Integration of Geographic Information System in Planning and Management of Industrial Developments in Nigeria

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Key words: Industrial development, GIS, Database structure, Location, Users interface.

SUMMARY

The expanding human needs and organized private sector participation in industrial activities are placing ever-increasing pressures on available resources and creating competitions. Thus the need for relevant industrial data for well informed decisions at all times. Geographic Information System (GIS) could furnish the entrepreneurs with needed information on the feasibility and viability of industrial projects, and also guide in the location or relocation based on production factors. Database containing information on industrial distribution and types in a particular area (site) were modeled, so as to furnish up-to-date and reliable data on its location. This was produced visually in form of special (thematic) maps based on the geographic area of Nigeria using appropriate GIS tools. Geo-statistical tools were on-hand to complement analysis and enable points to be uniquely related as required. Several industrial sectors were examined, with a view to ascertaining GIS roles that were either not utilized or under-utilized, and by using GIS as a tool for data analysis. In doing this, various forms of data acquisition systems in terms of data structures and modeling were examined. Contemporary GIS packages (software) and types of their user's interface were also investigated. The paper provides conceptual and methodological guidance for integrating industrial developments knowledge with geo-spatial technologies.

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1. INTRODUCTION

Nigeria has a surface area of about 923,766sqkm (CIA, 2009). The area lies within latitude 4º 10' to 14º 02'N of the Equator and longitude 2º 45' to 14º 35'E of the Greenwich meridian. It is bordered by Cameroon, Benin, Niger, Chad and the Atlantic coast of West Africa in the East, West, North and South respectively (Figure 1). The country has a population of 120million (FRNOG, 2007). Given the relative poverty, high unemployment, and range of living types, it is clear that there exists a need for adequate planning and development. Without data, industrial planning and development is not possible, and the basis for evaluating priorities is data. The Nigerian economic landscape still suffers from extreme levels of uneven development and structural unemployment, partly due to non-availability of maps and other industrial data in required format.

In this era of expanding human needs and increasing organized private sector participation in industrial projects in Nigeria. Geographic Information System (GIS) could furnish the entrepreneurs with needed information on the feasibility and viability of industrial projects, and also guide in the location so as not to fall foul of the environmental laws. A functional GIS should be able to achieve (store) database containing information on industrial distribution and types (heavy and light industries) in a particular area (site). On its location furnish up-to-date and reliable data on existing and state of infrastructure in place or would-be project site. This could be produced visually in form of special (thematic) maps. On non-spatial applications GIS techniques could also be on duty to collate data on the continuous functioning and welfare of the workers. Therefore, the objectives of the study were to develop the GIS tools for handling industrial developments in Nigeria, so as to provide database in digitized form for effective industrial management and GIS support operations of future industries. This is because of the employment and income potential it is supposed to offer to the immediate environment and the nation at large. This article presents the result of a recently conducted GIS integration with industrial developments in Nigeria. The study is concerned with the use of GIS in support of equitable redistribution of common wealth (resources) in Nigeria. In other to achieve the above objective, few industries were selected upon the assumption that industrial change here is rapid and dynamic.

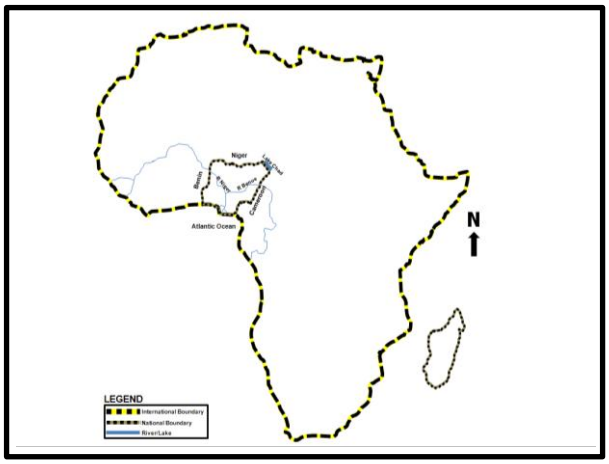

Fig. 1: Location Map of Nigeria **Scale**: 1:8000000

2 INDUSTRIAL DEVELOPMENTS AND POLICIES

Nigeria has some unique characteristics that tend to make development difficult. Industrial location policies are either formulated partially to favour certain non-economic gains or satisfy geo-political lines. Little attention is paid on diversification to economic factors. This unfortunately has given rise to the collapse of several industries. Moreover, most industries in Nigeria were sited using foreign consultancies, which were not really interested in the proliferation of such industries, partly to avoid competition from their home (foreign) industries. Therefore, such industries are concentrated almost at trade terminals or export routes. Most early industries were on cash crops and raw material to feed foreign industries (Eze, 2000). There were little or no comprehensive efforts to encourage local and indigenous development and ownership of industries. Therefore the design of early industries were made abroad and skillfully hoisted on our decision-makers (Leaders).

Overtime Nigeria through its appropriate policy making organs have had a multi-national and participatory industrial policy. Though, few industries (entirely foreign) owned by colonial masters (Britain) were existing. Those industries cannot be said to have been established by an independent policies. This was because those early industries were mainly export processing, and were meant to supply raw materials to foreign industries. However, at the attainment of independence, a number of policies were put in place to either argument some existing policies or entirely new one. These were perhaps to assert Nigeria's independence. These new policies were inter-alia to accelerate rapid industrialization of the country. The policy term was to encourage exploration and exploitation of petroleum, solid minerals, and simulation of the manufacturing sector with its attendant employment multipliers.

Since, industrialization is synonymous with development. According to Udu and Agu (1993) such developments is dependent on a certain number of factors such as: averability of raw materials, infrastructural facilities, geographical site, good and thoughtful planning, human resources, capital and investments, mental attitude of the population, size of the market, e.t.c. Fortunately, at this era of our national development there is no gain claiming that Nigeria is beginning to experience the benefits of information management technology made possible by advancement in digital electronics. The GIS is hence a sine qua non tool towards the full realization of the present drive for privatization policies aimed at accelerating industrial growth. What is required presently is to encourage and sustain capacity building and utilization of GIS products in various aspects of our life. The perceived drawbacks to this laudable objective may be in the face of dwindling income and investment compared to cost of hardware and software units.

3. APPROACH

The approach for the study was actually an integrated approach to project management (industrial) using GIS as a tool. In the process, an interactive digital map of Nigeria was achieved using the AutoCAD drafting and ArcView GIS mapping tools. However, special caution must be exercised during data acquisition, modeling and manipulation, because errors may crept-in and degrade the data quality, and since the application combined with the DBMS hinges critically on data quality and availability at appropriate scales.

3.1 Data inputs and sourcing

The first step of the study was the collection of base information on industrial, economic and environmental parameters of the country in consideration to its constituent states. Data of selected sectors of the industry was collected for analyzing industrial developments activities. A combination of spatial data and non-spatial data were selected for the study. The admin map of Nigeria with the 36 states (Scale: 1: 1,000,000 of 1996 edition) was treated as the base map for the analysis. Other maps such as States admin maps of 1:50,000 and local government (district) maps of 1:50,000 – 1:500,000 (1997 and 2001 reprints) were used for detailed data extraction. Data adjustments were carried out to meet the objectives of the study. The non spatial data like type of industry, year established, etc were also collected for analysis.

The data sourcing were carried out with concerned stakeholders to industrial developments. Such as: the Federal Office of Statistics (FOS) Lagos; Nigerian Stock Exchange (NSE); Central Bank of Nigeria (CBN); Nigerian Industrial Development Bank Ltd Lagos; Manufactures Association of Nigeria, Ikeja; Nigerian Association of Commerce Industrial Mines and Agriculture (NACIMA) - Maryland; Industrial Training Fund (ITF) Ojota; Ministry of Commerce and Industries – Alausa; Federal Ministries of Mines, Power, Steel; Dept. of Petroleum Resources, Victoria Island; Federal Survey Division, Lagos. The major

constraint was near absence of a computer compatible data where some industrial data exist. The data generated from these sources were mostly in analogue printouts (such as journals, monographs or texts, line or image maps, statistical tables, etc). These data were sieved and needed industrial information extracted using appropriate tools and skilled conversions of analogue maps and associated data to digital form. The resulting data were structured to develop the database for industries, especially in terms of inventory, location and spatial distributions of the industries in Nigeria.

3.2 System selection

A pre-analysis to select appropriate hardware and software tools was conducted. ArcView GIS, which was a relational database software for desktop GIS and mapping, was selected as the main package based on its capacity to handles multiple tables and relates them to each other with absolute ease. ArcGIS allows integration of CAD (e.g. AutoCAD) software to enhance a variety of drawings of various file formats onto the map without first converting the files. The software, allows joining of tabular data to the features in the CAD graphics. Also several forms of manipulations and queries are possible using appropriate commands. The hard-wares used besides the GPS (which enabled points to be uniquely defined) and the physical computer, includes the scanner, digitizer, printers and other peripherals.

3.3 Database development

Data is defined as raw material from which every information system is built (Dale and Melaughlin 1988). In the GIS, two broad categories of data are usually involved in the database development. This could be spatial data (georeferenced framework e.g. line maps, coordinates, etc) or non-spatial data (temporal or dynamic events e.g. banks financial information, stores sales records, commodity distribution from firms, etc). Therefore, relevant data were assembled to form the database, based on relational data model. Since, data models describe the database at some level (whether application-oriented or system dependent) and act as mediators between humans and machines (Worboys, 1998). Relational data structure physically consists of tables of attributes (columns) and topples (rows). The attributes and topples contain data which bear relations to one another.

Most commercial DBMS developed for general purpose are relational due to its flexible character, as such data integration were achieved through the implementation of relational algebra by DBMS. This enables multiple and complex queries and makes room for data query optimization. The relation operations such as PROJECTION, JOIN AND SELECT are achieved with the application of appropriate relational mathematics - relational algebra and calculus (Kroenke, 1983). Though, models such as hierarchal, network, or object-oriented, etc are possible options, relational database model was used due to its numerous advantages over other models. Especially, in terms of structural flexibility and easy manipulation (retrieval, addition, deletion, change, etc) of data or descriptive information associated with spatial data without affecting the original data tables. These could also be implemented through Active-X technology as demonstrated in Loney et al., 2004).

4. RESULTS AND ANALYSIS

Typically the major products of this work were presented in form of tables, maps, charts and figures. Therefore, the output specifics were further detailed below.

4.1 Tables

The interfacing of complimentary packages with the ArcView GIS resulted to the following tables that were logically created (designed and structured) and each table had its fields (tables 1 – 2). Tables 3-5 were samples of some of the resulting database tables. Necessary links and nodes were equally created to enhance the querying capability of the database.

Table 1: Created tables and Fields

Tables	**Attributes/Fields**
Aviation and Maritime Sector	[Company Name, State, LG/Town, Industrial Class, Industrial Group, Product Group, Product Type, No Pers. Moved, Ownership].
Educational Sector	Industrial Name, State, Phone, LG/Town, Address, Industrial Class, Industrial Group, Year Established, Ownership
Glass and Equipment	Industrial Name, State, LG/Town, Company Name, Industrial Class, Product Type, Ownership.
Milling Industries	Industrial Name, State, LG/Town, Industrial Class, Product Type, Ownership
Agricultural Sector	Industrial Name, State, LG/Town, Industrial Class, Product Type, Ownership.
Automobile	Industrial Name, State, LG/Town, Industrial Class, Industrial Group, Product Group, Product Type.
Banking Sector	Company Name, State, Phone, LG/Town, Address, Industrial Class, Industrial Group, Product Type, Ownership
Brewery and Mineral Waters	Industrial Name, State, LG/Town, Industrial Class, Product Type, Ownership
Building Material	Industrial Name, State, LG/Town, Company Name, Industrial Class, Product Type.
Chemical	Industrial Name, State, LG/Town, Industrial Class, Industrial Group, Product Group, Product Type, Ownership
Oil and Gas	Industrial Name, State, LG/Town, Company Name, Industrial Class, Product Type, Ownership.
Energy Sector	Industrial Name, State, LG/Town, Company Name, Industrial Class, Product Type, Ownership
Industrial Indices	State, Capital, Number of LGs, Population Estimate, Accident Cases, Armed Robbery, Bank Fraud, Civil Strife

Table 2: The data fields' definition table

Fields	**Definition**
Industrial Name	Name of particular industry
State	State of the Federation (Nigeria) where the industries exist.
LG / Town	The locality or town of its location
Industrial Class	The class of such industries (either extraction, manufacturing or services)
Industrial Group	The group (either local or foreign, heavy, medium or light)
Product Type	The Output
No. Persons moved	Number of moved per year
No. Employed	Number of persons employed
Ownership	Name and nature of ownership (private, state, federal, bilateral, multi-national, NGOs, joint)
Year Established	The year of particular establishment
Raw Material	Sources of Raw Materials Used

Table 3: AVIATION AND MARITIME SECTOR

COMP NAME	STATE	LG/TOWN	IND CLASS	IND GROUP	PROD GROUP	PROD TYPE	NO PERS MOVED	OWNERSHIP
Muritala Mohammed Airport	Lagos	Ikeja	Services	HEAVY	**Internati**onal	Aviation	540,345	Federal
Kano Airport	Kano	Kano	Services	HEAVY	International	Aviation	67,248	Federal
Port Harcourt	Rivers	Ph	Services	HEAVY	Sub International	Aviation	130,049	Federal
Calabar Airport	C/Rivers	Calabar	Services	HEAVY	Domestic	Aviation	20,869	Federal
Nnamdi Azikiwe	FCT	Abuja	Services	HEAVY	International	Aviation	284,192	Federal
Akure Airport	Ondo	Akure	Services	HEAVY	Domestic	Aviation	208	Federal
Benin Airport	Edo	Benin	Services	HEAVY	Domestic	Aviation	501	Federal
Enugu Airport	Enugu	Emene	Services	HEAVY	Domestic	Aviation	34,696	Federal
Ibadan Airport	Oyo	Ibadan	Services	HEAVY	Domestic	Aviation	73	Federal
Ilorin Airport	Kwara	Ilorin	Services	HEAVY	Domestic	Aviation	1,883	Federal
Jos Airport	Plateau	Jos	Services	HEAVY	Domestic	Aviation	26,564	Federal
Kaduna Airport	Kaduna	Kaduna	Services	HEAVY	Domestic	Aviation	67,331	Federal
Maiduguri Airport	Bornu	Maiduguri	Services	HEAVY	Domestic	Aviation	26,255	Federal
Sokoto Airport	Sokoto	Sokoto	Services	HEAVY	Domestic	Aviation	3,056	Federal
Yola Airport	Adamawa	Yola	Services	HEAVY	Domestic	Aviation	6,480	Federal
Minna Airport	Niger	Minna	Services	HEAVY	Domestic	Aviation	203	Federal
Oweri Airport	Imo	Oweri	Services	HEAVY	Domestic	Aviation	12,854	State
Kastina Airport	Kastina	Kastina	Services	HEAVY	Domestic	Aviation	536	Federal
Makurdi Airport	Benue	Makurdi	Services	HEAVY	Domestic	Aviation	897	Federal
Apapa Seaport	Lagos	Apapa	Sea port sev	HEAVY	International	Maritime		Federal
Tin-can Island	Lagos	Apapa	Sea port sev	HEAVY	International	Maritime		Federal
Port Harcourt	Rivers	Ph	Sea port sev	HEAVY	International	Maritime		Federal
Okirika	Rivers	Ph	Sea port sev	HEAVY	Domestic	Maritime		Federal
Fed.Lighter Terminal	Rivers	Ph	Sea port sev	HEAVY	Domestic	Maritime		Federal
Bonny	Rivers	Ph	Sea port sev	HEAVY	Domestic	Maritime		Federal
Brass	Delta	Warri	Sea port sev	HEAVY	Domestic	Maritime		Federal

Warri	Delta	Warri	Sea port sev	HEAVY	Domestic	Maritime		Federal
Koko	Delta	Warri	Sea port sev	HEAVY	Domestic	Maritime		Federal
Sapele	Delta	Warri	Sea port sev	HEAVY	Domestic	Maritime		Federal
Escravos	Delta	Warri	Sea port sev	HEAVY	Domestic	Maritime		Federal
Forcados	Delta	Warri	Sea port sev	HEAVY	Domestic	Maritime		Federal
Pennington	Delta	Warri	Sea port sev	HEAVY	Domestic	Maritime		Federal
Calabar	C/Rivers	Calabar	Sea port sev	HEAVY	International	Maritime		Federal
Qua-ibo (Eket)	Akwa Ibom	Eket	Sea port sev	HEAVY	Domestic	Maritime		Joint Venture
Merryland (Tuma)	Akwa Ibom	Tuma	Sea port sev	HEAVY	Domestic	Maritime		Joint Venture
Anitan	Akwa Ibom	Antan	Sea port sev	HEAVY	Domestic	Maritime		Joint Venture
Contain Terminal	Akwa Ibom		Sea port sev	HEAVY	Domestic	Maritime		Joint Venture
Roro	Akwa Ibom	Roro	Sea port sev	HEAVY	Domestic	Maritime		Joint Venture

Table 4: ENERGY SECTOR

INDUSTRIAL NAME	STATE	LG/TOWN	COMPANY NAME	INDUSTRIAL CLASS	PRODUCT TYPE	OWNERSHIP
Power Station (Thermal)	Enugu	Oji River	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Anambra	Ontisha	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Cross river	Calabar	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Rivers	PH	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Delta	Sapele	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Delta	Warri	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Edo	B/c	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Lagos	Ikeja	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Ogun	Abeokuta	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Oyo	Ibadan	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Osun	Oshogbo	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Adamawa	Yola	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Kaduna	Kaduna	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Kaduna	Zaria	NEPA	SERVICES	ENERGY	FEDERAL

Power Station (Thermal)	Kaduna	Kaduna	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Kano	Kano	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Sokoto	Sokoto	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Thermal)	Bornu	Maiduguri	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Hydro)	kwara	Jebba	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Hydro)	Niger	Kainji	NEPA	SERVICES	ENERGY	FEDERAL
Power Station (Hydro)	Plaeteau	Jos	NEPA	SERVICES	ENERGY	FEDERAL

Table 5:INDUSTRIAL INDICES DATABASE

STATE	CAPITAL	NO OF LG	POP EST (1991)	ACC CASES	ARMED ROBB	BANK FRD	CIV STRIFE
Abia	Umaihia	17	2,764,738	230	17	3	Moderate
Adamawa	Yola	20	2,484,483	116			Low
Akwa-Ibom	Uyo	31	2,848,828	342	69		Occational
Anambra	Awa	21	3,306,207	470	265	5	High
Bauchi	Bauchi	20	5,144,092	37	59		Moderte
Bayelsa	Yenagoa	9		271			Very high
Benue	Makurdi	22	3,254,899	800	11		Low
Borono	Maiduguri	27	2,998,256	120	50	1	High
Cross River	Calabar	18	2,259,681	487	73	2	Moderate
Delta	Asaba	25	3,062,676	781	109		Very high
Ebonyi	Abakiliki	12		28			Very low
Edo	Benin-city	18	2,567,910	1966	61	1	High
Ekiti	Ado-Ekiti	16		66			Moderate
Enugu	Enugu	17	3,729,349	151	26		Low
Gombe	Gombe	11		162			High
Imo	Owerri	27	2,938,708	121			High
Jigawa	Dutse	27	3,399,666	202	15		Low
Kaduna	Kaduna	23	4,652,989	987	63	2	Very high

Kano	Kano	44	6,869,582	1,333	39		Very high
Kastina	Kastina	34	4,437,241	295	32		Very high
Kebbi	Birnin-Kebbi	22	2,445,527	70	14		Very high
Kogi	Lokoja	20	2,539,241	288	22		Moderate
Kwara	Ilorin	16	1,830,651	188			Very high
Lagos	Ikeja	20	6,768,670	3,447	226	7	Very high
Nassarawa	Lafia	13		160			Low
Niger	Minna	25	2,862,978	473	1	3	High
Ogun	Abeokuta	19	2,759,109	1,169	129	6	High
Ondo	Akure	18	4,475,316	571	51		High
Osun	Osogbo	28	2,551,522	246	12	1	Very high
Oyo	Ibadan	32	4,082,069	748	78	2	Moderate
Plateau	Jos	17	3,916,187	239	9		Low
Rivers	P harcourt	22	5,095,088	816	173	1	High
Sokoto	Sokoto	22	5,284,984	213	13	3	Moderate
Taraba	Jalingo	15	1,787,794	33	20	1	Moderate
Yobe	Damaturu	17	1,654,816	117	98		High
Zamfara	Gisau	14		61			High
FCT	Abuja	6	439,421	486	14		Moderate

A close look at Table 3: shows that 37 ports exist, from that number (37) 7 (18.92%) ports render both local and international services and the remaining 30 (81.10%) render domestic services only. The entire (37) ports (air or sea) are under government control. This is indicative of the poor attitude exhibited by port workers as a typical Nigerian civil servant is not adequately remunerated. This could possibly give rise to poor performance and collapse of the industry in some cases. Table 4: shows that 21 power stations are in place, out of this number (21) 18 (85.71%) are thermally generated, and the remaining 3 (14.29%) are hydro generated. The generation of power via a modern gas powered plant is still at its infancy in Nigeria. Most of the thermal stations were equipped before the nations independence, as such majority are obsolete and redundant. This is indicative of the present power supply crisis that has become the second nature of the nation. These power crises do not encourage rapid industrial developments, and therefore, adds to the high cost of doing business in Nigeria. Table 5: shows the crime database which indicates the crime levels at various states of the federation of

Nigeria. The table (5) indicates that from the 37 states (Abuja inclusive) accident cases is highest in Lagos State with a figure of 3447, followed by Edo State (1966 cases) down to Taraba State with the lowest figure (33). In terms of armed robbery cases, Anambra State (265), Lagos State (226), and down to Niger State (1). On civil strife is very high in 9 states (24.32%); high in 11 states (29.73%); moderate in 9 states (24.32%); low in 6 states (16.22%); very low in 1 state (2.70%); and occasionally occurs in 1 state (2.70%). Statistically, some of these analyses could be represented as shown below (Figure 2). Hence, one could say that crime has been an obstacle to industrialization in Nigeria. Therefore, security personnel should be located at places where rapid response to some distress calls either from armed robbery attack, fire outbreaks, social upheaval and other industrial calamities. This could be achieved by an up-to-date crime database (containing crime occurrence, position, time, frequency, traffics, etc) via an interactive (dynamic) map.

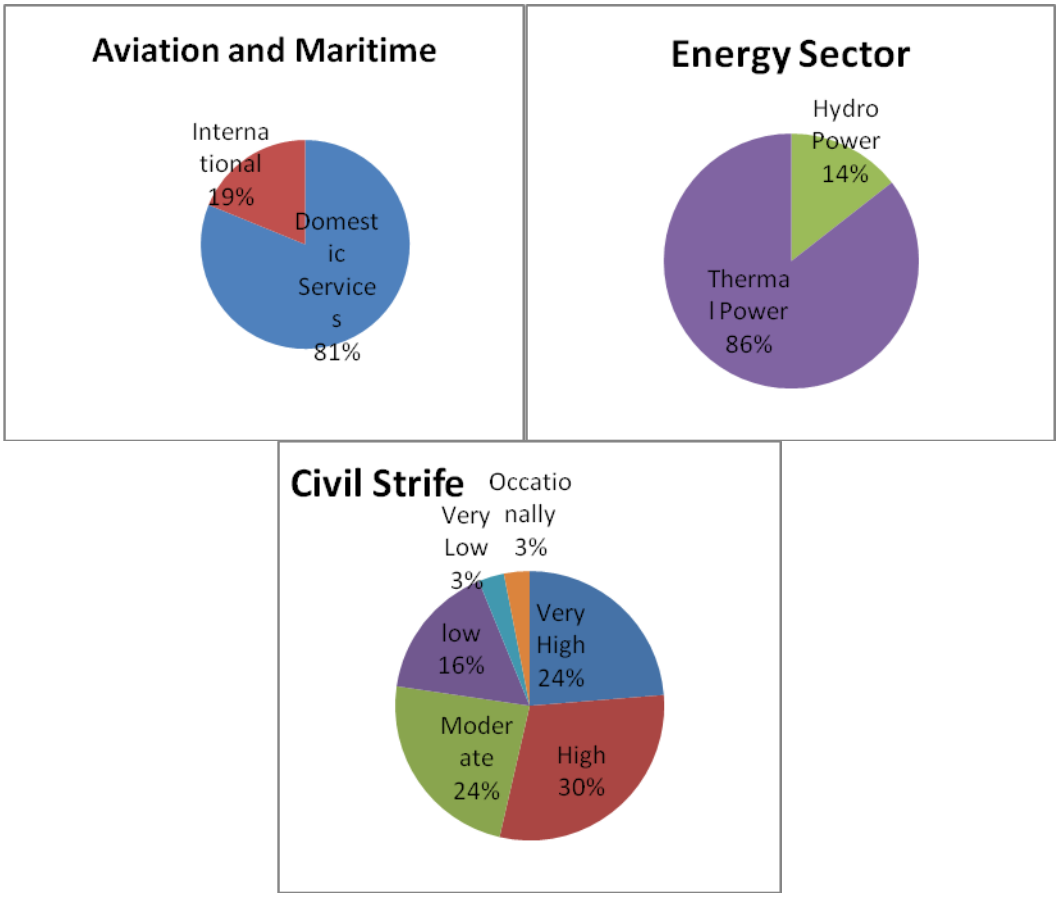

Fig 2: Statistical representation of the outputs of the database table analysis

4.2 **Query results**

The sampled queries on the database using the query (command) builder in the ArcGIS package resulted in the figures 3 –6.

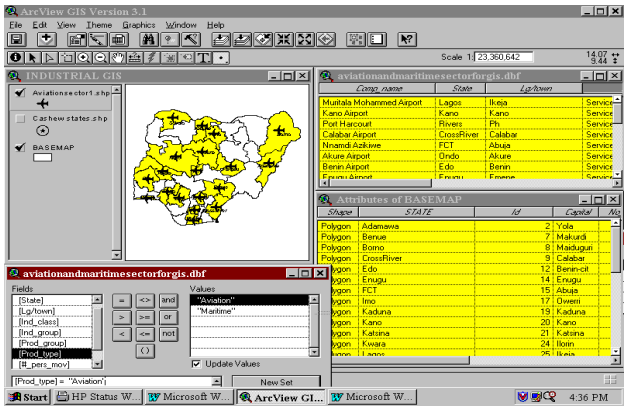

Fig. 3: [Prod_type] = "Aviation" Shows all states that contribute to the Aviation Industry.

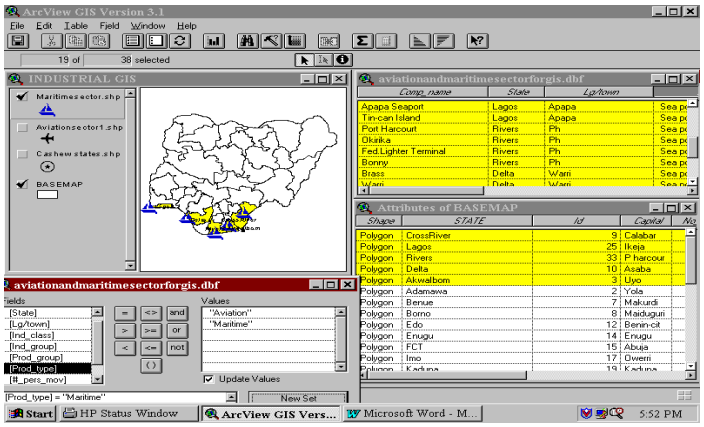

Fig. 4: [Prod_type] = "Maritime" Shows all states that contribute to the Maritimre Industry.

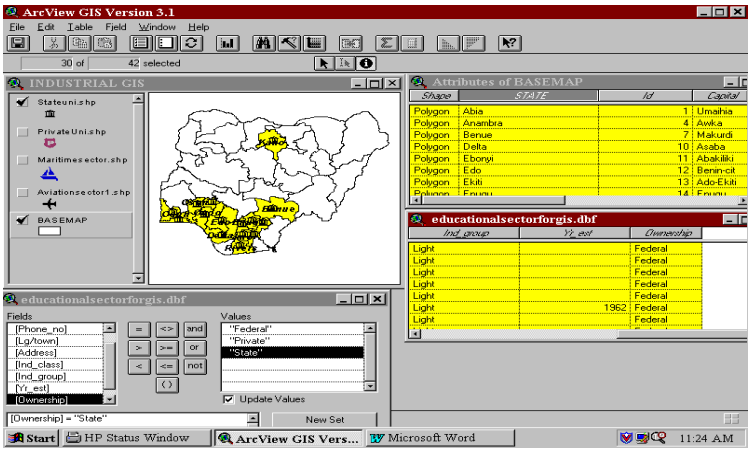

Fig. 5: [Ownership] = "State": this query shows the locations of all state owned universities.

From the GIS analysis (Figure 5), it is evident that 92.00% and 8.00% of state owned universities were located in the southern and northern regions of Nigeria respectively. It is clear from the above data that a greater majority of the past and present generations of the Southern Nigerians were having more access to higher education than their counterpart from the Northern part of the country. The implication means an educational imbalance in the country. Therefore, states concerned should be encouraged to open up universities as necessary. Similarly, 86.42% of privately owned universities have been established in the southern part of the country. This is indicative of the high level of educated youths from that area of the country. This could be linked to the early western influence on the southern part of the country. Further query on [Ownership] = "Private" reveals that 10 years ago Nigeria had only three 3 privately owned universities and all were located at the southern states of the country.

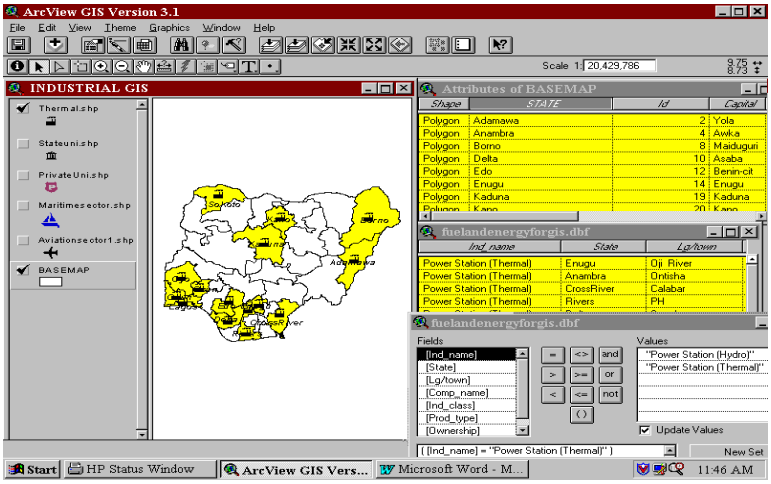

Fig. 6 [Ind_name] = "Power Station [Thermal]" shows the locations of all energy producing stations (thermal power).

Further query equally shows the locations of other energy source (with Hydro Power as the raw material) in 3 states of Nigeria. Several queries such as: [Prod_type] = "Glass" - this query shows the spatial locations of all glass producing industries. Other queries were conducted for palm oil, paper, gum, petroleum refinery, tobacco products, meat processing, fruits and vegetable canning industries. Also, the spatial distribution of all the light industries in Nigerian was shown. It was equally identified from the analysis of the graphic outputs that other possibilities with the GIS tool, such as the assessment of a particular industry (e.g. a manufacturing firm) already established. GIS techniques could also be used to plan for intended expansion by keeping accurate and systematic sales inventory in digital database that may be queried to provide necessary information (e.g. product consumption pattern) as demonstrated by Koronke (1983). Where conflicts as a result of boarder problems and intra ranglings are causing set back in the

development of an industrial potential zone, GIS could be used to proffer solutions.

4.3 **Users interface and data manipulation**

GIS users interface is a normal procedure in accomplishment of a diverse GIS computing process. Since, no single GIS software can take care of all users needs (graphical, data manipulation, or statistical analysis via mathematical computations) the need for user interfaces to bridge any deficiency as a result of this obvious phenomenon. The reason for this obvious deficiency was that the GIS packages were foremostly developed to solve problems in the immediate environment in which they were developed. Therefore, requires some other packages to compliment its effort on another environment. In some cases, despite the prohibitive cost of these packages, some of the modules were never supplied. Instead they were supplied as accessories with extra cost, hence the need for the software to be developed to be compatible to users-tailored interface via optimisation.

5. FINDINGS AND IMPLICATION

The following findings were made in the course of the data analysis and presentations on this study:

1. That about 18.92% of ports in Nigeria renders both local and international services and all are entirely government enterprise. A very minor international "industrial gateway" for potential inventors in-relation to the size and population of the country.
2. Over 85.71% of power stations are thermally generated, and the remaining 14.29% are hydro generated. The generation of power via a modern gas powered plant is still at its infancy in Nigeria. The implication is that most of the thermal stations were equipped before the nation's independence, as such obsolete and redundant resulting in epileptic power supply. Therefore, since power supply and other social infrastructure remains a basic ingredient for rapid industrial development. Therefore, stakeholders are to quickly budget for and provide these facilities.
3. The Lagos State has the highest accident cases among various states of the federation of Nigeria. This is associated to the high concentration of commercial and industrial concerns of Nigeria in Lagos State and its environs. Thus resulting to heavy traffic in the state. Armed robbery cases are very high in Anambra and Lagos States. Thus, genuine investors are discouraged due to perceived insecurity situation. Since crime is an obstacle to industrialization, people charged with national security should be located and relocated at places where they can easily answer some distress calls either from armed robbery attack, fire outbreaks, social upheaval and other industrial calamities. This could be made possible by an up-to-date crime database (containing

crime occurrence, position, time and frequency, traffics, etc) via a dynamic map.

4. That about 92.00% and 8.00% of state owned universities were located in the southern and northern regions of Nigeria respectively. It is clear from the above data that a greater majority of the past and present generations of the Southern Nigerians were having more access to higher education than their counterpart from the Northern part of the country. The implication means an educational imbalance in the country. Therefore, states concerned should be encouraged to open up universities as necessary.
5. That among the complementary database tools, relational data structure is by far more flexible and efficient for interfaces to GIS data processing. Therefore, database creation should remain mandatory to all GIS practitioners, so as to support local or regional spatial and non-spatial information base.
6. That industrial sitting (locations) in Nigeria is inclined to political lines than for more organized economic considerations.
7. Key aspects of computer knowledge in terms of software management are at the critical path. The GIS analysts and other stakeholders in earth resources management are lacking in adequate software development knowledge, such as system programming and analysis, database programming and programming using universal computer languages such as C^{++}, JAVA, VISUAL basic, oracle, etc. Therefore, efforts to develop an Industrial data bank for industries, such as tourism, petroleum, gas, solid minerals, security, manufacturing, etc, must not relent.

6. CONCLUSION AND RECOMMENDATIONS

This paper investigated an improved method of application of GIS to industrial developments in Nigeria. The objective of the study has been to develop the GIS tools for adequate handling of industrial developments issues. The various impediments (political, economic, social, crime, etc) to industrial developments of the country have been identified. Besides, the lack of adequate infrastructure and poor or non existing industrial databank, lack of adequate database creation and software development knowledge among other complementary database tools (such as: relational data structure) that are more efficient tools for industrial planning and management are very crucial, so as to support local or regional spatial and non-spatial information base. Government and non-governmental agencies are expected to embark on joint venture in the "match" to industrially develop Nigeria. Therefore un-necessary political handling of industrial sitting (locations) should be avoided for more organized economic considerations. Infrastructure remains a basic ingredient for rapid industrial development, therefore industrialization stakeholders are to quickly budget for and provide these facilities. Crime has been an obstacle to industrialization; hence, people charged with national security should be located and relocated at places where they can easily answer some distress calls either from armed robbery attack, fire

outbreaks, social upheaval and other industrial calamities. This could be made possible by an up-to-date crime database (containing crime occurrence, position, time and frequency, traffics, etc) via a dynamic map.

Further research work should therefore, make efforts to develop an Industrial data bank for Nigerian industries, such as tourism, petroleum, gas, solid minerals, security, manufacturing, etc. Most of the vital information contained in the databank should be linked to the worldwide web (WWW). This when implemented will add value to commerce and industries in Nigeria.

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