Original Research Article

SPATIAL ANALYSIS OF THE DISRIBUTION PATTERN OF PRIMARY HEALTHCARE FACILITIES IN ILE – IFE METROPOLIS USING GEOGRAPHIC INFORMATION SYSTEM.

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ABSTRACT

The importance of health to the overall wellbeing of every nation cannot be overemphasized. Therefore, there is a need for effective planning and management of the healthcare facilities in order to achieve optimum result in the country for equitable distribution of health facilities as a factor for sustaining the population in the cities.

This research explores potential use of Goespatial Techniques for analysing public healthcare facilities accessibility and distribution pattern in Ile- Ife metropolis. Primary and secondary data were acquired. Primary data include questionnaire administration and Global Positioning System (GPS) receiver's coordinate points of the health facilities while secondary data include administrative map of Ile-Ife metropolis and geo-eye satellite image 2011. These set of data were integrated into Arcgis environment and the following spatial analyses were carried out; overlay operation, statistical analysis and network analysis.

The results obtained are: study area map, digital road network, most centrally located facilities, mean center, standard distance, directional distribution, kernel density and nearest neighbourhood ratio (NNR=1.068821). The Nearest Neighbour Ratio shows a random distribution pattern for health care facility. The service area maps were also produced to show the total travel time from the points of resident to the nearest healthcare facilities within a given time of 2, 3 5 and 7 minutes. The total area served by the healthcare facilities in km² was determined. From the results it shows that the study area is fairly provided with health care facilities. However, they are concentrated around the center of the town while other areas are inadequately served. Primary healthcare facilities should be provided to serve the areas that are underserved in the study area. The centrally located primary health center should be well equipped by the government so as to serve the population better. Improvement should be made on healthcare provision by having a standardized regulation for establishing primary healthcare facilities.

Keywords: *Geospatial techniques, healthcare facilities, spatial Analysis, Ile- ife metropolis*

1.0 INTRODUCTION

Primary Health care has been long considered a major contributor to the health of a population (Perry and Gesler, 2000). Physical accessibility of health services is determined by the geographical location of homes in relation to available facilities, by physical and topographical barriers by the modes of transport that are available to reach these destinations.

Health facilities in Nigeria have evolved through a series of historical development including a succession of policies and plans which had been introduced by various

administrations. However, the health facilities are inadequate in meeting the needs and demands of the public. Man through technology has continued to expand his land holding capacity and to improve his well-being. This is because he believes that economic survival or self-sufficiency is synonymous with high standard of living. Also, various religious bodies and private agencies established hospitals, dispensaries and maternities in different parts of the country without considering the convenience of residents at patronizing them.

Primary Healthcare (PHC) service delivery in Nigeria has been faced with a lot of problems some of which are inadequate manpower, obsolete equipment and unavailable drugs etc. Depending on which perspective of observation, some have applauded the efforts of the government in providing grassroots healthcare services whereas in some quarters such services are not adequately provided. This is evidenced in the number of ailing hospitals across the country. Besides, most of the government-owned hospitals are not optimally located which implies that community-based accessibility to these medical facilities has been compromised.

By implication, the distribution of primary healthcare services in Nigeria has been characterized by significant disparity. Such disparity is shown in the ways some of these medical facilities are concentrated in one geopolitical region at the expense of others. This often resulted in spatial inequality that characterizes Nigeria's socio-political landscape. Also, this inequality places pressure on the facilities which are already inadequate. There is need to ascertain how this spatial inequality can be reduced to favour patients patronizing these healthcare facilities. Even though the government has shown serious commitment towards addressing these inequalities, more is still expected in the areas of technical knowhow.

However, attempt to address such disparity from technical perspective may require the use of a cut edge information management tool such as the geographic information systems (GIS) and remote sensing technology (RS) . As a result, this research work investigated the nature of distribution pattern of primary healthcare facilities in Ile – Ife metropolis Osun state with the view to addressing disparity where available.

1.1. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to analyse primary healthcare facilities distribution pattern in Ile – Ife Osun Nigeria Metropolis using Geospatial Techniques. This can be accomplished using the following objectives:

- production of digital road network of the study area.
- carry out an inventory and map out the health facilities in the study area.
- determine the spatial distribution pattern of the health facilities.
- evaluate the accessibility level of the health facilities.

1.2. SCOPE OF THE STUDY

This research work will basically be centered on healthcare facilities in Ife Central Local Government Areas and it is only based on orthodox healthcare facilities not traditional health centers.

1.3 STUDY AREA

Ife Central Local Government Area of Osun State, Nigeria covers an area of approximately 111 square kilometers with coordinates 7^{0} 28'N -7^{0} 35'N and 4^{0} 29'E- 4^{0}35'E. It is located in the southern part of Osun State which lies in the South Western part of Nigeria. It is bounded by Ife North, Ife South, Ayedaade, Atakumosa West and Ife-West Local Government Areas. Ife Central Local Government Area has a population of about 167,254 people comprising of about 84,653 males and 82,601 females (Federal Republic of Nigeria, Official Gazette, 2007) and total land mark of 111km². The population is made up of people of different cultural and socioeconomic background.

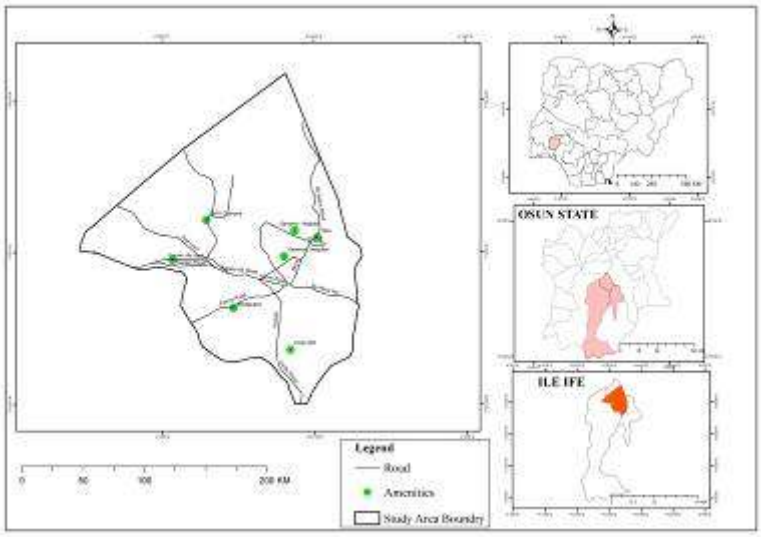


Figure1.0 Study Area Map of (Ile –Ife Metropolis)

2.0 LITRATURE REVIEW AND CONCEPTUAL FRAMEWORK

Although healthcare facilities have considerable impact on the population of any given area because of the almost universal demand for the services they provide, there is as yet no definite theory for the location and distribution of health facilities as in the case with other public facilities. Existing location theories are primarily concerned with agricultural, industrial, commercial and residential activities. There is therefore no clear theoretical basis for planning and evaluating the spatial efficiency of public facilities. The literature is however replete with a wide range of concepts and principles which can provide the framework for the analysis and planning of health facilities in a developing country such as theory which was articulated by Walter Christaller (1936) to show the relationship between the presence of a service and the population needed to support it, the size of the hinterland within which such a population was contained and the size and the central place itself. In an elegant and rigorous statement, Christaller (1936) demonstrated how, under specified conditions nested hierarchy of central places would result and these would be distributed in a hexagonal pattern of service areas. The main thesis of central place theory is that the spatial pattern of central places displays remarkable regularities. In the ideal case, if there is:

- a uniform plane of constant population density and purchasing power;
- a linear variation of transport cost with distance; and

- an equal movement ease in all directions, then central places will spring up at evenly spaced points to serve tributary market areas with goods and services.

The spatial expression of this arrangement is one of regularly spaced settlements or central places with hexagonal market areas. When central places are considered in terms of their mutual relationship, their organization follows a hierarchical pattern. At one extreme are the lowest order central places which provide low range goods and services for very small catchment areas. At the other extreme are the highest order central places, (towns and cities) which supply goods and services of their respective orders, as well as those supplied at lower-order centers. High-order central places have extensive catchment areas. Within a theoretically ideal landscape, a hierarchy of tiered size-orders of centers will therefore emerge and their trade areas in a regular way. That is to say that the trade areas of smaller centers lie within those of large centers. The area for which a central place is center is variously described as the complementary region, catchment area, market area or sphere of influence. Distance is important in determining complementary regions, especially economic distance measured in terms of travel time or transport cost. Economic distance determines the range of goods and services. In central place theory the range of a good or service is the maximum distance over which a seller will offer a good or service or from which a purchaser will travel for it. The former interpretation relates to the provision of ambulatory services while the latter relates to the utilization of point-located services. There is a functional relationship between the size of a central place, the order of the goods or services it offers and the size of its complementary region (Onokerhoraye, 1976a 1976b).

The concepts of the threshold population and of the range of a good which are implied in the central place theory are relevant to the analysis and planning of healthcare facilities in Nigeria. The threshold population for a particular grade of health center is the minimum population that justifies the allocation of scarce financial and personnel resources to the establishment and sustenance of that grade of health facility. Below that level, there are too few patients to allow the health and family planning center to operate with acceptable efficiency. On the other hand, the range of a particular category of health facility is the maximum distance which the users will be prepared to travel. This distance will vary with the category of health facility and the mode of travel available to the users. In line with the postulates of the central place theory, healthcare delivery facilities in Nigeria which are of three grades (tertiary, secondary and primary) can be conceived as constituting a hierarchical system with the tertiary facilities at the top, the secondary facilities in the middle and the primary facilities below. This hierarchical system is reflected in space by the geographical arrangements of service outlets in which a particular area tend to have numerous primary health facilities, much fewer secondary facilities and very few tertiary facilities if at all. The logic is quite simple. If a particular health planning facility has a very small catchment area, then the area in which it is located shall need many such facilities to cover a given area with services. Conversely, if a facility has an extensive catchment area, there would be need for very few (and probably only one) of such facilities to cover the area in question with services. The frequency of need as well as the type of services rendered therefore determines the spatial pattern of the different types of healthcare facilities.

The discussion in preceding paragraphs show that for efficiency to be attained in the provision of healthcare facilities in any locality the threshold population must exist within the range of that category of health care service. The capability of any geographical area to satisfy the threshold requirements for the provision of a particular category of healthcare facility will depend on the pattern of population density. There is generally a marked difference between urban and rural areas in Nigeria in terms of satisfying the threshold population requirements. Urban centers are known areas of high population concentration. Consequently it is easier for the threshold population's requirements for the three tiers of

healthcare facilities to be attained in most urban centers. The problem, however, is in the rural areas where settlements are quite small in terms of population size and transport facilities are poorly developed or non-existent. In most rural areas in Nigeria it is difficult and in most cases impossible to attain the minimum threshold population to provide secondary healthcare facilities. In such areas it is basically unrealistic to plan the provision of a tertiary healthcare facility which will achieve the required efficiency in terms of the utilization of scarce resources. The market on the day when it is their turn to hold the market. In this case the traders and sellers move from one market place to another so that they can sustain their continued stay in business by attracting customers periodically. If every settlement attempts to hold its market daily, the threshold population which will ensure a daily availability of customers to sustain the tracers to make sales will not be attained and so the markets will die a natural death of nonsurvival (Onokerhoraye, 1970).

The periodic market system as enunciated above can provide the basis for the establishment of mobile clinics in sparsely populated rural areas of Nigeria and indeed other parts of Africa. It is obvious that unless efforts are made to make healthcare services available to people in sparsely populated areas through a well organized and coordinated mobile clinics the hope of their being accessible to modern healthcare facilities will take a long time to realize. If the people are aware of the specific days and points where mobile clinics will be stationed, there is no doubt that they will organize themselves to visit such clinics. Apart from taking care of people in sparsely populated rural areas, mobile clinics can also serve mobile farmers and herdsmen in many localities in the country. Obviously such mobile clinics will be linked to specific primary health centers and thereby also linked to secondary and tertiary health centers through the referral system. It is only within such a framework that the much desired spatial equity in the provision of healthcare facilities can be assured in a less developed country such as Nigeria. It is within the framework provided by the central place theory and the concept of periodic markets that this study will examine the situation in Ife Central Local Government Area, Osun State.

2.1 CONCEPT OF HEALTH

Although healthcare facilities have considerable impact on the population of any given area because of the almost universal demand for the services they provide, there is as yet no definite theory for the location and distribution of healthcare facilities as in the case with other public facilities. Existing location theories are primarily concerned with agricultural, industrial, commercial and residential activities. (Onokerhoraye, 1999). The World Health Organization regards health rather as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity. The importance of health to individuals, communities and the nation in general cannot be over emphasized. Health is considered a crucial component of wellbeing and economic development. Therefore with the development planning in the Third World Countries, efforts have been made consistently to improve people's health since the Second World War. According to Olajinmi (2002), the healthy population of any nation is regarded as an asset in all ramifications, most especially in the area of economic development and as Okunade (2001), further stressed that the wealth of any nation is in its people.

Health is a dynamic process with ever changing stimuli and responses; it is generally regarded as a social welfare requirement in urban or rural setting in order to acquire a disease free society. It may also be seen as a series of complex interactions between an individual and his environment. Sherreffs, (1984), defines health as a quality of life involving social, mental and biological fitness on the part of an individual which results from adaptations to the environment. According to Robinson and Alles (1990), health is defined as entirely philosophic territory; it begins beyond diseases and illness. The outstanding feature of health is that it is a quality and therefore cannot be weighed and measured. Health

is not a single entity or condition, it is a state of mind, a projection of our belief about the nature and perfect ability of humans and our value judgment about what constitute a good person in a good society. Health is a state of feeling well in the body, mind and spirit together with a sense of reserve power based upon normal functioning of tissues, a practical understanding of the principles of healthy living. Olajuyin (1997) observed that strong association exists between healthcare facilities and nearby settlements. The study concluded that distance was a paramount factor in the accessibility of healthcare facilities to the people. Onokerhoraye (1978) also found out that distance influences the pattern of patronage of the healthcare centers in Offa area of Kwara State. He found out that 40% of the patients surveyed who were on admission at Offa General Hospital came within 10 kilometers radius. Iyun (1978) also carried out similar study in Ibadan. The study revealed that patients minimized distances travelled by using hospitals that were nearer to their homes.

2.2 PROVISION OF HEALTH FACILITIES

The subject of health is complex, sensitive, highly scientific and a technical issue with very serious and complicated ethical undertones. It is for this reason that the provision of healthcare services is not allowed to be determined neither by the whims and caprices of market forces alone with its inherent market failures nor by government monopoly that may fraught with inefficiency from over- centralization, instability, lack of continuity, misplacement of priorities, lack of political will and commitment. (Osenwofa, 1992)

The importance of health is reflected in the fact that in free-market societies, the provision of healthcare services is a function of the state and the private sector (organized and non-organized). For instance, the Nigerian constitution of 1997 and 1999 alike, place health in the concurrent list of responsibility with the exception of the external health relations, quarantine and the control of drugs and poisons which are exclusively the responsibility of the Federal Government FGN, (1988). The implication is that all the three tiers of Government (Federal, State and Local) and even individuals and non-governmental organizations can participate in the planning, provision and management of healthcare facilities. Without any exaggeration, the provision of different health institutions which are adequately staffed and guarantee of individual access of the utilization of the healthcare facilities is a pre-requisite to the realization of the laudable intention of Nigerian health policy, and the compliance with the WHO directives, World Bank (1995).

2.3 LOCATION OF HEALTHCARE FACILITIES

In most developing countries, some health-related studies (Onokerhoraye 1982, Olajuyin and Olanrewaju 1988, Olajuyin et al 1997) have established that there had never been comprehensive guidelines for the location of healthcare facility that consider proper mix of health services and where the facilities should be located in a region (or town) in order to satisfy the healthcare requirements of its population and comply with the social, economic and political criteria relevant to the region/town. Nonetheless, Vagale (1971) formulated planning standard for the location of healthcare facilities in Nigeria. He however, described the standard as rough guide and indicated the following.

Table1.0 Planning Standard for spatial Distribution of Healthcare Facilities.

S/N	Facility	Maximum Distance from Home of Patients
1.	General Hospital	50-75 miles (80-120km)
2.	District Hospital	20-30 miles (32-48km)
3.	Health Center	15-20 miles (24-32km)

4.	Maternity Home	1-7 miles (6.4-11.2km)
5.	Dispensary	2-3 miles (3.2-4.8km)

Source: Vagale,1971

3.0 MATERIALS AND METHOD

The study used data containing the list of healthcare centers and their addresses in Ife Central LGA and Geo–Eye Image of Ife metropolis sourced from google earth. Administrative map of Ife Central and part of Ife East LGA was also sourced from the local government to serve as the base map. GPS Device was used to collect coordinate points of the health centers in the local government. The administrative map of Ife Central LGA was scanned and geo-referenced to WGS UTM ZONE 31. Onscreen Digitizing of features such as roads and buildings in the study area were carried out as line and polygon features respectively. Healthcare facilities were digitized as point features and converted to Database format and these spatial data was organized in different layers. The existing status as well as the capacity of the health facilities were obtained through the administration of questionnaires which were filled by authorized personnel in each health facility. The outcome of this survey is contained in summary of the capacity in terms of the number of patients' bed spaces, doctors, nurses etc in each of these facilities.

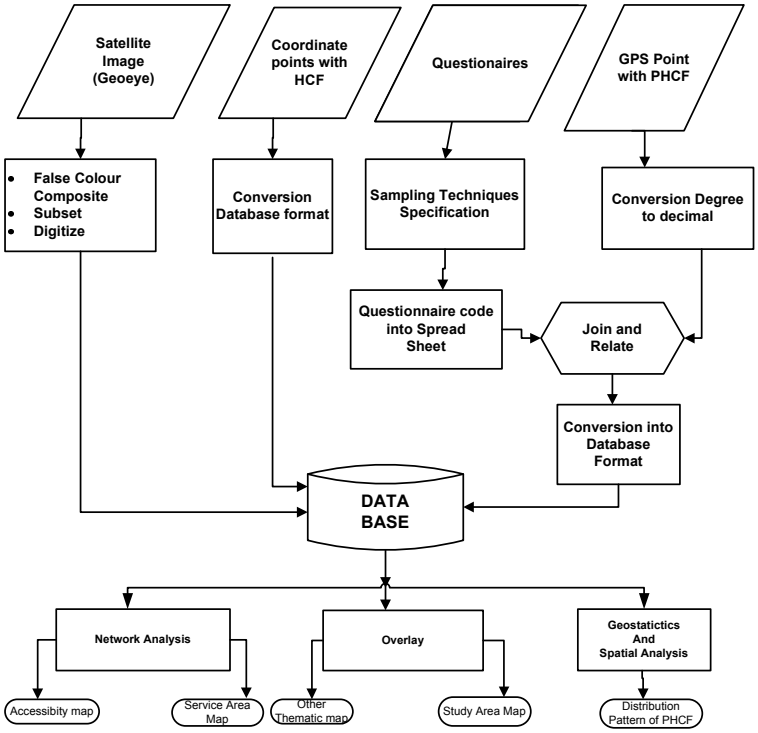


Figure 2.0 Work flow Chart

4.0 DATA ANALYSIS AND DISCUSSION OF RESULTS

Overlay analysis was carried out on the coordinate points and Road network to show the pattern of distribution and relationship between them.

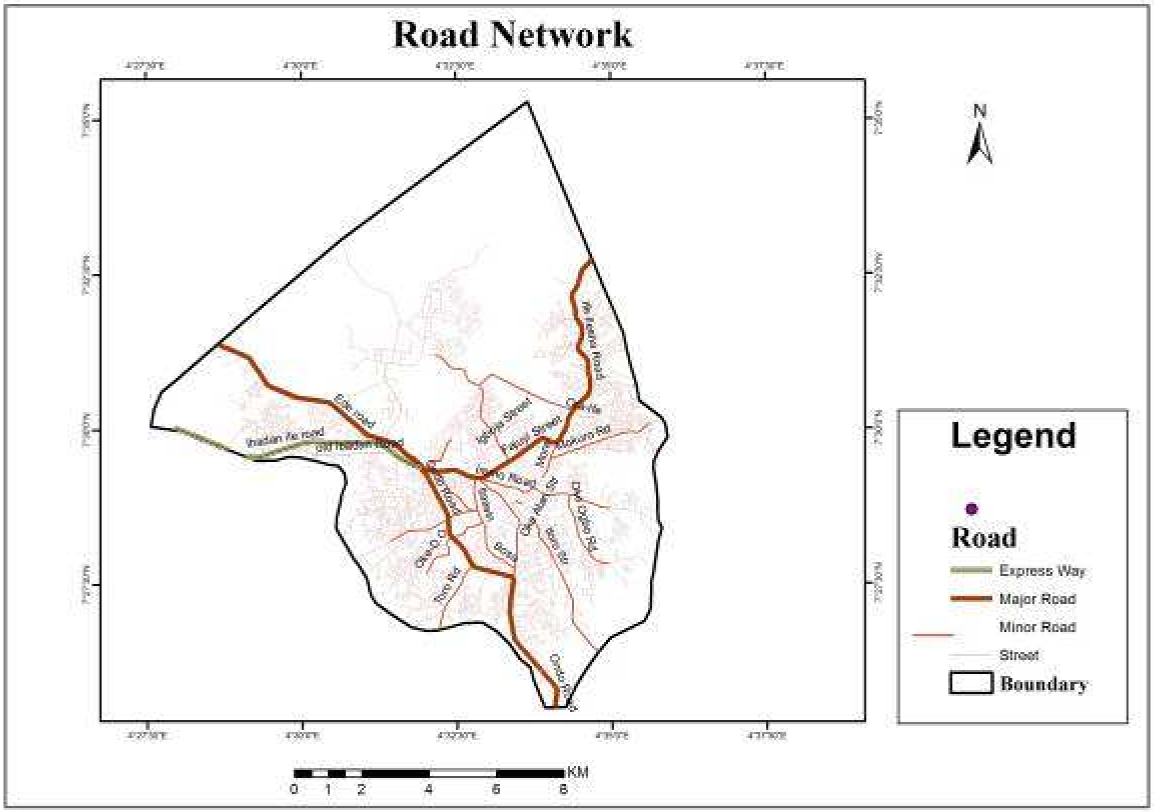


Figure 4.0 Road Network Map of Ile- Ife Metropolis

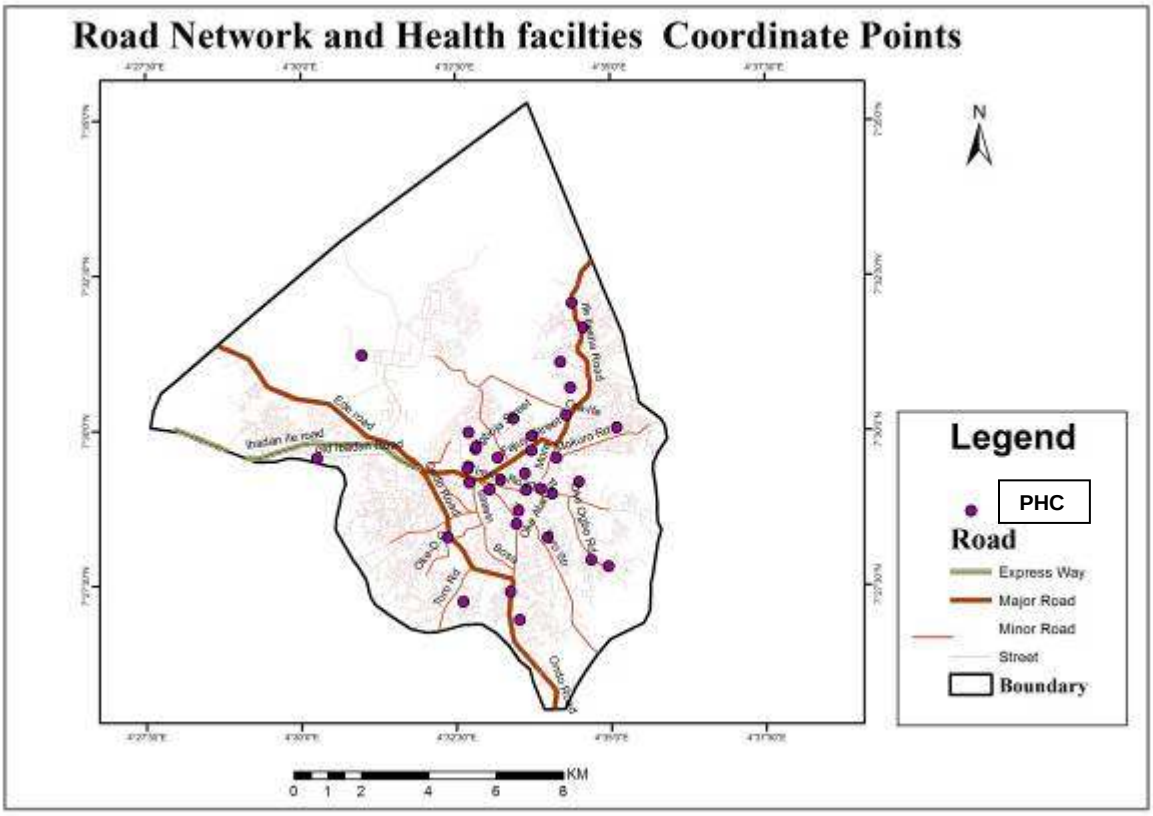


Figure 4.1 Road Network and Coordinate Points of Health facilities

The spatial Distribution of the facilities shows great disparity in the areas. The health facilities were observed to be unevenly distributed across space in Ile – Ife metropolis. The facilities were mostly concentrated in one area of the town.

table 4:0 Estimated population Of Study Area

Grid_No	No_Of_House	Population	Area	Population Density
1	1686	10116	2.767423	3655.3863
2	757	4542	2.767423	1641.2381
3	86	516	2.767423	186.45505
4	1359	8154	2.767423	2946.4234
5	2109	12654	2.767423	4572.485446
6	2027	12162	2.767423	4394.702703
7	3412	20472	2.767423	7397.496696
8	3182	19092	2.767423	6898.837691
9	1821	10926	2.767423	3948.077761
10	1764	10584	2.767423	3824.497073
11	3761	22566	2.767423	8154.1573
12	5318	31908	2.767423	11529.86138
13	5668	34008	2.767423	12288.69014
14	1720	10320	2.767423	3729.101455
15	428	2568	2.767423	927.939199
16	884	5304	2.767423	1916.584701
17	2930	17580	2.767423	6352.480968
18	2507	15042	2.767423	5435.382178
19	2227	13362	2.767423	4828.319151
20	183	1098	2.767423	396.75905
21	8	48	2.767423	3071.449841
22	7	42	2.767423	2710.102801
23	81	486	2.767423	175.614682
24	442	2652	2.767423	958.292351
25	417	2502	2.767423	904.090294
26	1869	11214	2.767423	4052.14578
27	2	12	2.767423	4.336164
28	356	2136	2.767423	771.837278
29	82	492	2.767423	177.782744
30	349	2094	2.767423	756.660702

The above table shows the estimated population of the study area using the National population Commision Standard Occupancy Ratio which specifies 6:1 that is, six people per household. The study area was divided into grid of equal size approximately 2.76km^2 for effective survey. The number of houses within each grid were counted on the google earth

image and the total number of houses in each grid was multiplied by 6 (6 people per house, NPC 2006) to get the estimated population and the population for each grid was divided by the area km^2 of each grid to get estimated population density for the area. The fomular used for estimated population density is given as follow:

Number of Houses in the Grid x 6 = Estimated Population Density

Area of Grid

4.1 MOST CENTRALLY LOCATED HEALTHCARE FACILITY IN THE STUDY AREA

It identifies the most centrally located features in the health facilities. Distances from each feature centroid to every other feature centroid in the dataset are calculated and summed. Then the feature associated with the shortest accumulative distance to all other features (weighted is selected and copied to a newly created output feature class. The Central Feature tool is useful for finding the center when you want to minimize distance (Euclidean or Manhattan distance) for all features to the center. As shown in figure 4.0 below.

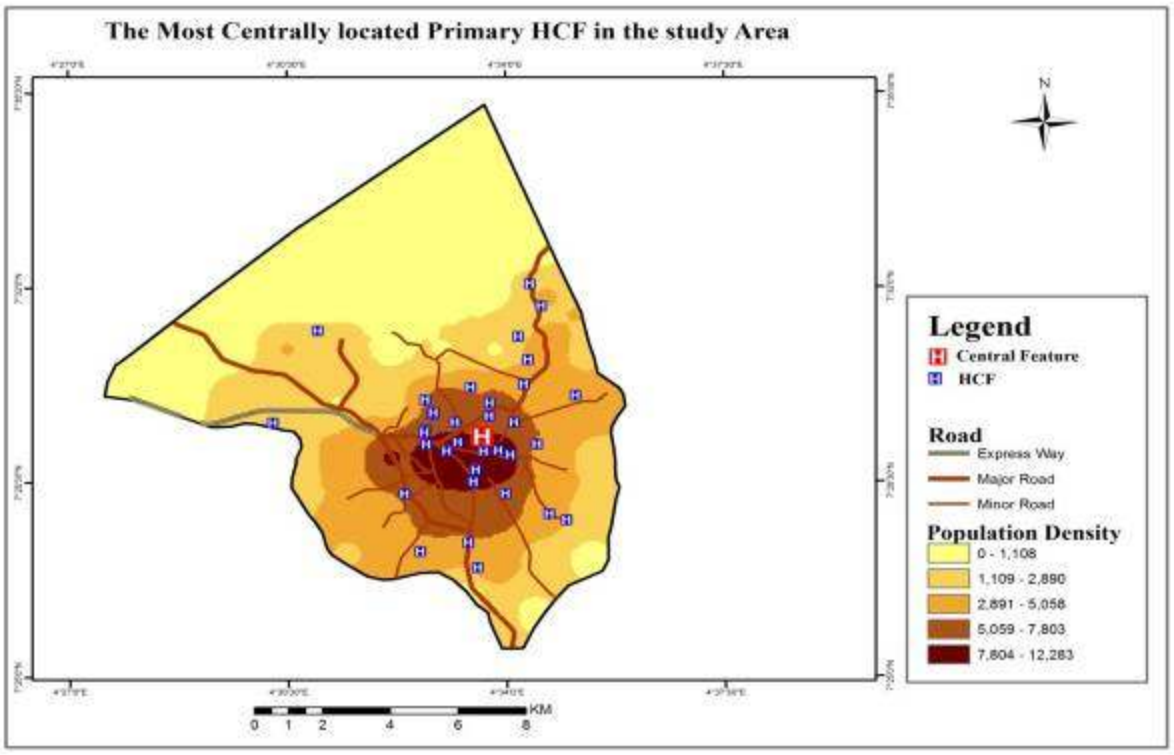


Figure 4.0 The Most Centrally Located Primary HCF in the Study Area.

4.2 MEAN CENTER AND STANDARD DISTANCE OF THE HEALTH CARE FACILITIES

The mean center is the average x- and y-coordinate of all the features in the study area. It's useful for tracking changes in the distribution or for comparing the distributions of different types of features. The mean center can also be mathematically represented as:

$$\bar{X}_{Coord} = \frac{\sum_{i=1}^{n} X_i}{n} \qquad \bar{Y}_{Coord} = \frac{\sum_{i=1}^{n} Y_i}{n}$$ …… Equation 1

where x_i and y_i are the coordinate for features i and n equal to the number of features.

4.3 STANDARD DISTANCE

Measuring the compactness of a distribution provides a single value representing the dispersion of features around the center. The value is a distance, so the compactness of a set of features can be represented on a map by drawing a circle with the radius equal to the standard distance value. The Standard Distance tool creates a circle polygon. It can also be represented mathematically as:

$$SDE = \sqrt{SDx^2 + SDy^2} = \sqrt{\left[\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right]^2 + \left[\frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})^2\right]^2}$$ ……Equation 2

where X_i and Y_i are coordinates,

and $\bar{X}$ and $\bar{Y}$ define the mean center.

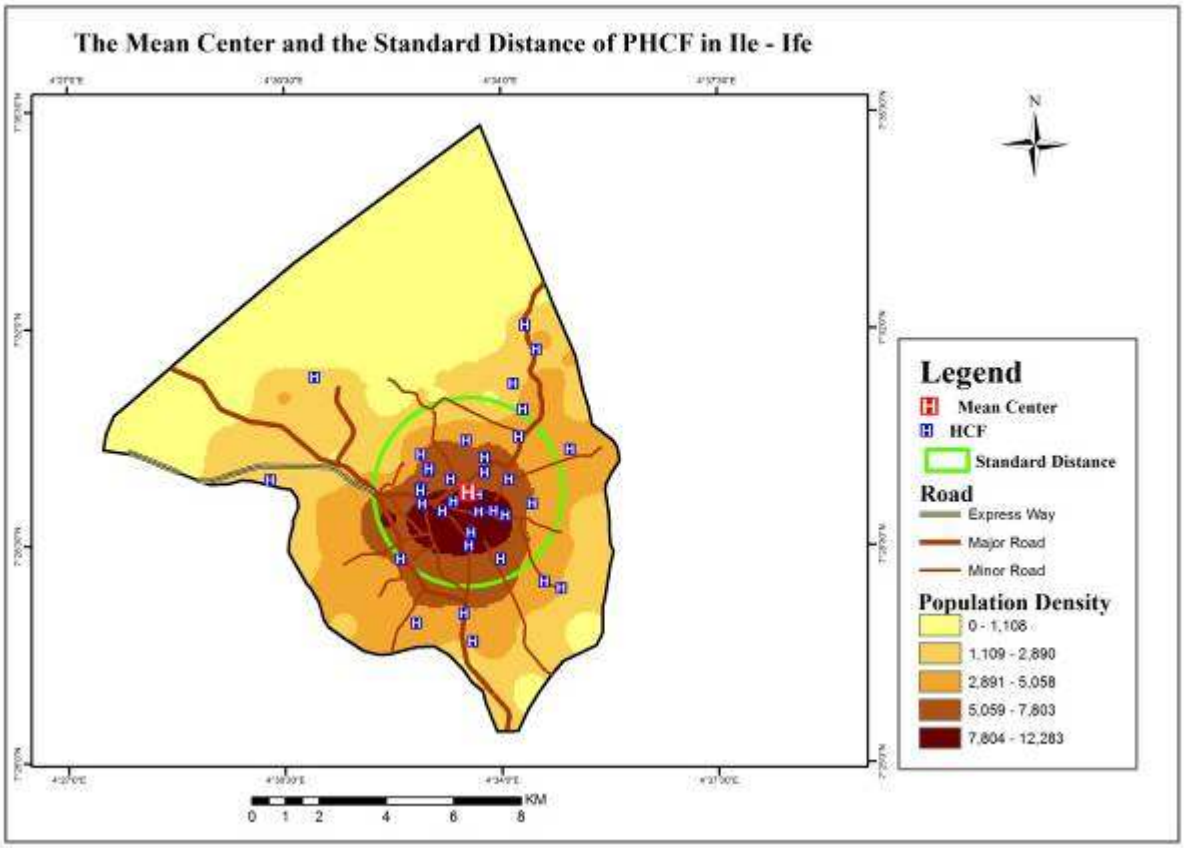


Figure 4.1 shows the Mean center and the Standard distance of Health care facilities in Ile –Ife.

4.4 Directional Distribution of the Health care facilities

A common way of measuring the trend for a set of points or areas is to calculate the standard distance separately in the x- and y-directions. These two measures define the axes of an ellipse encompassing the distribution of features. The ellipse is referred to as the standard deviational ellipse; the ellipse allows you to see if the distribution of features is elongated and hence has a particular orientation. This is mathematical expressed as:

$$SDE_x = \sqrt{\frac{\sum_{i=0}^{n}(x_i - \bar{X})^2}{n}} \qquad SDE_y = \sqrt{\frac{\sum_{i=n}^{n}(y_i - \bar{Y})^2}{n}} \qquad \text{...equation 3}$$

Where $\bar{x}_i$ and $\bar{y}_i$ are the deviation of the xy –coordinate from the mean center

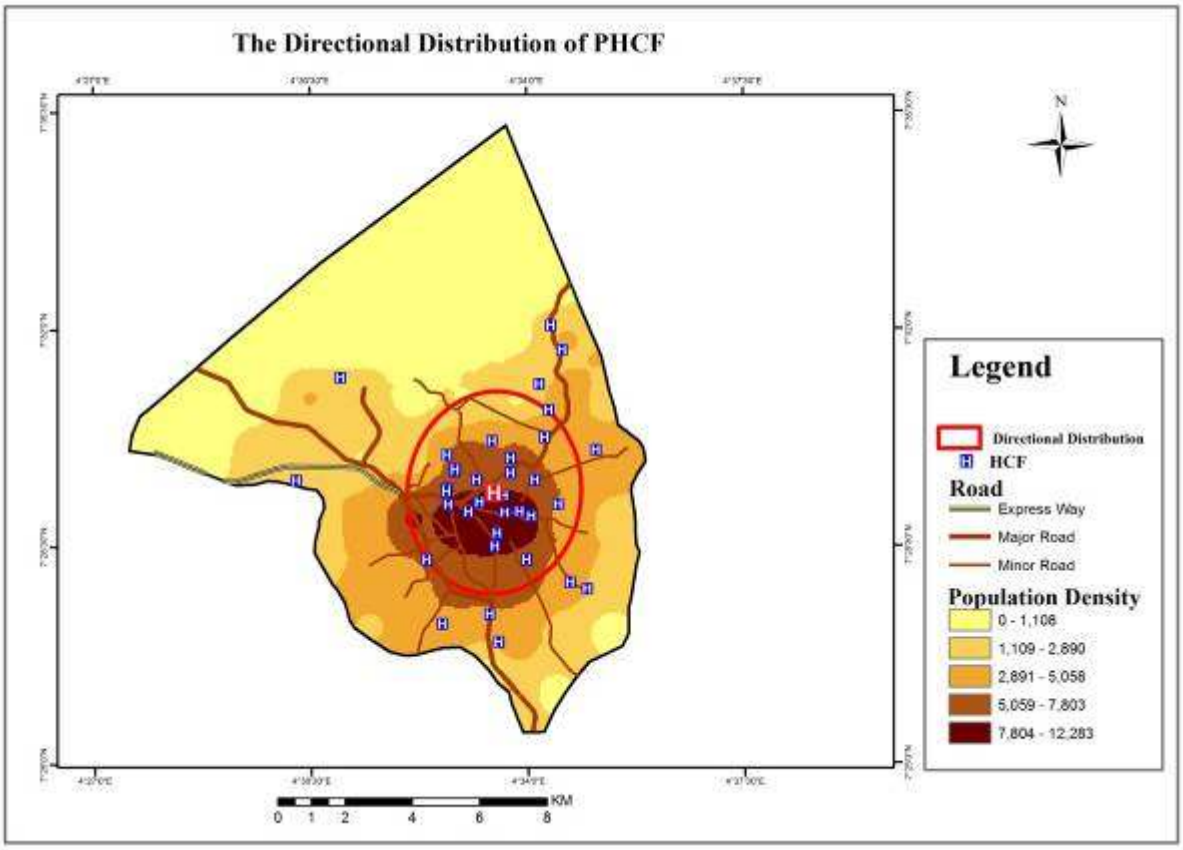
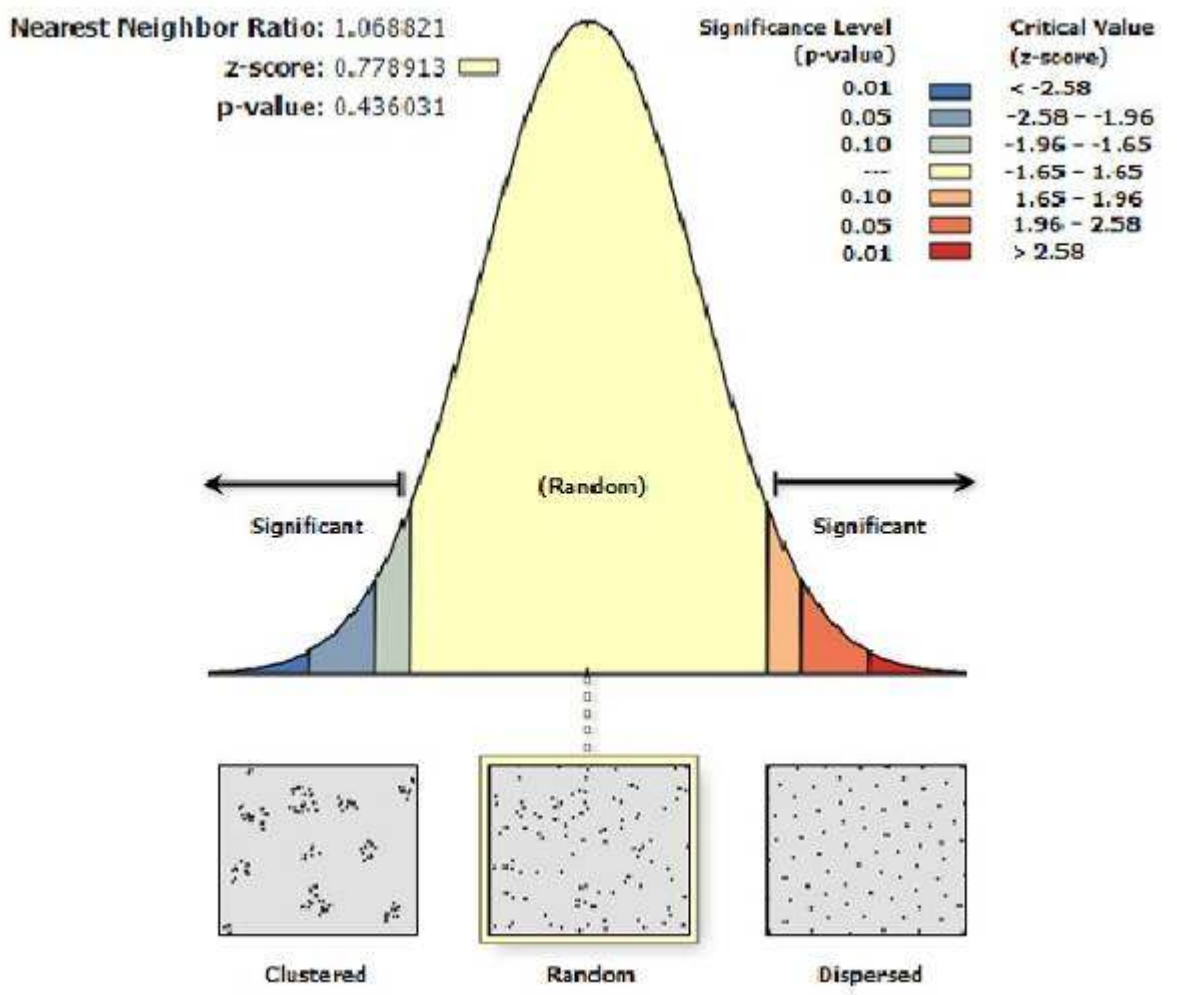


Figure 4.2 shows the directional distribution of the health care facilities.



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386 ***Figure 4.3 Nearest Neighbor Ratio of the Health care Facilities Ile – Ife.***

387 From the emerging result it is shown that the overall NNR of 1.068821 indicates a random
388 distribution of PHC Facilities as shown in fig 6.0 above. Radom Pattern which means no
389 pattern at all with a tendency toward cluster or regularity.
390

391 **4.5 KERNEL DENSITY MAP**

392 The Kernel Density tool calculates the density of features in a neighborhood around those
393 features. It can be calculated for both point and line features. Conceptually, a smoothly
394 curved surface is fitted over each point. The surface value is highest at the location of the
395 point and diminishes with increasing distance from the point.
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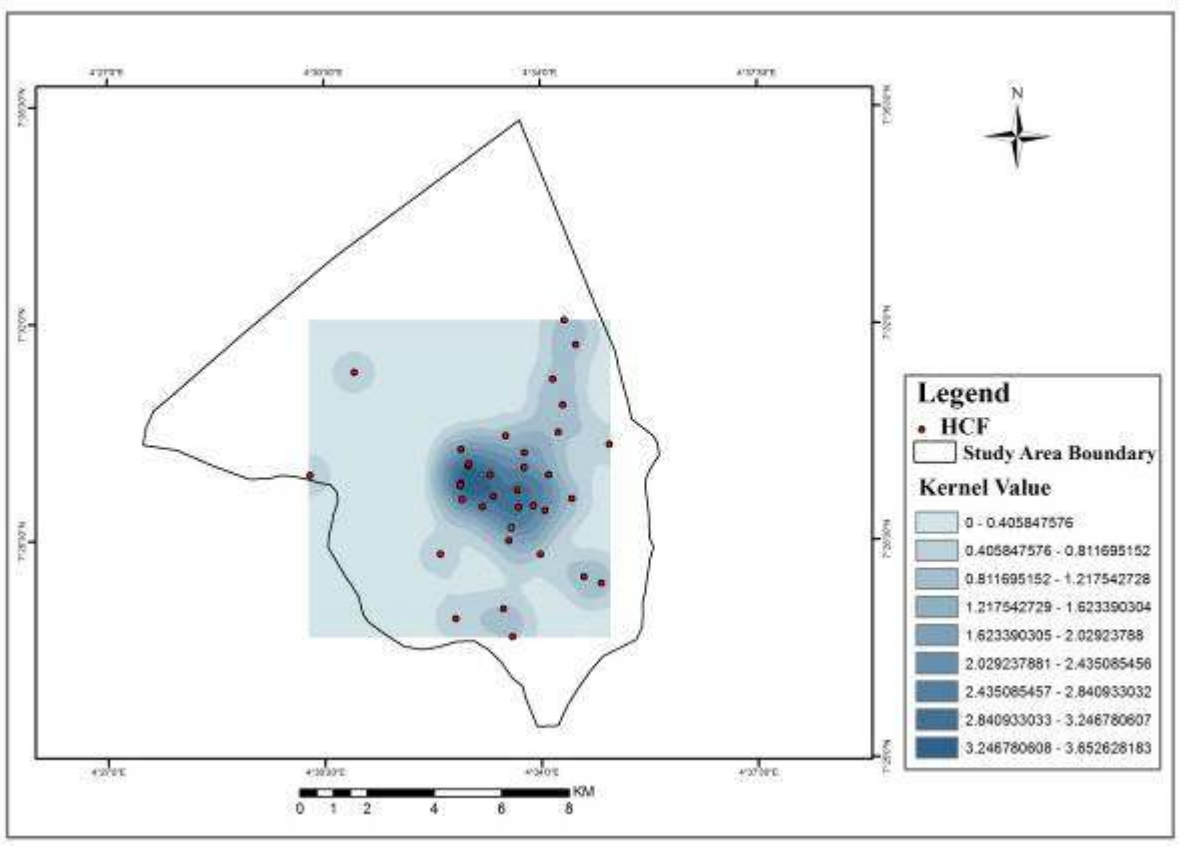

Figure 4.4: Shows the Kernel density map of the study area

4.6 NETWORK ANALYSIS

Network analysis is used for identifying the most efficient routes or paths for allocation of services. This involves finding the shortest or least-cost routes in which a location or a set of locations in a network can be visited. We have different types of network layer .which are: Route, closest Facility, Service Area, OD cost matrix, etc. All of these show the level of service effectiveness and level of accessibility to primary health care facilities.

A network service area is a region that encompasses all accessible streets, that is, streets that lie within a specified impedance (travel time). This solved the problem of accessibility.

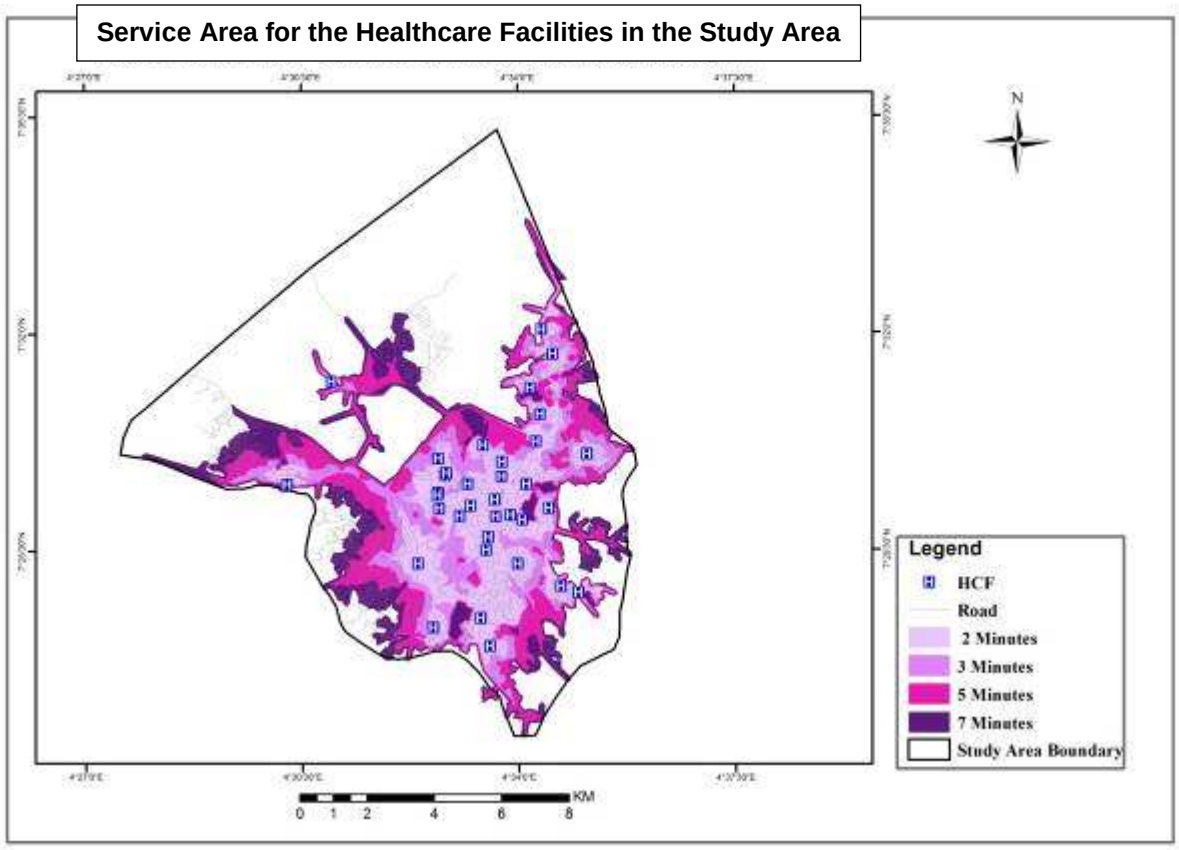

Figure 4.5 shows the service area of the healthcare facilities in the Study Area

In Fig.4.5 the travel times by road transport system (cars, buses and motor cycles) were between 2, 3, 5 and 7 minutes respectively. The grey colour shows that the household within its region gets to its nearest health facilities within travel time of 2 minutes, while the household within the purple colour gets to its nearest health facilities with 3 minutes. The household within pink colour and wine colour gets to its nearest health facilities within 5 and 7 minutes respectively.

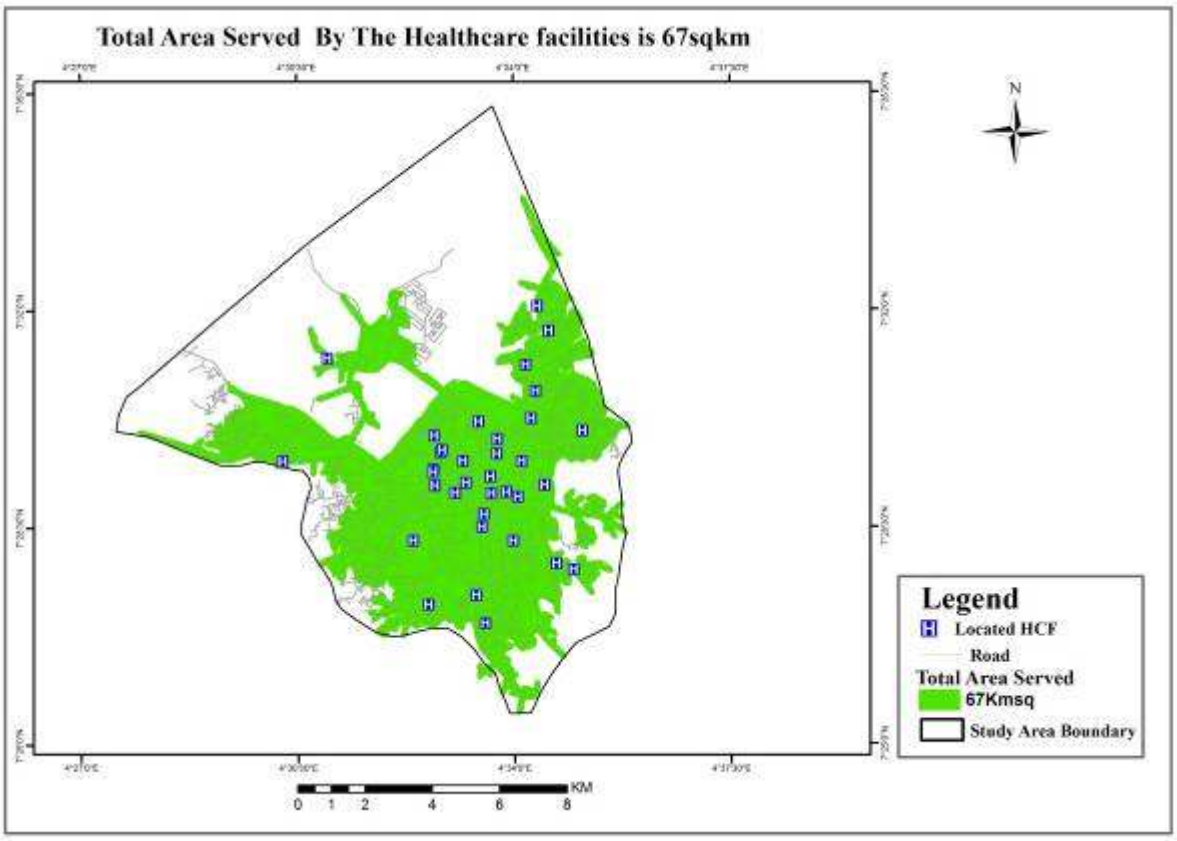

Figure 4.6 shows the total area served by the health facilities in the study area.

The total area served by the health facilities in the study area is 67km². It is observed that the served areas within the study area are within the green color of the fig. 4.6.and household outside the green colour were under served. Therefore additional health care centre need to be provided in the area outside the green colour in the figure 4.6 above

Table 2.0 Distribution of Health care facilities in Ife Central LGA, Ile – Ife metropolis.

Healthcare facilities	Number Identified
Federal Hospital	1
Federal Health Center	2
State Health Center	1
Local Govt Major Health center	1
Local Gvt Minor Health Center	16

5.0 CONCLUSION

Geographic information science is a useful tool in health management. The goal of the National Health Policy (1987) is to bring about a comprehensive health care system, based on this, primary health care is to promote, protect, prevent and rehabilitate to all citizens
The result shows that the study area is fairly provided with health care facilities. However, they are concentrated around the center of the town while other areas are inadequately served.

5.1 RECOMMENDATION

Primary healthcare facilities should be provided to serve the areas that are underserved in the study area.
The centrally located primary health center should be well equipped by the government so as to serve the population better.
Improvement should be made on healthcare provision by having a standardized regulation for establishing primary healthcare facilities.

References

1. Abbas, I. I. Auta, S. Z. & Na'iya, R. M. (2012): Health Care Facilities Mapping and Database Creation Using GIS in Chikun Local Government, Kaduna State,. Nigeria. Glo. Jor. of Human Social Science, Geography & Environmental GeoSciences;12:10.

2. Abiodun, A.J. (2010): Patients‟ Satisfaction with Quality Attributes of Primary Health Care Services in Nigeria. J. Health. Manag., 12(1): 39-54.

3. Ajala O. A, Sanni L, Adeyinka S. A (2005): Accessibility to Healthcare Facilities: A Panacea for Sustainable Rural Development in Osun State, South western Nigeria. Jor. of Human Ecology, 18 (2):121–128..

4. Christaller, W. (1936): The Central Places of Southern Germany, Englewood Cliffs, N. J.: Prentice Hall.

5. Michael, B., Steeve, E., Patricia, N. A., Manuel, V., & Zine, E. M. (2004): Using GIS to Measure Physical Accessibility to Health Care . Switzerland: World Health organisation.

6. Okafor, S. I. (1978): "Inequalities in the Distribution of Health Care Facilities in Nigeria", in Akhator , R.A. (ed.) Health and Disease in Tropical Africa: Geographical and Medical Viewpoints, London: Harwood.

7. Olajuyin, L.O., Olayiwola, L.M. and Adeyinka, S.A. 1997. Locational Analysis of Health Facilities: A Case Study of Irewole Local Government Area (1940-1985).

8. Osenwofa, O. (1992): Some Issues in Nigerian Health Planning and Management. Omega Publisher, Benin

9. Oyinloye R.O and Adeoti O.(2008): "Geoformation-based assessment of healthcare facilities in Ile-Ife, southwestern Nigeria." RECTAS

10. Park, E.B. (2000): ”Measuring access to primary medical care: Some examples of the use of geographic information systems,” Health and place” ;4 (2): 183-193.
11. Philips, R.L., Kinman, E.L. and Lindbloom, E.J. (2000): “Using geographic information systems to understand healthcare access,” Archives Family Medicine; 9:971-978.

12. Webster, T., Vieira, V. Weinberg, J. and Aschengrau, A. (2000). Method for mapping population-based case-control studies: An application using generalized additive models. Int.J. Health Geography; 5:23