# SPATIAL DECISION SUPPORT FOR HEALTH SYSTEM DEVELOPMENT IN OGUN STATE NIGERIA

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**Abstract:** Geographical information system was applied to map health facilities in Ogun State. The objective is to improve health care delivery in the state. Geographic coordinates of 1,141 health facilities across the 20 local governments were obtained and utilized to develop a Health Service Information Systems. Spatial database was constructed for all health facilities using information as ownership structure, number of personnel, capacities and building photographs. The facilities were categorized by spatial analysis into primary, secondary and tertiary health facilities; pharmaceutical, medical laboratories and traditional birth attendants. Analysis by ownership structure revealed that over 70% are privately managed while the other 30% were managed by either federal, state or local government authorities. Simpler medical services such as drug dispensary, maternity, pediatrics, family planning, immunization, dental, pharmaceutical and medical tests were provided by many of these health facilities, only very few could handle special services as surgery and other intricate medical services. The study revealed that the distribution of health facilities in the state is not equitable; they are rather clustered within urban areas and many people do not have direct access to good health services. Socioeconomic indicators also unveil the gross inadequacy of health facilities in all the local governments. The GIS maps indicates possible areas of locating new health facilities, it provides decision for geographical targeting of interventions for existing ones. The paper recommends particular attention to some identified towns in the construction of new health facilities in order to address inequality in health facilities distribution in the state.

**Keywords:** Health care deliver, Decision support, Ogun State

## Introduction

The critical role of mapping in geographical targeting of intervention has been demonstrated (Lang *et al*, 2013; Aral *et al*., 2015 and MacQuillan *et al*., 2017) by several authors across works of life (Owusu, 2016; Geanuracos, 2007). The development of health systems in particular, has beneffited from the introduction of mapping and spatial analyses in the last ten years (González-Block, 2011; Innocent *et al*., 2012; Vincenti-Gonzalez; 2017). In quite a number of ways, Geographical Information has been applied in location and allocation decision on health infrastructures (Photis and Maneto, 2007; Koutelekos *et al*., 2007; Taylor *et al*., 2012). Health system development is mandatorily part of the Sustainable Development Goals (WHO, 2012; Gitahi, 2017) and can therefore not be segregated from environmental management (Shu-kun, 2009). Development of health systems namely; improved infrastructures and effective health administration and governance should be seen as important part of human development drives.

Improvement of the of health systems is not however limited to architecture, spatial engineering or arrangement of physical structures in the environment, but also includes reduction of ration between personnel and patients (Vaillancourt *et al*., 1992). There is the need to improve on the number of qualified personnel while also increasing the number of facilities. There is the need to adequately furnish the facilities with drugs, requisite equipment and other vital accessories that makes the health system functional and effective (Kusi-Appouh, 2009). It is believed that after food comes drugs since health is wealth.

Mapping of health facilities goes beyond graphical presentation of the distribution of health infrastructures for mere visualization, it presents hidden information with the synoptic view of the facilities and offers opportunities for creating scenarios that could support right decision in planning and interventions (Fayad *et al*., 2014). For instance, the map of health facilities superimposed with a chart of qualified personnel with a demographically characterized base map as background tells more story than hundreds pages of reports and call for interventions. Representation of the locations with the use of GIS have a direct bearing on improvement of the quality of health care delivery; since this gives the picture of spatial distribution of the infrastructures with respect to needs by the people. It also provides basis for redirection of efforts for infrastructural developments including increasing accessibility of service, funding more cost effective delivery modes and preserving patients' confidentiality while satisfying the needs of the research community for data accessibility (Xiao, 2018).

Digital mapping systems such as GIS provides an excellent means of analyzing epidemiological data (Oyedepo *et al*., 2015), revealing trends, dependencies and inter-relationships that would otherwise remain hidden in data showed only in a tabular format. GIS can therefore be seen as valuable management tool in the enumeration programmes, strengthening national, regional and sub regional capacities in surveillance and monitoring. Mapping of health facilities in Ogun State through the use of GIS was one of the basic elements in an attempt at improvement of the health sector in the state.

The main objective of this study was to enable the State government (represented by Ogun State Ministry of Health, undertake a study aimed at determining the geographical spread of health facilities including their locations, ownership and nature of service (Public, Private and NGO) with a view to ensuring equitable distribution of interventions (through World Bank assistance) for development of health facilities in the State. The study therefore identified the existing health facilities in the state, considered their respective geographical locations, ownership and nature of service. This was

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important to determine the geographical spread of the health facilities in the state and decide on whether there is a need for construction of new health facilities.

## Materials and Methods

The project depended on the use of two spatial information technologies (Global positioning System and Geographical Information Systems. The materials used includes a structured interview guide, a hand held GPS receiver with a digital camera. The study commenced with a preliminary survey/census in two local government area (Abeokuta South and Ogun Water side) to enable the study pretest and adjust the instruments and methodology for data collection. The pretest also enabled the enumerators have an insight to the reactions of respondents during actual field survey. The period was also used to modify the instruments, test the functionality of the GPS and the Digital Cameras.

Two enumerators were assigned to 3 local government areas and complete enumeration of all health facilities and personnel were done within the period.

### *Compilation of health facilities in the twenty local government area of the state*

The list of the health facilities (Private and Public) with their physical addresses in each local governments of the state were compiled from the Ogun State health Bulletin. The coordinates of the physically sighted facility and its present status as at the study time were documented by photographs and in writing.

### *GPS coordinate acquisition*

Garmin hand held GPS receivers were acquired and taken to the field. Each health facility was marked by reading the coordinates of its position on the receiver. These and other attributes of the health facilities were transferred into a spread sheet right on site.

### *Database development and digital map creation*

The coordinates of each health infrastructure were recorded and all other information were tabulated against the coordinates. Where the facility is a maternity, clinic or hospital information such as names, year of establishment, ownership, nature of service, number of qualified personnel (doctors, nurses, attendants etc) number of beds, number of patients were recorded against the coordinates in separated fields (columns). A separate column was created for hyperlinked photographs of each facility. The information were compiled in a spreadsheet and saved as a Database file format (DBF) for onward transmission into GIS environment. The DBF was imported into GIS on an existing map of the state and local government administrative boundaries as base maps. The base maps (State and LGA administrative maps) were further enriched by capturing other features such as community, rivers and road networks acquired from high resolution satellite imagery and analogue map of Ogun State, Bureau of Lands and Survey. The paper map were simply scanned, imported into the GIS software, 'geo-referenced' using coordinates of known features on the ground and the features captured with minimal root mean square (RMS) error through "On-screen digitizing".

### *Symbolization of health facilities on the map*

The point symbols were changed to unique symbols and the various facilities were categorized using user defined symbolization. With this we had health facilities symbolized by categories of ownership and nature of service.

The determination of equitable distribution of health facilities in the state or otherwise was achieved by overlaying the health facilities (point symbols) of the interpolated population communities in the state. The population of each settlement obtained from the population commission were interpolated to produce a grid map of human population. This helped in comparing the facility distribution across the state with population density.

### *Charting of health facilities/population per LGA*

A chart of number of facility vis-à-vis population per LGA was created. The ratio of health facilities to population per LGA was also calculated and used in producing the choropleth maps (graduated colour symbol) of local government areas

### *Hyperlinking photographs to data*

Hyperlinking of facility photographs was done in the health facility database. This is to enable appreciation of the physical condition of each facility which is also a guide for decision in development intervention. Photographs corresponding to each facility were hyperlinked to them in the cell designated for hyperlinks for each records. All photographs were called from the directory named "photographs" containing 20 folders representing each of the 20 LGAs. A typical hyperlinking directory will look like this: D:\photographs\odeda\DSC\001

To determine whether there is a need for the construction of more and newer health facilities, the number of health facilities in each local government vis-à-vis the population of that local government was compared with international standards as recommended by WHO, UINAIDS and World Bank (Comparative socio-economic indicators). Equitable distribution of health facilities in the state was also assessed by comparing the number, spread/clustering of health facilities in each of the local government in the state.

## Results/Findings

Table 1 shows the ratio of health facilities to patients in each of the twenty LGAs in Ogun State as at study time. Determination of whether there is a need for the construction of new health facilities can be done by comparing the population of each local government to the available health facilities. The table further shows the number of doctors to patients. The only socio-economic indicator that can be used to determine whether there is a need for construction of new health facilities or not is the ratio of Doctors to the population since there are dearth of information or standard on the number or ratio of health facilities to population.

**Table 1: Health facilities versus population in each LGA's in Ogun State**

| LGAs | No. of Health Facilities | Total Population* | No of Doctors/ LGA | Facility to People is 1 to: |
|---|---|---|---|---|
| Odeda | 37 | 125446 | 19 | 3390 |
| Ijebu North | 50 | 207969 | 41 | 4159 |
| Ewekoro | 27 | 152148 | 41 | 5635 |
| Ijebu East | 36 | 85686 | 10 | 2380 |
| Remo-North | 18 | 66582 | 13 | 3699 |
| Ikenne | 45 | 111735 | 20 | 2483 |
| Yewa South | 57 | 181891 | 41 | 3191 |
| Shagamu | 68 | 224500 | 22 | 3301 |
| Ijebu North east | 32 | 83761 | 117 | 2617 |
| Odogbolu | 34 | 143789 | 11 | 4229 |
| Ijebu-Ode | 62 | 191008 | 67 | 3081 |
| Ifo | 84 | 172392 | 83 | 2052 |
| Ipokia | 59 | 196504 | 19 | 3331 |
| Ado-Odo-Ota | 86 | 328961 | 66 | 3825 |
| Ogun Water side | 30 | 86811 | 12 | 2894 |
| Abeokuta South | 183 | 369651 | 96 | 2020 |
| Abeokuta North | 73 | 131735 | 50 | 1805 |
| Yewa North | 78 | 227888 | 28 | 2922 |
| Imeko Afon | 23 | 93114 | 14 | 4048 |
| Obafemi Owode | 59 | 192154 | 30 | 3257 |

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The column of the number of the total number of Doctors per LGAs revealed that all the local government had less than 57.6 doctors per 100,000 people. This is a far cry when compared to 78.0 and 287.0 recommended for developing and developed countries. There is therefore an urgent need to construct more health facilities and recruitment of more medical personnel to operate the health facilities.
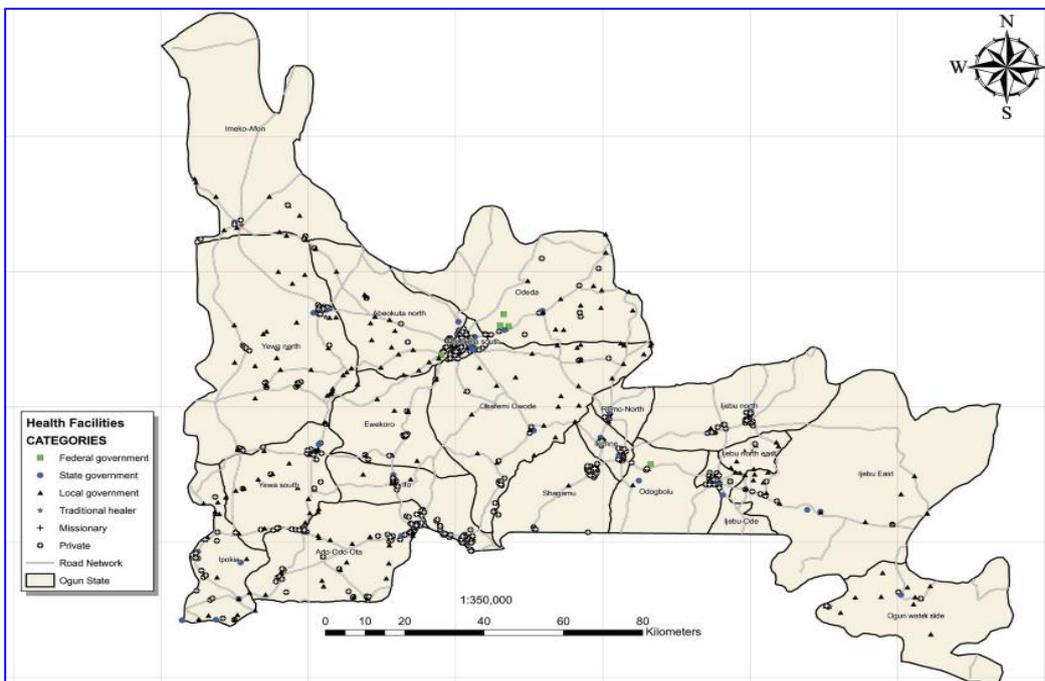
Further analysis of Table 1 in comparison to the World Bank recommendation reveals that the distribution of health facilities in Ogun state is not equitable. There is a large variation in the ratio presented in the table. Abeokuta North LGA has a ratio of 1:1805 (health facilities: people) while a local government like Ewekoro has a ratio of 1:5635 (health facility: people). These deficiencies are graphically presented in Fig. 1. Abeokuta South location for instance with a population of 369,651 people has just 183 health facilities out of which are government owned. Ado-Ota LGA with a population of 328,961 people has just 86 health facilities with … as government owned. Many of the local governments fall into this group.

Often private health centers are not well equipped and where they are, the bills are too high than what most patients can afford. The deficiency observed by this study need to be rectified urgently by constructing new health facilities in all the local governments with particular attention to all the local governments that has less than 78 doctors to 100,000 people. The need for rectification in allocation of modern health facilities is further revealed by Fig. 2 showing distribution of health facilities by ownership (this reveals the proportion of public (government owned) to privately owned hospitals and clinics across the State.

To do this accurately without falling into error of disproportionate apportionment, a GIS-based location/allocation spatial decision support must be developed for health systems in the State. This will urgently bring the number of health facilities in the state to be close to the WHO recommendation.
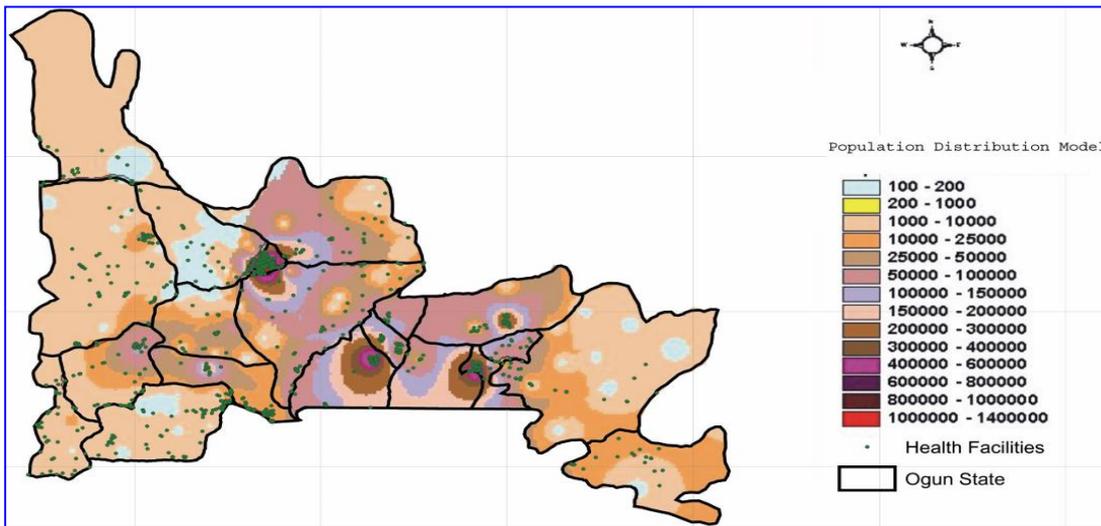


**Fig. 1: Map of health facilities overlaid on population distribution map**



**Fig. 2: Spatial distribution of health facilities by ownership in the State**
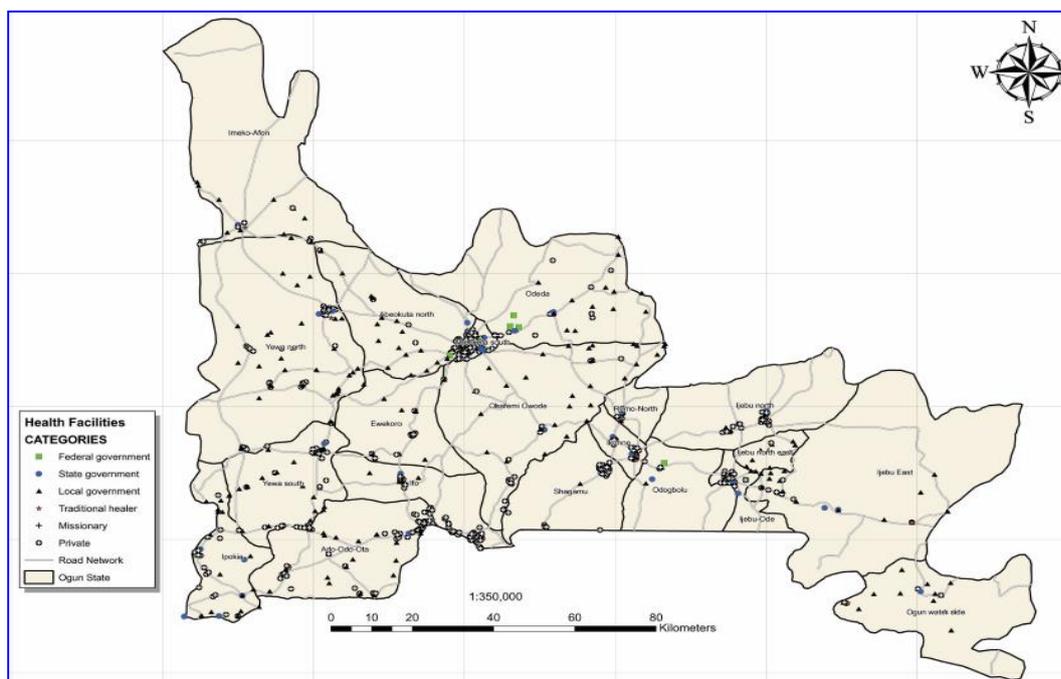
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**Fig. 3: Spatial distribution of health facilities in Ogun State by ownership structure**

Apart from construction of newer health centers, the existing ones need to be strengthened by facilities and qualified personnel. Table 2 for example reveals the number of hospitals that have enough beds to admit patients. Majority do not have facilities for admission of ill patients and less than 10 health centers have up to 50 hospital beds.

**Table 2: Number of hospitals with beds for patient under medical observation**

| No of Beds | Private Hospital | Public Hospital | No of Hospital |
|---|---|---|---|
| 1 - 5 | 74 | 2 | 76 |
| 6 - 10 | 45 | 3 | 48 |
| 11 - 20 | 25 | 3 | 28 |
| 21 - 50 | 3 | 2 | 5 |
| above 100 | 1 | 0 | 1 |

**Table 3: Health personnel in private and public hospitals**

| Personnel | Private Hospitals | Public Hospitals | All Hospitals |
|---|---|---|---|
| *Doctors* | | | |
| 1 | 87 | 5 | 92 |
| 2 | 16 | 3 | 19 |
| 3 | 7 | 2 | 0 |
| 4 | 3 | 0 | 3 |
| 5 | 2 | 0 | 2 |
| Above 10 | 0 | 2 | 2 |
| *Nurses* | | | |
| 1-5 | 110 | 9 | 119 |
| 6-10 | 18 | 2 | 20 |
| 11-20 | 1 | 2 | 3 |
| 21-50 | 0 | 1 | 1 |
| above 50 | 0 | 1 | 1 |
| *Pharmacists* | | | |
| 1-3 | 80 | 13 | 93 |
| 4-10 | 0 | 0 | 0 |
| Above 10 | 0 | 1 | 1 |
| *Others* | | | |
| 1-10 | 122 | 7 | 129 |
| 11-20 | 2 | 5 | 7 |
| Above 20 | 0 | 1 | 1 |

**Table 4: Range of average monthly patronage of hospitals by patient**

| Patients/month | Private Hospitals | Public Hospitals | Total health centers |
|---|---|---|---|
| Less than 10 patients | 17 | 0 | 17 |
| 10 - 20 | 22 | 0 | 22 |
| 21 - 50 | 40 | 1 | 41 |
| 51 - 100 | 26 | 3 | 30 |
| 101 - 500 | 41 | 3 | 44 |
| 501 - 1000 | 10 | 2 | 12 |
| 1001 - 3000 | 8 | 2 | 10 |

The same is true for medical personnel as shown in Table 3; only 2 hospitals have more than 10 doctors, more than 100 have less than 4 doctors; many do not even have at least 1 resident doctors.

Hospital patronage by patient is a function of a number of factors which include: efficiency in service delivery, affordability of the cost of service and proximity to the patients. The Table shows the pattern of hospital patronage by patients in Ogun State.

Table 4 shows ranges of monthly patronage of hospital by patients. The table shows that most private receive an average of less than 100 patients in thirty days. Most of the hospitals that receive up to 1000 patients are government owned. The scenario that this paints is over congestion of the hospitals and health complications where there are inadequacies of personnel and facilities to attend to the patients.

People generally prefer public health facilities on the general belief that it should be well equipped and more efficient. A secondary consideration which is equally important is affordability. People tend to patronize privately owned health facilities when they cannot trust efficiency of service delivery in public hospitals. Incidentally, more privately owned health institutions are thriving against the public ones. Fig. 3 shows the map of Ogun state and the spatial distribution of health facilities by ownership structures.

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**Conclusions and Recommendations**

The results of the study reveal the existence and geographic location of all kinds of facilities namely; primary, secondary, tertiary health care facilities with traditional birth attendants, private pharmaceutical facilities and medical laboratories in the state. The ownership type of these facilities include the Federal, State, Local government, Private and Non-governmental organizations. The study also shows that the services provided includes medical, surgical, maternity, pediatrics, family planning, immunization, dental services, pharmaceutical and medical laboratory. However, the distribution of health facilities in the state is not equitable because there is a large variation when the ratio of health facilities to population in each local government was compared. Further, concentration of good health facilities are in major towns in all local government where the population appeared dense while there are little or no health facilities in other parts of all the twenty local government surveyed. There is therefore an urgent need for the construction of new health facilities to be allocated with Location/allocation Spatial Decision Support Systems (LADSS) in all the local governments of the state. The deficiencies identified can be rectified through the urgent construction of new health facilities in all the local government of the state and most especially in all the local government with very high ratio of health facilities in population.

**Recommendations**

The study recommends regular update of information (names, numbers and location) of all health facilities in each of the local government of the state from time to time. This is important in planning, admiration and health governance.

Interventions to be extended to all primary health centers in the State to put them back on track since they are the closest to the grassroots. At the moment many of the buildings are derelict.

It is important as part of interventions to open up roads leading in the State to link up all government health facilities in rural areas.

More funds should be injected in the health systems development for the construction of new modern and functional health facilities in all local government areas.

Urgent efforts should be made to correct the lopsidedness of health facilities in the state through equitable distribution of new facilities in all the local government areas with high population density.

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