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Multi-Criteria Suitability Analysis of Healthcare Infrastructure for Optimized Health Service Delivery in Uyo, Nigeria

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Abstract

This study employs Geographic Information Systems (GIS) and spatial statistical techniques to evaluate the inventory, structural composition, and geographical distribution of healthcare facilities (HCF) in Uyo Capital City, Nigeria. Utilizing handheld Global Positioning System (GPS) receivers for primary data collection and ArcGIS 10.8 for spatial modeling, the research identified 64 healthcare facilities within the study area. An inventory analysis revealed a significant structural imbalance in the healthcare hierarchy: 14 facilities (22.6%) are categorized as Primary Health Care (PHC), 49 (76.6%) as Secondary facilities—predominantly privately owned—and only one (1.6%) as a Tertiary facility. The spatial pattern of distribution was assessed using Nearest Neighbour Analysis (NNA), yielding a Nearest Neighbour Ratio (Rn) of 0.603357 and a highly significant z-score of -5.926470 ($p < 0.01$). These statistics confirm a significantly clustered distribution pattern, with infrastructure concentrated primarily within the urban core (Eniong, Oku, Uyo, and Aka regions) while the suburban fringes remain underserved. Furthermore, the study evaluated accessibility based on the World Health Organization (WHO) standard walking distance of 4 km. The findings indicate that while central urban residents enjoy high proximity, peripheral communities such as Ikot Udo Ibiono and Mbiakong Uruan suffer from locational disadvantage and increased travel burdens. This manifestation of the "Inverse Care Law" suggests that private-sector dominance has driven facility placement toward high-population density areas at the expense of equitable spatial coverage. The study concludes that the current distribution is uneven and inadequate for the city's projected growth. It recommends the strategic siting of new public PHCs in identified "blind spots" and the adoption of GIS-driven suitability modeling by the Ministry of Health to ensure healthcare delivery transitions from a clustered urban luxury to a spatially accessible right for all citizens.

Keywords: *Geographic Information Systems (GIS), Healthcare Facilities (HCF), Spatial Distribution, Nearest Neighbour Analysis, Inverse Care Law, Uyo Capital City, Nigeria.*

1.0 Introduction

Accessibility is a key factor in making the most of healthcare services. It gives a way to measure how far people can travel or how long it takes them to get to important health facilities (Parvin et al., 2020). Access to healthcare affects how people use services and shows how well health facilities are spread out in a certain location. In this context, access includes not just distance, but also important factors like capacity, availability, and cost, all of which have a big impact on how people use healthcare (Kibon & Ahmed, 2013).

Access to healthcare facilities is a vital element of any health system and has a direct impact on illness burden, especially in low-income countries. It is an important factor that affects the health of the population. Jaro and Ibrahim (2012) say that accessibility is complex and includes physical, temporal, economic, and social factors. The physical dimension pertains to the condition of road networks and transportation infrastructure. The time aspect has to do with how long it takes to go to care and any delays that might happen. The economic dimension refers to the

costs of travel and using services, while the social dimension refers to the cultural norms and values that affect people's choices of healthcare providers.

Accessibility can also be defined by the existence of dependable transportation systems and well-maintained road networks that enable access to healthcare facilities (Bakar et al., 2021). It is the job of governments to make sure that all citizens have fair and high-quality access to basic healthcare services. To achieve this kind of fairness, we need to arrange our spaces strategically so that the distribution of people, healthcare facilities, and transportation networks all work together to make spaces as accessible as possible. This is becoming more significant as the needs of public health grow along with the quality of life.

The unequal distribution and lack of medical resources frequently create big problems for communities, which is why choosing the right location for healthcare institutions is so important. Because everyone needs health care, the placement of health facilities influences the health of populations. Healthcare facilities are similar to other public services in terms of location theory, but their placement needs to be thought about in a different way (Nasri, 2014). The World Health Organization (1997) suggested that health facilities in developing countries should be no more than 4 kilometers from the people they serve. To fix differences in healthcare access and make sure that services reach the right people, it is important to make sure that the site is suitable.

Arifin (2010) stressed that the best place to put healthcare facilities should take into account things like the right distance, the size of the facility, the number of people living in the area, and the cost-effectiveness of the facility. Cheng-Ru et al. (2007) used an Analytical Hierarchy Process (AHP)-based evaluation methodology to find the best place for a hospital in Taiwan. They also used sensitivity analysis to see how strong the criterion weighting was. Choosing a hospital site is naturally complicated and affects many areas of society. So, it needs an interdisciplinary strategy that includes healthcare administrators, lawmakers, engineers, environmental experts, and social scientists.

Disparities in healthcare access around the world are intimately linked to how income is spread out. Developed nations typically exhibit superior healthcare accessibility relative to developing countries (Era et al., 2015). In many nations, health facilities are often found in high-income districts where people often possess their own care facilities and total health demands may be lower. On the other hand, people with low incomes often have trouble getting care even though they may need it more. Even when people from low-income neighborhoods are ready to travel far to get services in wealthier regions, they may still not be able to use them because of high charges, inadequate quality of treatment, limited hours of operation, and bad relationships between providers and patients.

The World Health Organization (2018) says that Africa has the lowest level of Universal Health Coverage in the world. This is mostly because of problems with infrastructure, a lack of healthcare workers and medicines, and a lack of political will. Socioeconomic growth is directly tied to how easy it is to get good healthcare services. This is because healthy people are better able to help society move forward. The United Nations sees longevity as a fundamental sign of development, and advances in healthcare services and infrastructure have a big impact on it. So, it is still important to make sure that health services are fairly spread out in order to support populations and encourage regional growth (Oyinloye, 2014). According to the World Health Organization (2018), there are several types of healthcare facilities, such as hospitals, primary healthcare centers, clinics, outpatient facilities, isolation centers, burn units, feeding centers, and specialized institutions like birthing and psychiatric care centers (MedlinePlus, 2018).

Proposing new site for health facilities has been a major concern towards suitable location for constructing new healthcare facilities that will solve the problems of unequal distribution and the issue of accessibility while rendering better services to the people.

Uyo Capital City area has experienced rapid increase in population, so there is need for adequate and proper healthcare delivery. This should prompt the health sector to focus on the creation of more healthcare facilities to meet the fast-growing population needs, as well as various studies to investigate the distribution, accessibility, and utilization of healthcare facilities. The spatial distribution and accessibility of healthcare facilities in Uyo Capital City have received very little attention. Against this background, this research will examine the spatial distribution pattern of health facilities in Uyo Capital City with a view to ascertain whether there is any imbalance in the pattern of the healthcare facilities distribution and accessibility compared with population distribution of the area as well as siting a suitable site for building more new hospital for the fast-rising population in the study area.

This study aimed to draw attention to existing spatial pattern of healthcare centres, accessibility as well as inventory and find out the possible sites for the provision of new healthcare facilities centres within the study area. The following research objectives were necessary in the study including assessing the suitable location with inadequate coverage of the healthcare facilities in the study area as well as determining the level of accessibility of healthcare facilities by the people in the study area.

2.0 Literature Review

The contemporary management of urban healthcare infrastructure is increasingly defined by a shift from traditional administrative planning to a sophisticated paradigm of spatial intelligence, primarily driven by the integration of Geographic Information Systems (GIS) and Multi-Criteria Decision Support Systems (MCDSS). This evolution is necessitated by the global persistence of the "Inverse Care Law," a sociogeographic phenomenon where the availability of quality medical care tends to vary inversely with the need for it in the population served. Across diverse geopolitical landscapes, from the arid regions of Upper Egypt to the rapidly urbanizing corridors of Nigeria and the dense settlements of West Bengal, researchers have consistently identified a systemic failure in the distribution of healthcare—a failure characterized by historical accident, market-driven clustering, and a disregard for the dynamic growth of urban populations. The synthesis of global literature, spearheaded by scholars such as Asmaa et al. (2016) and Almasi et al. (2022), underscores that the resolution of these inequities lies in the rigorous application of the Analytical Hierarchy Process (AHP). This mathematical framework allows planners to weight competing variables—such as population density, land slope, and proximity to existing road networks—to identify "Best," "Good," and "Unsuitable" zones for medical intervention. Asmaa's work in Egypt, for instance, proved that by applying seven sub-factors across urban and economic domains, a city can move from a state of "bad distribution" to one of optimized coverage where 30% of land is designated as high-priority for new hospital construction.

However, the mere identification of suitable land does not automatically translate to accessibility, a distinction that forms the core of recent spatial audits. Almasi et al. (2022) exposed a sobering reality in Kermanshah, where despite the presence of numerous facilities, 88% of households lacked appropriate walking access to public healthcare, with private-sector laboratories often filling the gap at a higher cost to the urban poor. This disparity is not unique to the Middle East; in Nigeria, researchers like Adesina et al. (2016) and Atser and Akpan (2009) have documented a recurring "urban bias" in states like Niger and Akwa Ibom. Their findings suggest that healthcare facilities are frequently "randomly distributed" or "lopsided," with a heavy concentration in city centers, leaving the suburban and rural "edges" in a state of medical invisibility. This clustering effect is a direct result of "reactive planning," where facilities are sited based on the availability of existing utilities or political patronage rather than a proactive analysis of the actual catchment area. The work of Abdurrahman and Nurünnisa (2013) further illustrates this, revealing that while the majority of healthcare providers were located in one developed district, the more populous residential zones remained chronically underserved, creating a "zero-sum" scenario where medical proximity becomes a luxury of the urban elite.

The technical methodology used to expose these gaps has evolved from simple buffering to complex network analysis and hybrid decision-making models. Farhana et al. (2020) and Alessandra et al. (2016) introduced a "three-tier" evaluation strategy that utilizes the TOPSIS method (Technique for Order of Preference by Similarity to Ideal Solution). This approach does not just map where a hospital *can* go, but ranks potential sites by their ability to minimize "travel friction" for the most deprived segments of the population. By incorporating road network analysis, as seen in the studies of Umar (2016) and Ifeanyi et al. (2012), researchers have shifted the metric of accessibility from static distance to functional time. This is critical because, as Musa and Abdulhameed (2012) observed, a community might be geographically close to a Primary Health Care (PHC) center but remain effectively isolated due to a lack of road connectivity, with travel distances increasing from a manageable 3.2 km to an insurmountable 10.5 km depending on infrastructure quality. Consequently, this "distance decay" effect—where the utility of a service diminishes as distance increases—forces residents in the urban periphery to abandon formal medical systems in favor of traditional practices, as noted by Kwaku (2008) in rural Ghana.

The socio-economic implications of this spatial neglect are profound, as highlighted by Christopher and Fadare (2014) and Ajala et al. (2012). Their research into the "human element" of healthcare reveals that accessibility is as much about manpower and affordability as it is about geography. In Ibadan, for example, 70% of residents were found to travel more than 5 km for their medical needs, paying a significant portion of their income on transportation. This suggests that even when a city appears to have an adequate number of hospitals on paper, the "travel cost" and the lopsided population-to-personnel ratio render the system inaccessible to the majority. The findings of Atser and Akpan (2009) regarding Akwa Ibom State specifically call for an "aggressive intervention" to rebalance the distribution of healthcare, particularly since the private sector has become the dominant provider, often prioritizing profit over universal coverage. This reinforces the need for integrated health planning, where local, state, and federal governments use GIS as a shared data platform to coordinate the siting of primary, secondary, and tertiary facilities to ensure a seamless "referral ladder" for patients.

To bridge these gaps, the literature concludes that urban planners must adopt a "Soft Path" of spatial governance that

prioritizes "Geospatial Auditing." The integration of AI-driven remote sensing and AHP-weighted overlay analysis provides a transparent, data-backed framework that can replace the "blame game" of political neglect with objective evidence of where the next medical intervention should occur. By utilizing the "Gravity Model"—which accounts for both population size and the "decay" of distance—cities can move toward a sustainable healthcare footprint. This transformation from a clustered, unplanned urban landscape to a strategically dispersed and suitable network is the only viable route to achieving Universal Health Coverage. Ultimately, the synthesis of these global studies proves that the map is not just a tool for visualization, but a weapon against the systemic marginalization of the urban poor, ensuring that healthcare becomes a reachable right for every citizen regardless of their location on the urban grid.

Materials and Methods

Study

Geographically, Uyo is found between Latitude 4˚ 52'N and 5˚07'N and Longitude 7˚ 47'E to 8˚ 03'E of Akwa Ibom State. Uyo Capital City is made up of Uyo urban and bounded in the north with Ikono, Itu and Ibiono Ibom Local Government Area, In the East it is bounded with Uruan LGA, in the West it is bounded with Abak LGA, in the south it is bounded with Ibesikpo Asutan and Nsit Ibom Local Government Area. The city covers an area of about 214.32square kilometers. In terms of health care facility availability, Uyo Capital City has scanty health facilities (government and private) that cater for the needs of its residents. It is made up of tertiary, secondary and primary healthcare, it offers a wide range of medical services to the people of the area, including specialized department such as Gynecology, pediatrics, surgery and a lot more. It also comprises of general hospital, cottage hospital The primary health care services which render health services like, immunization, prenatal care and other basic medical treatment to the people of the area.

Methods

The methodology for this research is centered on a Geospatial Analysis Framework, primarily utilizing Geographic Information Systems (GIS) to evaluate the spatial relationship between healthcare supply and community demand. The core analytical technique employed is buffering analysis, a spatial method used to generate zonal areas of a specific range around point, line, or polygon entities to determine the scope of accessibility for every existing health facility.

By generating these proximity zones, the study identifies residential settlements based on whether they fall within or outside the service boundaries, effectively mapping the reach of the current medical infrastructure.

To provide a rigorous benchmark for this evaluation, the study adopts the World Health Organization (WHO, 1997) recommendation for developing countries, which establishes that the maximum travel distance to access primary healthcare should not exceed 4km along existing road networks. Communities situated beyond this 4km threshold are classified as underserved, forming the basis for the subsequent site suitability modeling.

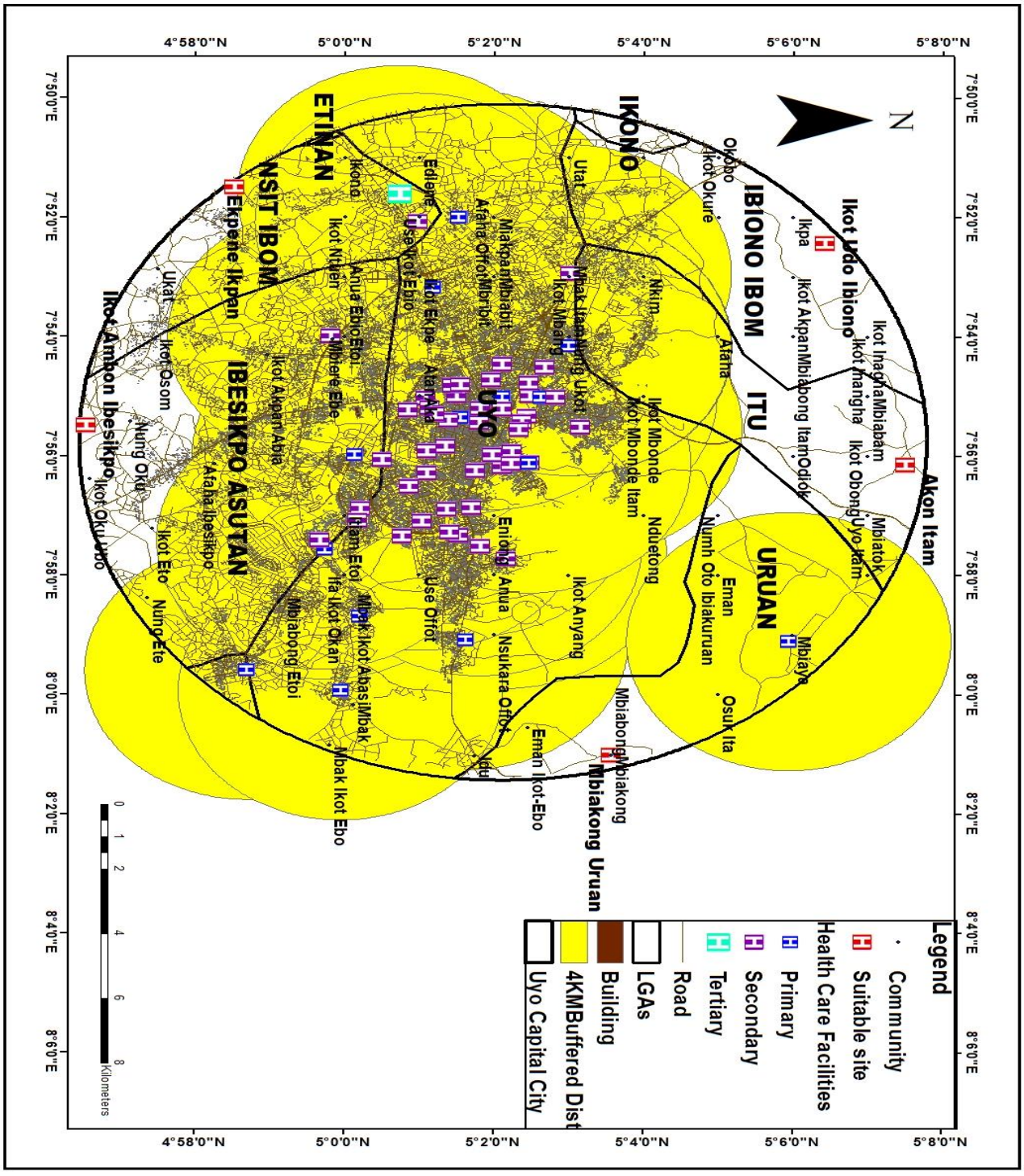
The selection of optimal locations for new healthcare facilities is conducted by analyzing the "white spaces"—the open areas not currently covered by existing buffers—while simultaneously considering high-priority spatial determinants.

These determinants include proximity to residential settlements to ensure centers are located near the target population, the overall population density of the area to maximize service utility, and the proximity to major transportable routes to facilitate ease of movement for both patients and emergency services. By integrating these layers of spatial intelligence, the methodology transitions from a simple inventory of facilities to a prescriptive tool capable of identifying the most suitable sites for future healthcare investment, ensuring that new centers are strategically placed to bridge existing gaps in the urban fabric.

Results and Findings

The study found some suitable sites within the study area with inadequate access where people are deprived from better healthcare facilities.

From the results obtained in **(Fig 4.1)**, it can be seen that, the communities at the city center of Uyo capital city in Uyo local government area enjoys more of the presence of health care facilities than any other parts of the location within the study area. This may be due to the population density in the area. Also, some communities were also observed within the study area with low access to health care facilities. Based on the result presented in **(Fig 4.1)**, it has showed that the suitable sites with inadequate coverage was considered based on buffered overlayed regarding areas that is not covered by the buffered walking distance of 4km (WHO) to access the health care facilities, the location nearer to settlement, population of the area and also the communities closer to transportable routes within the study area, Thus, **5** suitable sites were proposed within the study area which can offer health services in inaccessible region within the study area shown in **(Fig.4.1).** The proposed health care in a suitable site can also be merged and interlinked with existing health care to make the community enrich and accessible in term of health services. Each of the proposed site was validated by verifying ground truth. In this study, the proposed site was, Ikot Udo Ibiono in Ibiono Ibom local government area, Akon Itam in Itu local government area, Mbiakong Uruan in Uruan local government area and Ikot Mbon Ibesikpo in Ibesikpo Asutan local government area. All these sites were selected in open space, by considering their location nearer to settlement, population of the area, and also communities closer to transportable routes.



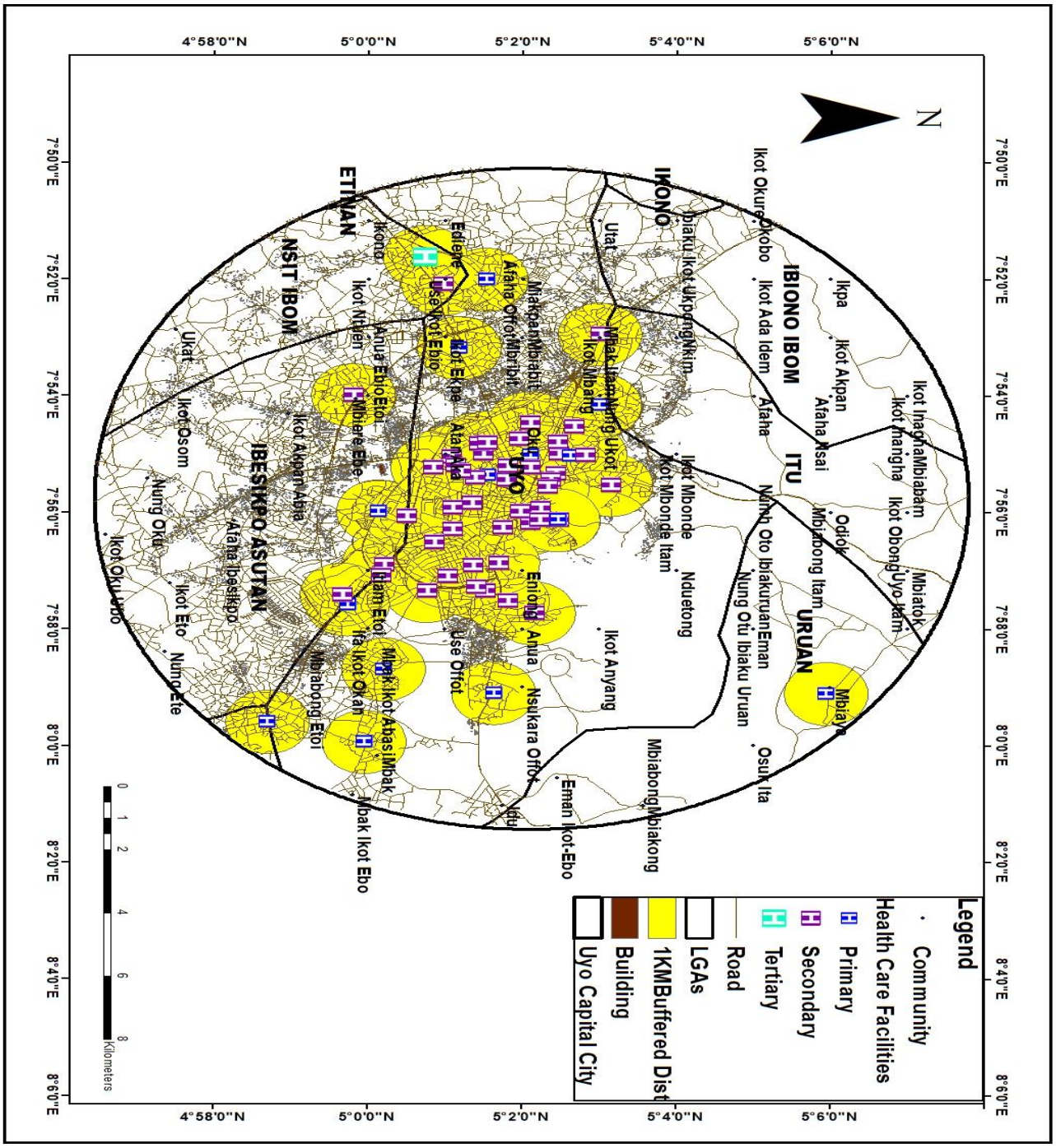
Source: Field data 2024

FIG: 4.1: Map showing the suitable location of Health Care Facility in the study area.

4.1.4 Level of accessibility of Health Care Facilities in the study area.

Buffered overlayed of all the existing health care facilities within the study area was done using ArcGIS 9.3 Software.

(Figure 4.2,), (Figure 4.3), (Figure 4.3), (Figure 4.4). Depict the representation of service area created by buffer zone overlayed for connectivity of buffer where the distance was measured 1km, 2km, 3km, 4km from the existing health care facilities. This means that each health care facilities within a walking distance of 1km, 2km, 3km, 4km, However, in a densely populated country like Nigeria, this research is of opinion that primary health care facilities should be cited within accessible distance along the existing roads in order to care for the less privileged who may not have access to health care services when needs arises. although this depends on individual choice to patronize those by or far away from the resident and the affordability of transport fare.



Source: Field data 2024

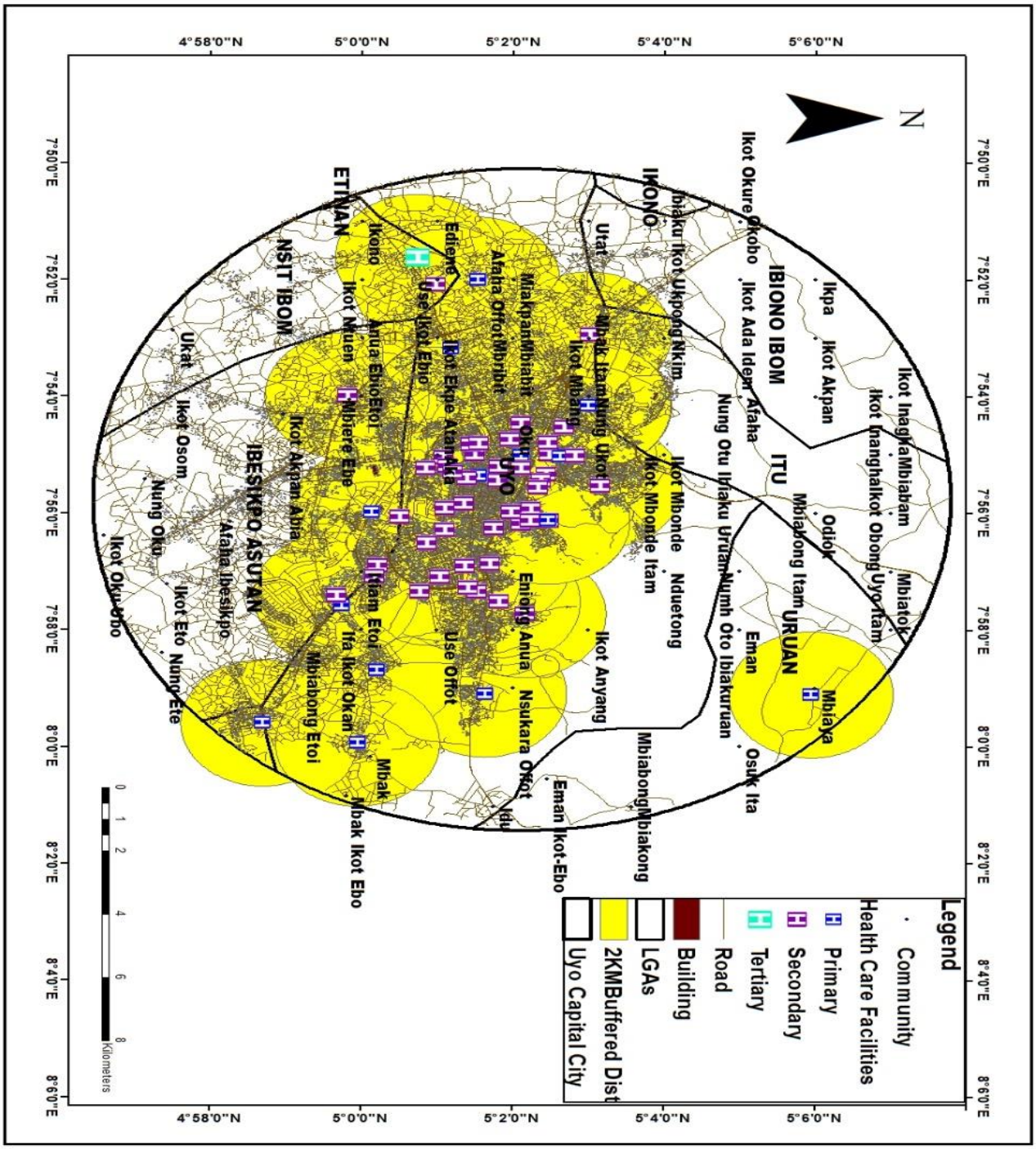
Figure 4.2 Map showing the accessibility of Health Care Facilities buffered on a walking distance of 1km within the study area.

The results of the buffer analysis as shown in (figure 4.2) above indicate the walking distance of 1000m to access the nearest health care facilities in the study area. Based on the analysis, the result indicates that some communities, Ikot Inangha Mbiabam, Ikpa, Ikot Akpan, Afaha Nsai, Ibiaku Ikot Ukpong, Nkim, Ikot Ada Idem, Utat, Ikot Okure in Ibiono local government area, Uyo Itam, Mbiatok, Odiok, Mbiabong Itam, Ikot Obong, Mbak Itam, Afaha, in Itu local government area, Ibiaku Uruan eman, Osuk Ita, Nung Otu, Numh Oto Ibiakuruan Iman, Idu, Eman Ikot Ebo, Mbiabong Mbiakong in Uruan local government area, Nduetong, Ikot Mbonde Itam, Ikot Anyang, Nung Ukut in Uyo local government area, Nung Ete, Ikot Eto, Ikot Oku Ubo, Ikot Osom, Afaha Ibesikpo, Ikot Akpan Abia, Nung Oku, in Ibesikop local government area and Ikot Ntuen, Ukat in Nsit Ibom local government area

have inadequate access to health care facilities of both primary, secondary and tertiary health care services and

these communities are not within the buffer overlayed. The residents of these communities had to travel a distance of more than 1000m before being able to access the health care facilities within the study area.

Meanwhile, some communities; Eniong, Oku, Uyo, Atan Aka, Itiam Etoi, Ediene,,Miakpan Mbiabit, Anua Offot, Afaha Offot, Nsukara offot, Ifa Ikot Okan, Use Ikot Ebio, Nung Ukot, Ikot Mbang, Ikot Ekpe, in Uyo local government area, Mbierebe, Anua Ebio Etoi in Ibesikpo Asutan local government area, Ikpa, in Ibiono Ibom local government area have adequate coverage of both primary, secondary and tertiary health care facilities with average distance between the closest facilities to the farthest health care facilities. Which implies that the household resident within this communities do not travel farther distance to access a particular type of health care facilities.



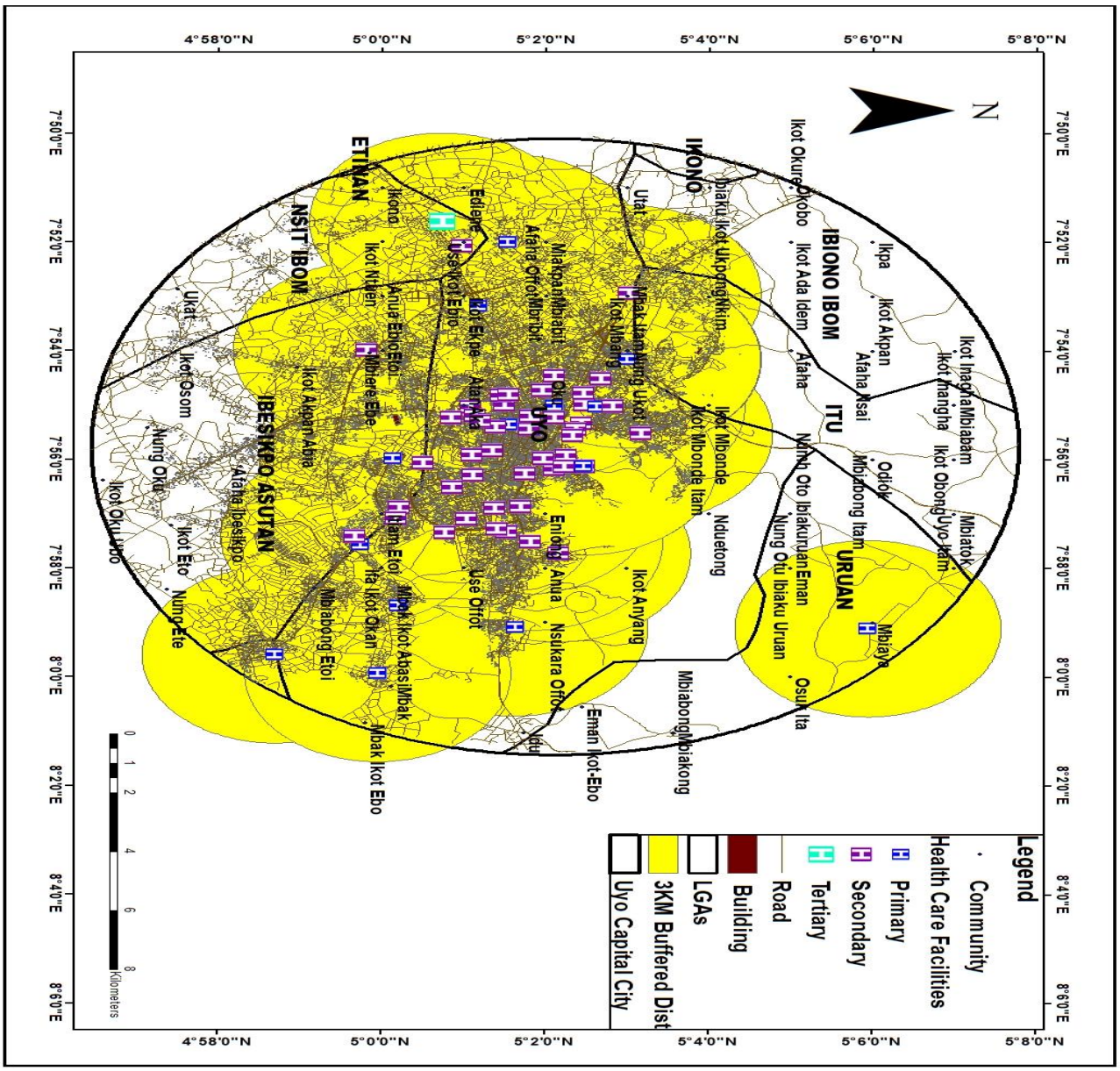
Source: Field Data 2024

Figure 4.3: Map showing accessibility of Health Care facilities buffered on a walking distance of 2km within the study area.

The results of the buffer analysis shown in (figure 4.3) above indicate the walking distance of 2000m to access the nearest health care facilities within the study area. Based on the analysis, the result indicates that some communities; Eniong, Oku, Uyo, Atan, Aka, Itiam Etoi, Ediene, Anua Offot, Afaha Offot, Nsukara offot, Ikot Mbonde Itam, Mbak Itam, Nung Ukut, Miakpan Mbiabit, Ikot Ekpe, Ifa Ikot Okan in Uyo local government area, Mbierebe, Ikot Akpan Abia, Anua Ikot Ebio in Ibesikpo Asutan local government area, Ikot Ntuen, Ikono in Nsit Ibom and Mbiaya in Uruan local government area has adequate coverage of both primary, secondary and tertiary health care facilities with average walking distance between the closest facilities to the farthest health care facilities.

Which implies that the household resident within this communities do not travel farther distance to access a health care facility have because they have access to health care facilities of both primary, secondary and tertiary health care services and these communities are within the buffered zone.

some communities; Ikot Inangha, Ikpa, Ikot Akpan, Afaha Nsai, Ibiaku Ikot Ukpong, Nkim, Ikot Ada Idem, Utat, Ikot Okure, Okobo in Ibiono local government area, Uyo Itam, Odiok, Mbiabong Itam, Ikot Obong, Mbak Itam, Afaha, Ikot Mbonde Itam, in Itu local government area, Mbiatok, Ibiaku Uruan Eman, Osuk Ita, Nung Otu, Numh Oto Ibiakuruan Iman, Idu, Eman Ikot Ebo, Mbiabong Mbiakong in Uruan local government area, Nduetong, Ikot Anyang in Uyo local government area, Nung Ete, Ikot Eto, Ikot Oku Ubo, Ikot Osom, Afaha Ibesikpo, Nung Oku, in Ibesikop local government area and Ukat in Nsit Ibom local government area have inadequate access to health care facilities of both primary, secondary and tertiary health care services and these communities are not within the buffer overlayed. The residents of these communities had to travel a distance of more than 2000m before able to access the health care facilities within the study area.

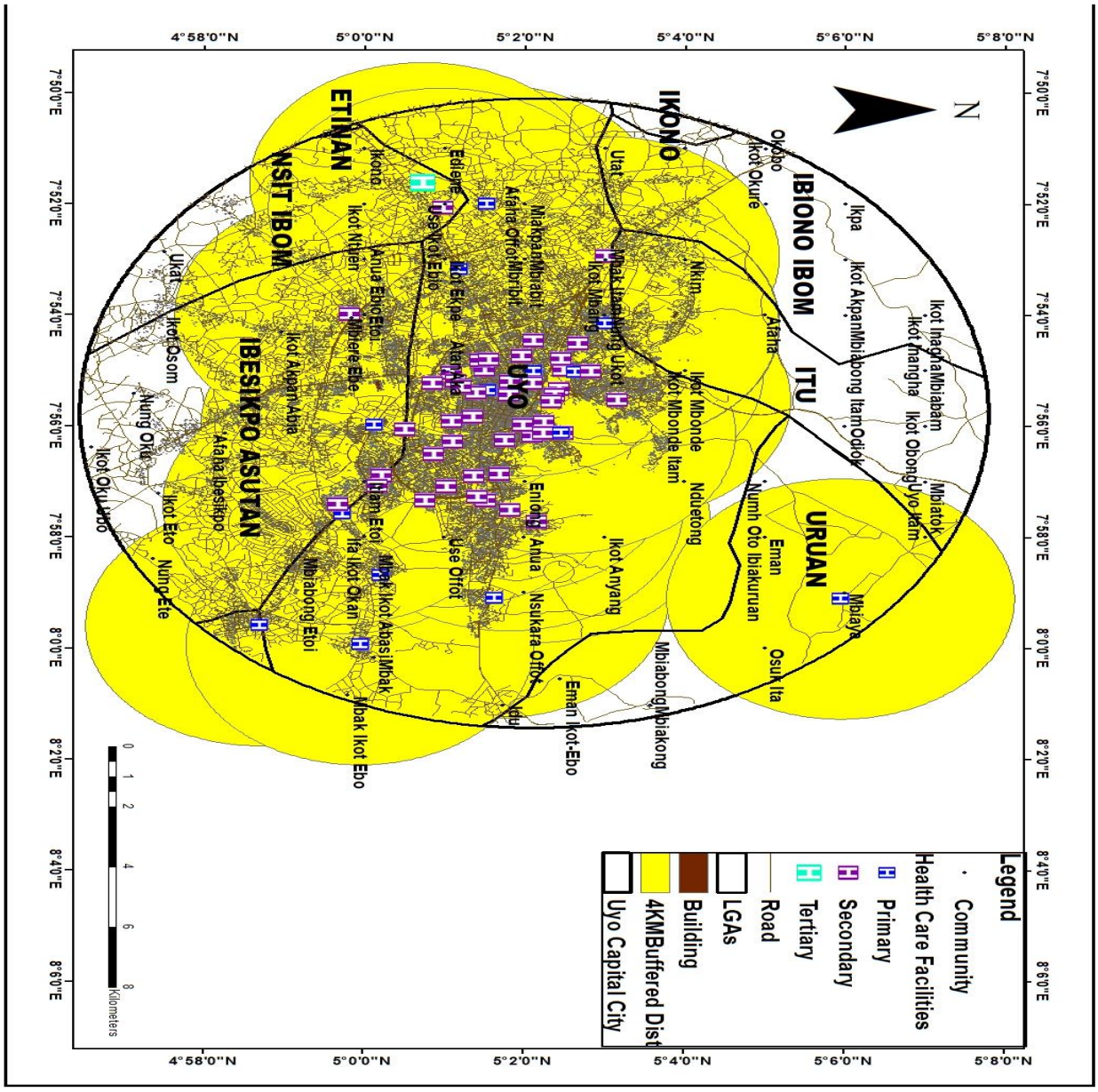


Source: Field Data 2024

Figure 4.4 Map showing accessibility of Health Care Facilities buffered on a walking distance of 3km within the study area.

The results of the buffer analysis as shown in (figure 4.4) for a walking distance of 3000m to access the nearest health care facilities within the study area. Based on the analysis, the result indicates that some communities; Eniong, Oku, Uyo, Atan, Aka, Itiam Etoi, Ediene, Anua Offot, Afaha Offot, Nsukara offot, Ikot Mbonde Itam, Mbak Itam, Nung Ukut, Miakpan Mbiabit, Ikot Ekpe, Ifa Ikot Okan, Ikot Anyang in Uyo local government area, Mbierebe, Ikot Akpan Abia, Anua Ikot ebio in Ibesikpo Asutan local government area, Ikot Ntuen, Ikono Use Ikot Ebio in Nsit Ibom and Mbiaya, Osuk Ita, Ibiaku Uruan in Uruan local government area, Nkim, Ikot Mbonde Itam in Itu local government area have adequate access to health care facilities of both primary, secondary and tertiary health care services and these communities has the shortest distance to access all the health care services within the study area. This implies that household within this communities are well served and have access to various types of health care services.

In the other hand, some communities; Ikot Inangha, Ikpa, Ikot Akpan, Afaha Nsai, Ibiaku Ikot Ukpong, Ikot Ada Idem, Utat, Ikot Okure, Okobo in Ibiono local government area, Uyo Itam, Odiok, Mbiabong Itam, Ikot Obong, Ikot Mbonde Itam, Afaha, in Itu local government area, Ibiaku Uruan eman, Osuk Ita, Nung Otu, Numh Oto Ibiakuruan Iman, Idu, Eman Ikot Ebo, Mbiabong Mbiakong in Uruan local government area, Nduetong, in Uyo local government area, Nung Ete, Ikot Eto, Ikot Oku Ubo, Ikot Osom, Afaha Ibesikpo, Nung Oku, in Ibesikop local government area and Ukat in Nsit Ibom local government area has inadequately coverage with average distance between the closest facilities to the farthest health care facilities. Which implies that the household resident within this communities had to travel farther distance to access a particular type of health care facilities.



Source: Field Data 2024

Figure 4.5 Map showing accessibility of Health Care facilities buffered on a walking distance of 4km within the study area.

The results of the buffer analysis as shown in (figure 4.5) above indicate the walking distance to access the nearest health care facilities in the study area. Based on the analysis, the result indicates that some communities; Eniong, Oku, Uyo, Atan, Aka, Itiam Etoi, Ediene, Anua Offot, Afaha Offot, Use Offot, Nsukara offot, Nung Ukut, Miakpan Mbiabit, Ikot Ekpe, Ifa Ikot Okan, Ikot Anyang, Ikot Mbang, Mbak Itam, Nduetong, Mbak Ikot Abasi,Mbak Ikot Ebo, Mbiabong Etoi in Uyo local government area, Mbierebe, Ikot Akpan Abia, Anua Ebio Etoi, Nung ete, Afaha Ibesikpo in Ibesikpo Asutan local government area, Ikot Ntuen, Ikono, Use Ikot Ebio in Nsit Ibom, Mbiaya, Osuk Ita, Eman Numh Oto Ibiakuruan, Eman Ikot Ebo, Idu in Uruan local government area, Ikot Mbonde Itam, Nkim, Afaha in Itu local government area have adequate access to health care facilities of both primary, secondary and tertiary health care services and these communities are centrally located and it has the shortest distance to access all the health care services within the study area. This implies that household within this communities are well served and have access to various types of health care services.

Meanwhile, there are some communities; Ikot Inangha Mbiabam, Ikpa, Ikot Akpan, Ikot Okure in Ibiono local government area, Uyo Itam, Odiok, Ikot Obong, Ikot Inagha Mbiabam in Itu local government area, Eman Ibiakuruan, Nung Otu, Numh Oto Ibiakuruan Iman, Mbiabong Mbiakong in Uruan local government area, Ikot Oku Ubo, Ikot Osom, Nung Oku, in Ibesikop local government area and Ukat in Nsit Ibom local government area has inadequately covered with average distance between the closest facilities to the farthest health care facilities. Which implies that the household resident within this communities had to travel farther distance to access a particular type of health care facilities. Hence, all these variation in spatial accessibility of health care facilities in those locations might have restricted movement in a deprive area due to the frictional effect of distance and cost.

4.2 Discussion of Findings

The analysis of health care site suitability was done by considering accessibility first. Poor accessibility needs proposing new health care facilities. So, it was essential to analyzed accessibility first for proposing and constructing of new health care facilities. Thus, Factor and constraint maps were produced and overlayed on buffers of the existing health care facilities within a walking distance of 4km using ArcGIS 10.8 Software.

Based on the present study, some suitable sites have been identified within the study area to solved the problem of inadequate access where people are deprived from better healthcare services. Site Suitability Analysis Allocation of site for new health care facilities was done based on the proximity to settlement and was also affected with criteria of buffered overlayed, population, communities closer to transportable routes. Thus, **5** suitable sites were proposed within the study area which can offer health services in inaccessible region within the study area shown in **(Fig.4.1).** The proposed health care facilities selected in a suitable site can also be merged and interlinked with existing health care to make the community enrich and accessible in terms of health services of both primary, secondary and tertiary health care facilities. Each of the proposed site was validated by verifying ground truth. In this study, the proposed site was, Ikot Udo Ibiono in Ibiono Ibom local government area, Akon Itam in Itu local government area, Mbiakong Uruan in Uruan local government area and Ikot Mbon Ibesikpo in Ibesikpo Asutan local government area. All these sites were selected in open space, by considering their location nearer to settlement, population of the area, and also communities closer to transportable routes.

To examine the accessibility of health care facilities within the study area, this research showed that, the city center in the study area is enjoying more presence of public health facilities than some other part within the study area with fewer facilities.

The representation of service area created by buffer zone overlayed for connectivity of buffer where the distance was measured 1km, 2km, 3km, 4km form the existing health care facilities. This means that each health care facilities within a walking distance of 1km, 2km, 3km, 4km, was buffered to determine the easily accessible distance that will be suitable for the densely populated country like Nigeria, in order to care for the most privilege who may not have access to health care services when needs arises. Even though the WHO walking distance as shown in (figure 4.5) of health care facilities is 4km, although this depends on individual choice to patronize those by or far away from the resident and the affordability of transport fare. It was observed based on the accessibility analysis of 1km walking distance in (Fig 4.2) that some communities; Eniong, Oku, Uyo, Atan Aka, Itiam Etoi, Ediene,,Miakpan Mbiabit, Anua Offot, Afaha Offot, Nsukara offot, Ifa Ikot Okan, Use Ikot Ebio, Nung Ukot, Ikot Mbang, Ikot Ekpe, in Uyo local government area, Mbierebe, Anua Ebio Etoi in Ibesikpo Asutan local government area, Ikpa, in Ibiono Ibom local government area have adequate coverage of both primary, secondary and tertiary health care facilities with average distance between the closest facilities to the farthest health care facilities. Which implies that the

household resident within this communities do not travel farther distance to access health care facilities but only walk a distance of 1km which is very good for a densely population like Nigeria.

(Fig 4.3) showed the accessibility analysis of a walking distance of 2km to access health care facilities, it was observed that, some communities; Eniong, Oku, Uyo, Atan, Aka, Itiam Etoi, Ediene, Anua Offot, Afaha Offot, Nsukara offot, Ikot Mbonde Itam, Mbak Itam, Nung Ukut, Miakpan Mbiabit, Ikot Ekpe, Ifa Ikot Okan in Uyo local government area, Mbierebe, Ikot Akpan Abia, Anua Ikot Ebio in Ibesikpo Asutan local government area, Ikot Ntuen, Ikono in Nsit Ibom and Mbiaya in Uruan local government area has adequate coverage of both primary, secondary and tertiary health care facilities with average walking distance between the closest facilities to the farthest health care facilities. Which implies that the household resident within this communities do not travel farther distance to access a health care facility because they have access to health care facilities of both primary, secondary and tertiary health care services and these communities are within the buffered zone. some communities; Ikot Inangha, Ikpa, Ikot Akpan, Afaha Nsai, Ibiaku Ikot Ukpong, Nkim, Ikot Ada Idem, Utat, Ikot Okure, Okobo in Ibiono local government area, Uyo Itam, Odiok, Mbiabong Itam, Ikot Obong, Mbak Itam, Afaha, Ikot Mbonde Itam, in Itu local government area, Mbiatok, Ibiaku Uruan Eman, Osuk Ita, Nung Otu, Numh Oto Ibiakuruan Iman, Idu, Eman Ikot Ebo, Mbiabong Mbiakong in Uruan local government area, Nduetong, Ikot Anyang in Uyo local government area, Nung Ete, Ikot Eto, Ikot Oku Ubo, Ikot Osom, Afaha Ibesikpo, Nung Oku, in Ibesikop local government area and Ukat in Nsit Ibom local government area have inadequate access to health care facilities of both primary, secondary and tertiary health care services and these communities are not within the buffer overlayed. The residents of these communities had to travel a distance of more than 2000m before able to access the health care facilities within the study area.

(Fig 4.4) showed the accessibility analysis of a walking distance of 3km to access health care facilities, it was observed that, some communities; Eniong, Oku, Uyo, Atan, Aka, Itiam Etoi, Ediene, Anua Offot, Afaha Offot, Nsukara offot, Ikot Mbonde Itam, Mbak Itam, Nung Ukut, Miakpan Mbiabit, Ikot Ekpe, Ifa Ikot Okan, Ikot Anyang in Uyo local government area, Mbierebe, Ikot Akpan Abia, Anua Ikot ebio in Ibesikpo Asutan local government area, Ikot Ntuen, Ikono Use Ikot Ebio in Nsit Ibom and Mbiaya, Osuk Ita, Ibiaku Uruan in Uruan local government area, Nkim, Ikot Mbonde Itam in Itu local government area have adequate access to health care facilities of both primary, secondary and tertiary health care services and these communities has the shorter distance to access all the health care services within the study area. This implies that household within this communities are well served and have access to various types of health care services when needs arises.

And some communities; Ikot Inangha, Ikpa, Ikot Akpan, Afaha Nsai, Ibiaku Ikot Ukpong, Ikot Ada Idem, Utat, Ikot Okure, Okobo in Ibiono local government area, Uyo Itam, Odiok, Mbiabong Itam, Ikot Obong, Ikot Mbonde Itam, Afaha, in Itu local government area, Ibiaku Uruan eman, Osuk Ita, Nung Otu, Numh Oto Ibiakuruan Iman, Idu, Eman Ikot Ebo, Mbiabong Mbiakong in Uruan local government area, Nduetong, in Uyo local government area, Nung Ete, Ikot Eto, Ikot Oku Ubo, Ikot Osom, Afaha Ibesikpo, Nung Oku, in Ibesikop local government area and Ukat in Nsit Ibom local government area has inadequately coverage with average distance between the closest facilities to the farthest health care facilities. Which implies that the household resident within this communities had to travel farther distance of more than 3km distance to access health care facilities which they need urgent attention from the authority concerned, to solving the problems of inaccessibility so that it can help in the case of emergency situation.

Based on the recommended walking distance for health care facilities by WHO (4km), shown in (figure 4.5) the result of this research work has also depicted that some communities; ; Eniong, Oku, Uyo, Atan, Aka, Itiam Etoi, Ediene, Anua Offot, Afaha Offot, Use Offot, Nsukara offot, Nung Ukut, Miakpan Mbiabit, Ikot Ekpe, Ifa Ikot Okan, Ikot Anyang, Ikot Mbang, Mbak Itam, Nduetong, Mbak Ikot Abasi,Mbak Ikot Ebo, Mbiabong Etoi in Uyo local government area, Mbierebe, Ikot Akpan Abia, Anua Ebio Etoi, Nung ete, Afaha Ibesikpo in Ibesikpo Asutan local government area, Ikot Ntuen, Ikono, Use Ikot Ebio in Nsit Ibom, Mbiaya, Osuk Ita, Eman Numh Oto Ibiakuruan, Eman Ikot Ebo, Idu in Uruan local government area, Ikot Mbonde Itam, Nkim, Afaha in Itu local government area have adequate access to health care facilities of both primary, secondary and tertiary health care services and these communities are centrally located and it has the shortest distance to access all the health care services within the study area. This implies that household within this communities are well served and have access to various types of health care services.

Meanwhile, some communities; Ikot Inangha Mbiabam, Ikpa, Ikot Akpan, Ikot Okure in Ibiono local government area, Uyo Itam, Odiok, Ikot Obong, Ikot Inagha Mbiabam in Itu local government area, Eman Ibiakuruan, Nung Otu, Numh Oto Ibiakuruan Iman, Mbiabong Mbiakong in Uruan local government area, Ikot Oku Ubo, Ikot Osom, Nung Oku, in Ibesikop local government area and Ukat in Nsit Ibom local government area have inadequately coverage

with average distance between the closest facilities to the farthest health care facilities. Which implies that the household resident within this communities had to travel farther distance that is more than 4km walking distance to access a particular type of health care facilities. Hence, all these variation in spatial accessibility of health care facilities in those locations might have restricted movement in a deprive area due to the frictional effect of distance and cost.

5.2 Conclusion

The present study, has determine the best accessible location for country Nigeria to ease the less privilege from using traditional medicine but rather access health facilities when needs arises. some suitable site within the study area with inadequate access where people are deprived from better healthcare facilities was also cited. This attempt will be highly helpful for preparing a spatial decision support system which assists the health authorities regarding the health care services in inaccessible, underprivileged, within the study area. some of these communities; Ikot Inagha, Ikot Akpan, Ikpa, Mbiakong, Nung Oku, Ukat, Ikot Okure, traveled a longest distance before able to access health care facilities within the study area. Because of their inability to access health care facilities, The present study emphasized the issue of accessibility thereby proposed sites for new healthcare facilities to remove spatial disparity in the study area. these communities are; Ikot Udo Ibiono in Ibiono Ibom local government area, Akon Itam in Itu local government area, Mbiakong Uruan in Uruan local government area and Ikot Mbon Ibesikpo in Ibesikpo Asutan local government area.

However, in a densely populated country like Nigeria, this research is of opinion that primary health care facilities should be cited within accessible walking distance along the existing roads in order to care for the less privileged who may not have access to health care services when needs arises.

5.3 Recommendations

i. Location of primary, secondary health care facilities should be based on demographic and spatial accessibility. It is the responsibility of every government to ensure that all citizens in the country have access to health care services. Therefore; government should allow the mandated institutions the free hand to select communities that genuinely need health facilities, for instance in Uyo Capital City communities, Ikot Udo Ibiono in Ibiono Ibom local government area, Akon Itam in Itu local government area, Mbiakong Uruan in Uruan local government area and Ikot Mbon Ibesikpo in Ibesikpo Asutan local government area, are the areas that needs health facilities, to served people of that area which will help to avoid skewed of health facilities toward a region.

ii. Government should intensify effort in building more public health care facilities for affordability and cost especially in those area with inadequate coverage. where the availability of these facilities is either low or non-existence. To solve the problem of inaccessibility.

iii. It is recommended that Government and local planners can start medical emergency in proposed sites of health facility with primary equipment and service to reach target population.

iv. Thus, there is need to site more healthcare facilities in order to solve the problem of uncovered areas in the study area by considering proximity (distance) to the demand (potential users) within the study area with the primary goal of maximizing response time (i.e time between a demand and nearest service location). And to also help the less privileged to afford the cost and ease distance barrier at least primary health care facility for that can served as a first contact in the case of emergency situation.

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