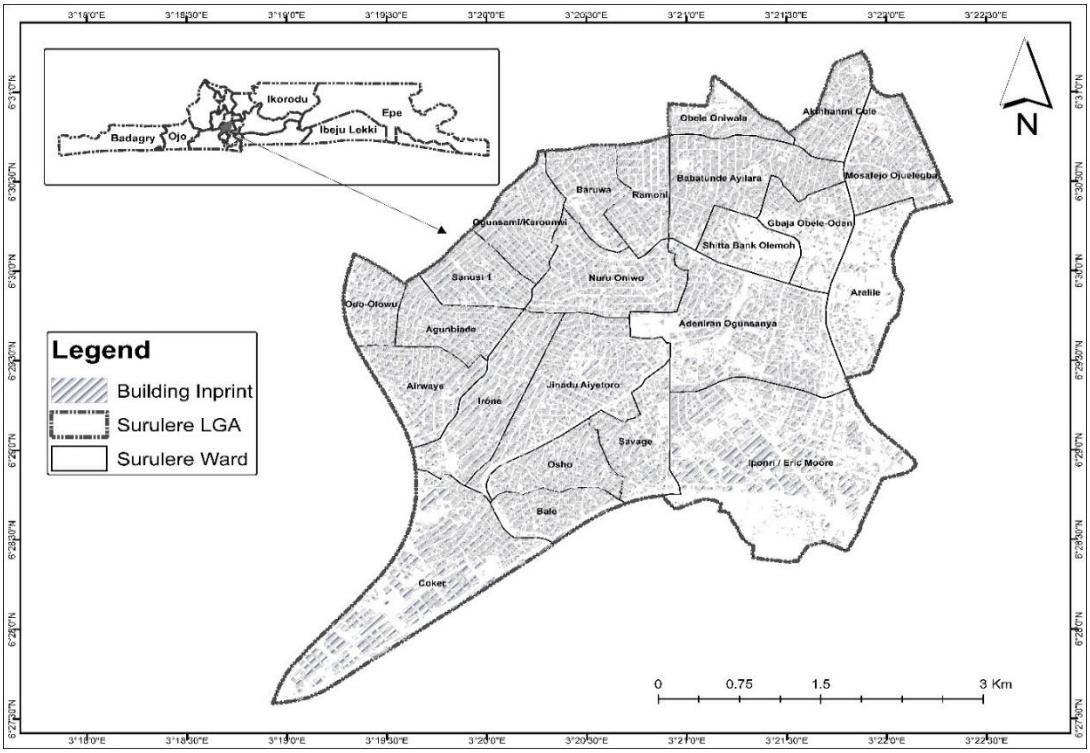

Figure 1: Surulere LGA

Data Source and Characteristics

To provide a realistic representation of the relationship between the healthcare facilities and the population of the area, the study integrates healthcare facilities, demographic information, and administrative maps of Surulere LGA. To do this, the study employed a variety of data that were obtained from diverse agencies, organisations, and sources. The healthcare facility for the study includes primary facilities; secondary facilities and tertiary healthcare facilities. In a Geographic Information System (GIS) setting, a point pattern designates these facilities as presented. The locations of the healthcare facilities were obtained via the GRID3 open-source website (https://geonetwork.grid3.gov.ng/geonetwork/srv/en/), and they were verified using field surveys (using a GPS portable device), Google Maps, and Open Street maps. Due to the constraints and challenges involved in carrying out a comprehensive GPS survey, this method was chosen for the study (Daniel et al., 2021). Other types of healthcare institutions are not included in the research, such as traditional/midwives centres and unlicensed clinics in Surulere. Each healthcare facility has a set of related characteristics, such as its name, coordinates, category, and owner (either a government agency, a commercial company, or an NGO).

The healthcare facilities in Surulere were categorized into three classes:

Tertiary healthcare facilities:

Teaching hospitals, which are regarded as the highest hierarchy hospitals in the region, are included in the tertiary level/category healthcare facilities, which are the top healthcare facilities in Surulere for both government and privately held institutions. All local and distant residents are given comprehensive medical treatment at these institutions, which also treat patients who are referred by secondary hospitals in Surulere, the area around it, and outside of Lagos.

Secondary healthcare facilities:

Specialized services including general medicine, surgery, paediatrics, obstetrics, gynaecology, and community health services are offered by the secondary medical facilities. Therefore, depending on referrals from smaller hospitals, accepts referrals through in-patient services from primary healthcare institutions for residents of Surulere, Lagos State, and even beyond (Doyani et al., 2020). Healthcare institutions in the secondary category offer greater and more extensive medical services to more residents.

Primary healthcare facilities:

At the lowest level of healthcare facilities, primary healthcare centres offer residents nearby basic medical treatment. Governments often want primary healthcare facilities to support growth while concentrating on the main, mostly preventable causes of death and morbidity. When classifying primary healthcare facilities, they are supposed to be the first point of contact for patients, offering preventive, curative, health-promoting, and rehabilitative services. Patients who cannot be managed at the centre are directed to other levels of care as necessary (Doyani et al., 2020). The high-resolution population density maps 2020 from Meta (https://data.humdata.org/organization/facebook?q=high%20resolution%20population%20density&ext_page_size=100) were used to estimate the population of the wards in the Surulere LGA in 2020. Due to the limits of the population statistics and census in Nigeria, this data source was selected. Also, the deficiencies and unavailable of community-based or political ward census data in the most recent national population census (the 2006 National and Housing Population Census), are insufficient for geographical analysis. The Conversion tool (*Raster to Point)* feature on the Arc Toolbox of the ArcGIS 10.5 programme was used to extract the 2020 population estimates of the 23 political wards in Surulere LGA, which are shown in polygon format.

The data for the GRID3 website (https://geonetwork.grid3.gov.ng/geonetwork/srv/en) and the Laboratory for Cartography and Remote Sensing, Department of Geography, University of

Lagos, Akoka were used to create the administrative maps of Surulere LGA, including the political ward maps.

Data Analysis and Presentation

The healthcare facilities were extracted from the GRID3 website and validated using field surveys and Google Maps and Open-Street maps. Where required, the database was cleaned up and corrected. Particularly, 40% of the facilities were verified using Google and Open Street maps, while 10% were certified using field surveys. To verify that the database overlaps with the Surulere LGA base map, a geometric modification of the database was also carried out. The Fuzzy Analytical Hierarchy Process (FAHP) was used to find the optimal location for healthcare facilities in Surulere LGA. According to Vahidnia et al. (2009) and Tripathi et al. (2022), the process entails combining several assessment criteria into thematic layer maps. Population density, distance from main highways and waterways, the distance between primary healthcare facilities, and Surulere LGA's elevation are all included in this criterion.

To construct the thematic maps, a variety of geospatial techniques, including interpolation and Euclidean distance, were applied for the various data types. The *Arc Toolbox + Spatial Analyst + Fuzzy Membership* and later the *Fuzzy Overlay* Options were used to build the FAHP suitability map. Using an established fuzzification technique, the Fuzzy Membership tool was used to transform the raster data of the five adopted variables into rasters with values that range from 0 to 1, indicating the strength of membership in a set. Full membership in the fuzzy set is indicated by a value of 1, while non-membership is indicated by a value of 0. Based on the chosen overlay type, the fuzzy overlay tool merges fuzzy membership raster data. The *PRODUCT* Overlay type was used for the study because the combined evidence is equally important to each piece of information. A five-scale table of Very Suitable, Suitable, Moderate Suitable, Unsuitable, and Very Unsuitable is used to display the study's suitability region map.

RESULT

Spatial distribution of healthcare facilities in Surulere LGA

There were 183 healthcare facilities found in Surulere, according to the spatial distribution and summary of the institutions. The Babatunde Ayilara ward has the most facilities among the 23 political wards in the region, followed by Adeniran Ogunsanya with 13 facilities. While Osho and Coker each have 10 facilities, Iponri/Eric Moore and Nuru Oniwo each have 11. With 1, 3, and 4 facilities, respectively, Odo-Olowu, Baruwa, and Bale wards have the fewest healthcare facilities.

In terms of the categories of healthcare facilities, there are 101 Primary Health Centres spread over the 23 political wards, which are often the closest to the population in terms of the hierarchy of healthcare services. In addition to other facilities, Surulere has 2 medical facilities, 16 specialist hospitals, 15 maternity homes, and private non-profits. There are 16 tertiary HCF, 6 secondary HCF, and 16 primary HCF out of the 183 facilities in Surulere LGA. One facility is owned and operated by the Federal Ministry of Health and the National Primary Healthcare Development Agency. Of these facilities, 152 are owned by private and nonprofit organisations, 22 by the State Primary Healthcare Development Agency, three by missions or religious organisations, two by the Lagos State Ministry of Health, and one by the Surulere LGA.

Based on political wards and categories (Figure 2), the majority of the facilities are located in the northern part of the LGA, close to the two general hospitals in the Babatunde Ayilara and Gbaja Obele-Odun wards and the Lagos University Teaching Hospital (LUTH), which is situated just outside Surulere LGA's boundaries. Only 28 of the 183 HCF in Surulere are run by the government and its agencies, and these 28 would serve as the foundation for the analysis because they are the facilities that the vast majority of the residents—most of whom, according to Oyelola and Balogun (2008), are middle- to low-income earners who can only afford these facilities—use.

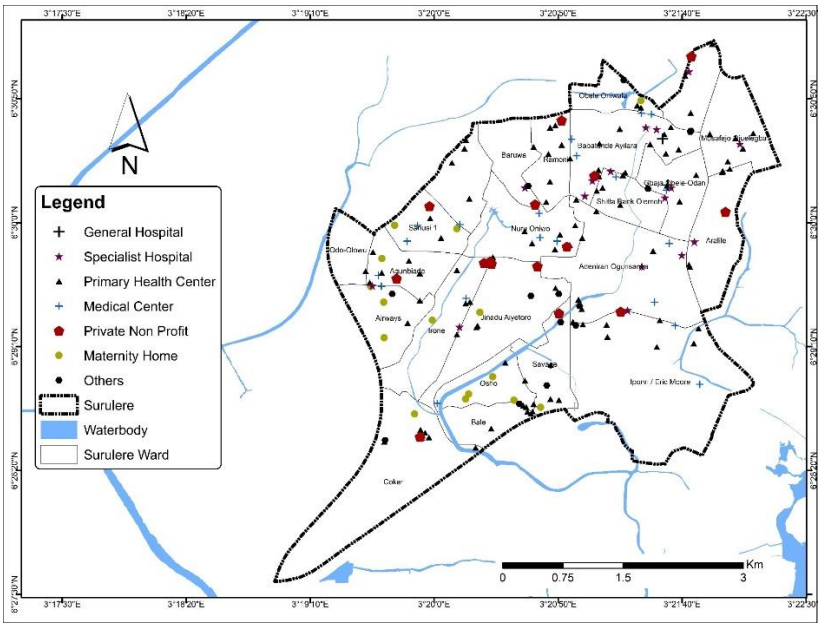

Figure 2: Categories of healthcare facilities in Surulere LGA

A dispensary (2), a medical centre (4), and one maternity home are among the 24 government primary health centres in Surulere (Figure 3). Ramoni, Babatunde Ayilara, and Gbaja Obele-Odan

Political Wards are the primary HCF centres, according to the spatial presentation of these facilities. Residents of the political wards of Coker, Ogunsami/Karounwi, Baruwa, Obele Oniwala, Mosafejo, Ojuelegba, Odo-Olowu, Agunbiade, and Irone must leave their area to reach HCF in Surulere LGA.

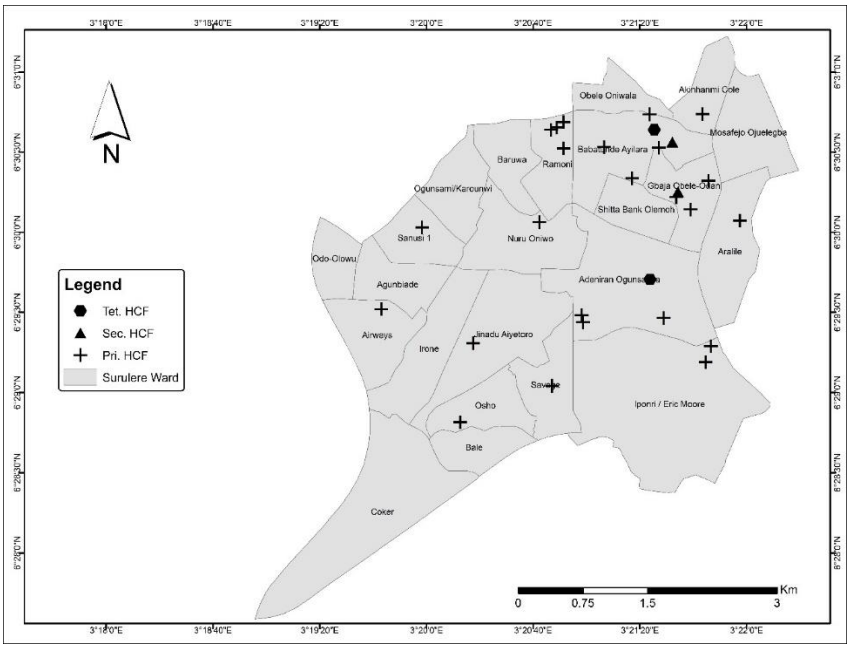

Figure 3: Spatial distribution of government HCF in Surulere LGA

Population vs Healthcare Facilities of Surulere

Coker, Iponri/Eric Moore, and Adeniran Ogunsanya political wards have the biggest population in Surulere LGA, with a combined total of between 53,321 and 94,360 people (Table 1). Jinadu Aiyetoro and Babatunde Ayilara are next, with a combined total of between 40,601 and 53,320 people. A population estimate for Airways, Iron, Nuru Oniwo, and Mosafejo/Ojuelegba ranges from 27,401 to 40,600 people. An estimated 19,241-27,400 people live in Aralile, Gbaja Obele-Odan, Ramoni, Baruwa, Ogunsami/Karounwi, Sanusi 1, and Agunbiade. A population estimate for Odo-Olowu, Bale, and Shitta Bank/Olemoh ranges from 14,481 to 19,240 people. The Obale Oniwala Political ward in the Surulere neighbourhood has the lowest estimated population, with 14,480 people as shown in Figure 4.

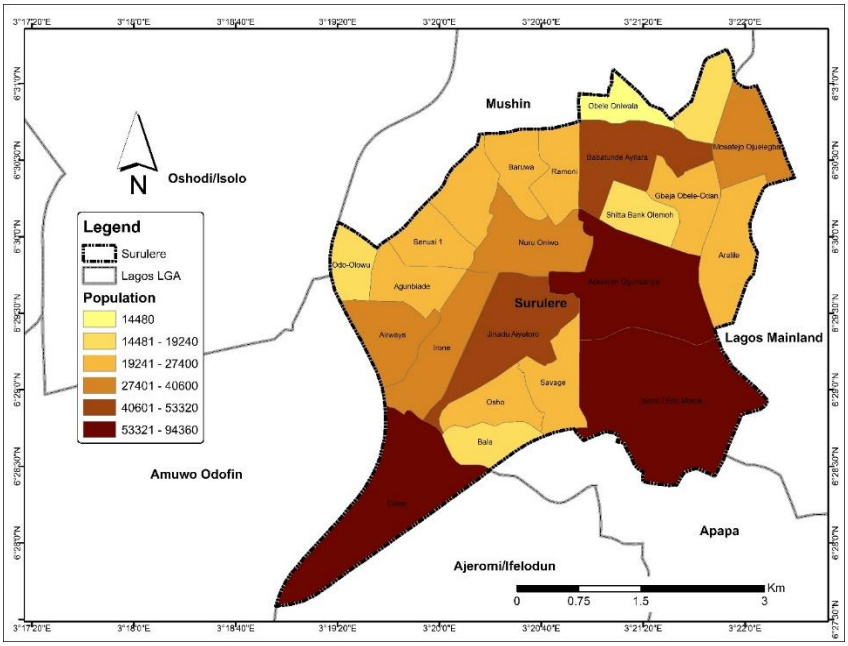

Figure 4: Estimated population by political wards in Surulere LGA

The interaction between the general public and the healthcare facility is crucial. The National Primary Healthcare Development Agency (2012) proposed one primary healthcare facility and one general hospital for each political ward with a population of 10–20,000 people. As a result of this proposal, all political wards have at least one Primary Healthcare Centre (PHC), except for Baruwa political ward (Appendix 2). With 10 PHC facilities and 4,380 residents per PHC facility, Babatunde Ayilara is the second most well-served region in Surulere LGA (Table 1). There are 8 PHC facilities in the Ramoni political district to accommodate the roughly 22,400 citizens who live there, with 2,800 people in each facility. Shitta Bank Olemoh has 4 PHC facilities that serve an estimated 19,240 persons, which is approximately 4,810 people per PHC facility.

The Airways political ward, on the other hand, has just one PHC facility and serves an estimated population of roughly 29,760, following the Baruwa political ward, which has none. This falls short of the NPHDA (2012) guideline of 1 PHC facility for every 20,000 residents. When we take into account that government HCF is more cost-effective for the majority of Surulere LGA citizens to attend. HCF is not accessible to people living in the nearby communities of Agunbiade, Bale, Baruwa, Coker, Irone, Mosafejo-Ojuelegba, Obele Oniwala, Odo-Olowu, Ogunsami/Karounwi, and Shitta Bank Olemoh. Savage, Sanusi 1, Osho, Nuru Oniwo, Jinadu AIyetoro, Aralile, Airways, and Adeniran Ogunsanya households also do not have access to the recommended PHC facility for 20,000 residents.

Table 1: Relationship between population and PHC facility in Surulere LGA.

Ward	Population, 2020	Total PHC	Pop/PHC	Govt. PHC	Pop/PHC
Adeniran Ogunsanya	68,800	7	9,829	3	22,933
Agunbiade	23,800	6	3,967	0	0
Airways	29,760	1	29,760	1	29,760
Akinhanmi Cole	18,320	3	6,107	1	18,320
Aralile	27,400	3	9,133	1	27,400
Babatunde Ayilara	43,800	10	4,380	4	10,950
Bale	17,320	3	5,773	0	0
Baruwa	21,520	0	0	0	0
Coker	71,640	7	10,234	0	0
Gbaja Obele-Odan	23,600	3	7,867	3	7,867
Iponri/Eric Moore	94,360	7	13,480	2	47,180
Irone	37,600	4	9,400	0	0
Jinadu Aiyetoro	53,320	3	17,773	1	53,320
Mosafejo Ojuelegba	32,840	7	4,691	0	0
Nuru Oniwo	40,600	7	5,800	1	40,600
Obele Oniwala	14,480	2	7,240	0	0
Odo-Olowu	16720	1	16,720	0	0
Ogunsami/Karounwi	25520	4	6,380	0	0
Osho	23520	5	4,704	1	23,520
Ramoni	22400	8	2,800	4	5,600
Sanusi 1	21920	2	10,960	1	21,920
Savage	26000	4	6,500	1	26,000
Shitta Bank Olemoh	19,240	4	4810	0	0
	774,480	**101**	**198,308**	**24**	**32,270**

Additionally, the Surulere LGA operates and owns both of the general hospitals located in the political wards of Gbaja Obele-Odan and Babatunde Ayilara. A total of 24 government PHC facilities and 1 HCF provide services to 32,270 inhabitants in Surulere LGA, which has a population of almost 700,000. This is much more than the 20,000 people per PHC facility that the WHO and NPHDA suggest.

Optimal Location for Healthcare Facilities in Deficient Areas in Surulere LGA

Based on the observed geographical disparities in how healthcare facilities, notably Primary Healthcare Centres, are distributed throughout political wards, it can be shown that certain places

have a concentration of amenities while others lack them. For residents to easily access these services, they must be located in the best possible locations. To do this, the Fuzzy Analytical Hierarchy Process (FAHP) was employed to identify the ideal Surulere locations for future healthcare facilities. To build the best appropriateness map for site selection, the FAHP needs pre-set criteria. The study adopted 5-criteria (thematic layers) as presented in Figure 5. These thematic map criteria represent:

- Distance from other primary healthcare facilities: Primary healthcare facilities must be situated adjacent to other facilities for simple access as well as to make sure that new hospitals are strategically placed across the region (Soltani and Marandi, 2011). Despite the NPHDA (2012) and the WHO (2012) recommending a spacing of 5 km between each primary healthcare institution, the study chooses 1 km due to the dense population in the region. To choose the best location for the Primary Healthcare Facility in Surulere LGA, the Fussy membership gave more importance to places far away from other hospitals.
- Proximity to the waterbody and major roads: Hospitals should be located adjacent to major highways and other transportation hubs, according to Rahimi et al. (2017) and Tripathi et al. (2022). Figure 5b&c illustrates the theme criterion for the distance from a water body and the main roadways in the Surulere LGA with the area to achieve this. This makes it possible to give areas in Surulere LGA that are closer to the main roads and water bodies a greater priority to facilitate access.

- Elevation: Surulere's elevation is shown in Figure 5d. The most suitable locations to situate new hospitals must be those that are substantially elevated, as this will lower the likelihood of local natural disasters like seasonal and flash floods. For this reason, the Fuzzy membership prioritises areas that are higher in the Surulere.

- Population density: Population density is a key factor in deciding where to situate the hospital, which is best situated adjacent to densely populated regions of the city. According to Vahidnia et al. (2009) and Sahin et al. (2019), hospitals should be positioned in or adjacent to highly populated regions so that the greatest number of people may get healthcare services at the closest available location. The population criterion map for the

research is shown in Figure 5e. In Surulere, regions with a greater population received a higher score than those with a lesser population.

FAHP Criteria Analysis

By giving each criterion a spatial presentation and combining several geographical layers to build suitability maps, the criterion gives decision-makers more detail and visual information that aids in their capacity to act swiftly and efficiently (Tripathi et al., 2022). These criteria come in a variety of categories and formats, for instance, the distance from a water body, a road, and between healthcare facilities underwent Euclidean distance analysis (Spatial Analyst tool on ArcGIS), while population estimates underwent interpolation analysis (IDW on the Spatial Analyst as well). The Fussy Membership and Fussy Overlay options of the ArcGIS 10.5 software's Spatial Analyst tool function are then used to alter the surface maps. As a consequence, Figure 5 displays several theme layer maps of the criterion.

Figure 5a shows that the Primary Healthcare facilities are clustered and cover most of the wards in Surulere LGA and are assigned low priority compared to areas without these facilities. Proximity to water and road facilities is presented in Figure 5b&c. From the map, a large part of the study area is within 45 meters of a waterbody and a major road this is important because these 2 criteria can aid in effective transportation to the Healthcare facilities and thus higher priority is given to the pixels near the roads and the water body.

Particularly in a low-lying area like Surulere, the elevation is a key factor for locating a healthcare centre. The hospital is better situated at a greater elevation relative to the area, and thus, places with comparatively higher elevations in the area received higher scores on the Fuzzy assessment. As regards the population density, the thematic map is presented in Figure 5e. Wards with greater population density are given a higher score than those with lower populations.

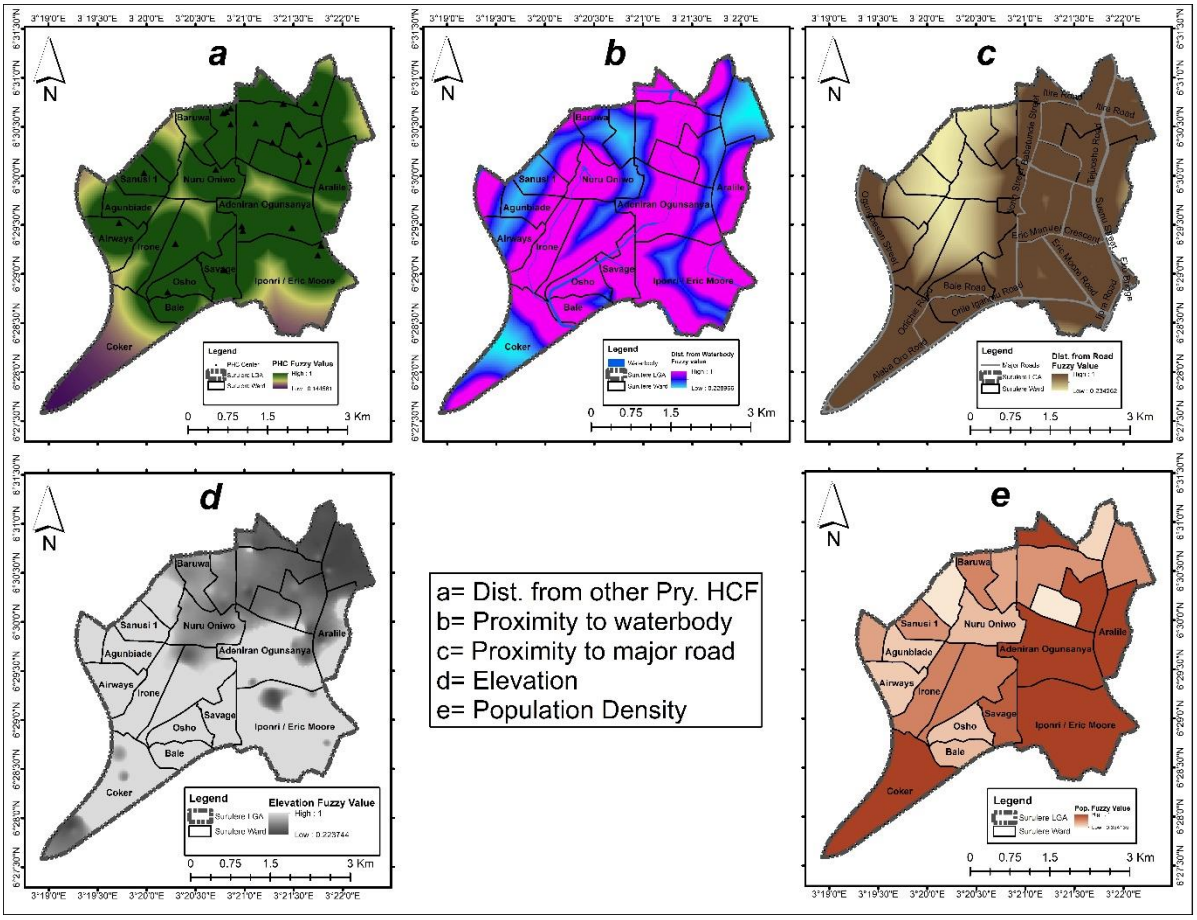

Figure 5: Thematic layer maps of criterium for optimal location of PHC in Surulere LGA

FAHP Suitability Maps

Figure 6 shows the most suitable places for Primary Healthcare facilities to be situated to fill the deficiencies in Surulere LGA. The suitability map reveals that some areas of the Iponri/Eric Moore, Savage, and Adeniran Ogunsanya political wards are the Most Suitable for the placement of new primary healthcare facilities. Due to their proximity to the Badagry Motorway, Orile-Iganmu, Eric-Moore, Bode Thomas, Babs Animashaun, and other major roads in the area, as well as their higher population density when compared to other areas in Surulere LGA, these areas have the highest FAHP scores.

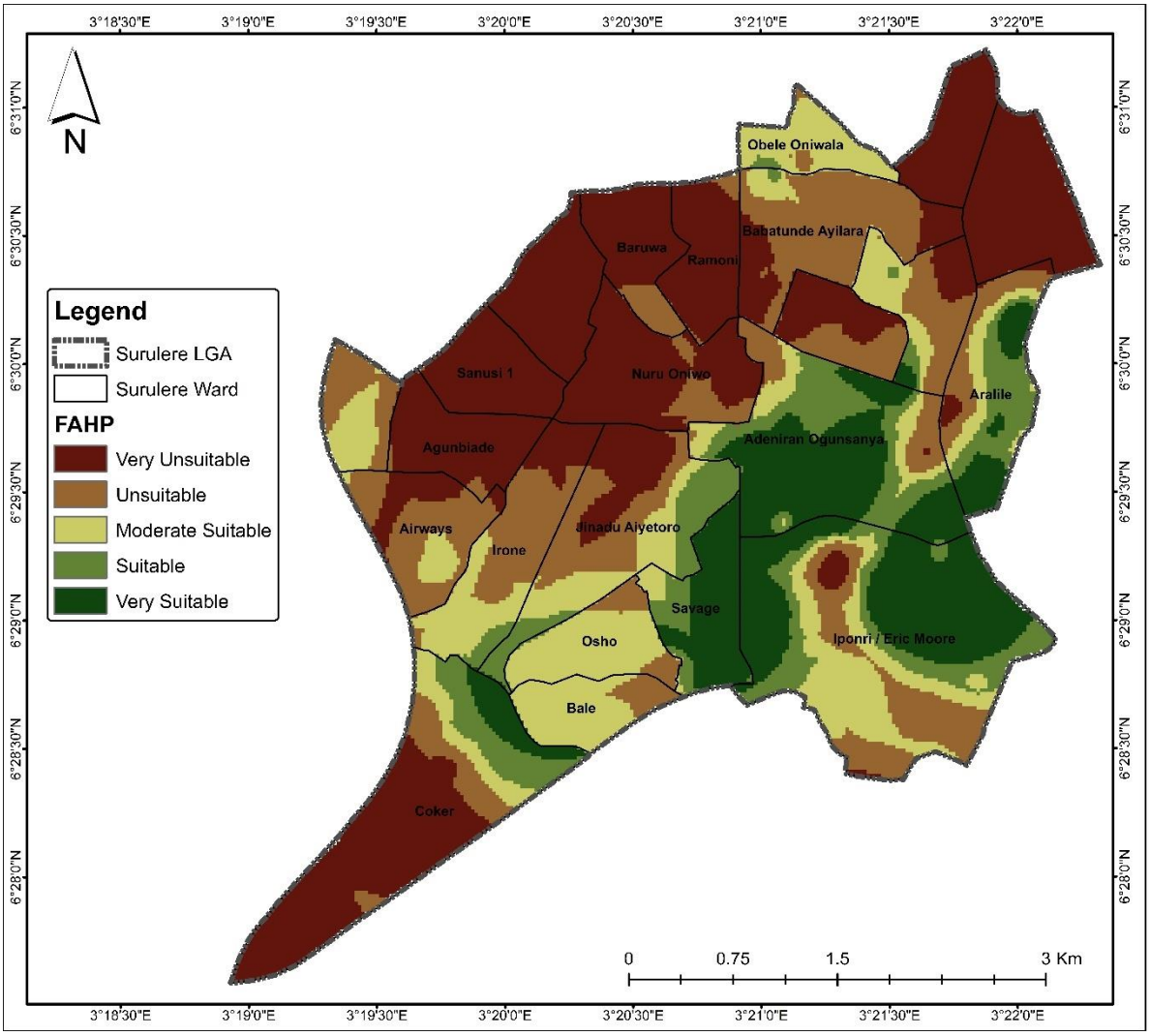

Figure 6: Optimal location of PHC in Surulere

DISCUSSION

The mapping and the spatial presentation of the healthcare facilities in Surulere LGA revealed a significant discrepancy in the distribution of the HCF across the political wards in Surulere LGA with Babatunde Ayilara having the highest number of HCF followed by Adeniran Ogunsaya, Iponri/Eric Moore, Nuru Oniwo while Odo-Olowu, Baruwa and Bale wards have the lowest number of HCF located in them. Many criteria, such as easy access, the presence of appropriate roadways, and population density, among others, can be blamed for the differences in the distribution of the facilities (Luo and Qi, 2009). The uneven distribution of this HCF in Surulere is consistent with findings from similar studies in other parts of the country, Adewoyin et al., (2018) in Ibadan, Muhammed et al., (2014) in Kaduna, Idoko et al., (2021) in Nasarawa, Atser and

Akpan (2009) in Akwa Ibom State, Usman et al., (2020) in the Hawul LGA. The spatial disparities in the distribution of healthcare facilities in Surulere LGA and other urban areas of Nigeria have the effect of limiting citizens with middle-to-low incomes' access to healthcare facilities, which has a significant impact on their general health and well-being.

The Surulere LGA's political ward demographics demonstrate how densely populated the region is. Except for the Baruwa Political Ward, most political wards have at least one PHC facility and adhere to the NPHDA (2012) recommendation of at least one PHC facility per political ward or every 20,000 population, as well as one general hospital in every LGA. Babatunde Ayilara and Ramoni recorded the highest serviced wards with 10 and 8 PHC facilities, respectively, while the Airport ward only had one PHC facility to serve over 30,000 residents, falling short of the NPHDA (2012) guidelines. This conclusion supports the prior buffer study and demonstrates that the majority of Surulere complies with the guidelines for healthcare facilities serving Surulere inhabitants. According to the report, the Surulere LGA has a minimum of 2 major HCF deficits, one in the Baruwa and one in the Airport Political wards. This is a vast improvement over what happens in other parts of Nigeria. For instance, Fadahunsi et al. (2017) found a shortage of 7 Secondary Healthcare institutions in 4 of the state's 30 LGAs in their research of Osun state.

However, these findings can be contested if we take into account that the majority of Surulere residents are middle-to-low-income earners who, due to their financial situation, would mostly use government facilities. In sum, the primary healthcare facilities in Surulere do not meet the requirement of one hospital per political ward and one hospital serving no more than 20,000 residents. The conclusions of Usman et al.'s (2020) research in Hawul LGA, Bornu State, and those of Uwala's (2020) study on the geographic distribution of public healthcare facilities in Yewa South LGA, Ogun State, support this assumption.

The observed geographical pattern is consistent with the findings of Fadahunsi et al. (2017) and shows that Surulere's HCF, particularly the Tertiary and Secondary HCF, is distributed in a disorganised and ineffective manner. The distribution of the primary HCF was discovered to be more evenly distributed than the secondary and tertiary HCF, in line with the findings of Adewale et al., (2022) on HCF in Ibadan. Adewale et al. (2022) ascribed the observed geographical distribution of the secondary and tertiary HCF to the centrifugal organic expansion of cities, with

the consequence that the HCF is sparser the further one goes. The research further ascribed the trend to the excellent quality of the infrastructure and population density, which are more likely to be found there than on the city's periphery. This may lead to a lack of accessibility to these facilities and their inability to effectively satisfy the citizens' healthcare requirements.

CONCLUSION

The research made an effort to provide decision-makers with geospatial approaches as a tool, particularly in issues related to the location of healthcare facilities in Surulere LGA in Lagos state. It brought attention to the unequal and insufficient distribution of healthcare facilities in 14 political wards, which are largely found in heavily populated regions, for healthcare services. 15-20 new primary healthcare facilities must be situated in the most advantageous locations in Savage, Adeniran Ogunsanya, Iponri/ Eric Moore, Coker, and Aralile, which are the most suitable locations, as well as sections of Irone, Jinadu Aiyetoro, Gbaja Obele-Odan, and Obele Oniwara, to ensure equity in the distribution of these new facilities throughout Surulere LGA. The study successfully demonstrated the ability of the GIS approach and the FAHP as genuine instruments for a decision support system for investigating the spatial distribution of healthcare facilities and supplying optimal sites for PHC facility deficiencies in the region. This could aid in closing the growing gap between patients' needs and the accessibility of health care.

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