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Analysis of the Spatial Distribution and Characteristics of Petrol Filling Stations in Minna, Niger State

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Abstract

In many developed countries, urban growth has an increased use of automobile manufacturing, in turn influencing the need for fueling services and consequently the construction of petrol filling stations, which lack the minimum requirements for operation according to the DPR criteria for PFSs. The study analyzed the distribution and characteristics of petrol filling stations, which was supplemented using GIS techniques and tools like buffers and the average nearest neighbor tool, and integrated with the physical planning standards set by the Department of Petroleum Resources (DPR). However, names and street addresses of the PFSs were obtained from through field observation. Maps, field observation, and satellite images were used to collect locational information about the area. The result indicates that there are 79 petrol filling stations located in the Minna metropolis. Premium Motor Spirit (PMS) is the major product traded by the stations; the overall pattern of the distribution of PFSs in the area is clustered where the z-score is -7.864847 and the pvalue is 0.000000 as the Nearest Neighbor index is <1. The major factors governing the spatial distribution and characteristics of filling stations are the traffic flow and exit site from the city, which are part of the owner‘s preference. However, most of the petrol filling stations had not satisfied the minimum requirement of 1089 m² land area, 50 m set back

from the nearest residential structures representing 25.3% and (20.8, 32.1, 29.2%) respectively. Also, many stations had not met the criteria of 400 m minimum distance to other stations on the same axis, representing 84.8%. The study concluded that the substandard requirement of PFSs in the study area poses threats on the health and safety of users and residents in the vicinity and environs. Based on these findings, it is recommended that the regulatory agencies take proactive planning measures and integrate GIS in a manner that ensures that filling station operators comply with the standard.

Keywords: Analysis, Spatial Distribution, Characteristics, Petrol Filling Stations, Minna.

Introduction

The advancement of technology in the automobile industry has a significant influence in the petroleum industry which also propelled the building and redevelopment of petrol service stations (petrol filling stations) at strategic locations to meet the demand of vehicular operations (Abdul *et al*., 2009). Petroleum products have played more significant roles in the country's economy. Chinambu (2011) acknowledged that petroleum is the key driver of industrial activities. Studies have shown that a petrol filling station is a facility where fuel and lubricants for automobiles are sold (Sangotola *et al.*, 2015). Petrol filling stations are installations that sell petrol (PMS—Premium Motor Spirit), diesel (AGO—Automobile Gas Oil), and kerosene for public consumption; however, some are incorporated with other land uses (Mshelia *et al.*, 2015). In recent times, there has been a sustained increase in the number of petrol stations established in different parts of the country. The reasons for such unprecedented increase include: the growing number of population in the country influencing the attendant increase in the purchase of vehicles, the attractive price of petrol both at control price and black market prices which made more people to go into the petrol retailing business (Uchegbu, 2002). However, many marketers take advantage of this need and build service stations haphazardly without giving consideration to the possible effect of the location of the service stations on other land-use determinants. It has now generally been recognized that economic development can be a major contributing factor to growing

environmental problems, particularly when such development is not sustainable to adjoining land use (KASUPDA, 2009). The increase in human population globally is a causal factor for the increase of automobiles as such an influential factor in the petrol filling stations, which provide fuel and lubricants on which automobiles run (Afolabi *et al.*, 2011). This prompts the need for control and management of future development of petrol filling stations (Ministry of Housing and Lands, 2012). This form of land use has socio-economic and environmental impact either negatively or positively on the society which includes provision of convenient goods and services, business opportunities and competition between petrol filling station, leakage of fuel on surface and ground water thereby leading to pollution, pollution of storm water runoff also result in pollution of the immediate environment, generation of traffic and risk of explosion due to the flammable nature of petrol (Weyer, 2011). In the Petroleum Act of 1969, some of the regulations stipulated to avoid and mitigate the negative impacts of petrol filling stations include ―employees hired on a site shall be educated on how to utilize the fire-fighting equipment,‖ directives to employees in case of fire shall be clearly and concisely expressed and prominently displayed,‖ and "no smoking" symbols shall be posted as needed in restricted areas,‖ etc.

Most of these petrol service stations sell petrol, diesel, and kerosene. PFS are characterized in terms of locational optimization by population and service it renders, such as automobile repairs, car washes, and mini shopping complexes. Filling stations highly contribute to traffic problems such as traffic gridlock, pollution, fire, and explosion in most cases in urban settlements in Nigeria (Ayodele, 2011). As documented in Mohammed, Musa and Jeb (2007), it is recommended by DPR provides certain standard for PFS and should be sited away from usual human traffic, secluded from entrance of buildings and also public congregation place; however, petrol filling stations are distributed haphazardly due to the corollary of the lack of development control and non-conformity with planning standards in urbanized settlements. Though, planning oddities are expressed in poor sitting, inadequate size of land allocated, limited set back from other land use like residential property, road and poor radius allowance from major facilities like worship place and school (Mohammed *et al*, 2007). This culminates in environmental hazards and disamenities such as traffic congestion, fire, pollution, and many problems resulting from uncoordinated development. The Minna metropolis is a developing urban city, considering its expansion had also witnessed the proliferation of PFS, most of which are poorly sited and essentially

disregard to planning standards. This study is also borne out of the non-existence of spatial data in respect of petrol filling stations in the area, as no study has been conducted in this regard. Presenting information on the pattern of distribution of petrol filling stations in Minna metropolis is required given the city‘s rapid spatial growth. The primary goal of this study is to close the gap by analyzing the spatial distribution and characteristics of petrol filling stations in Minna metropolitan area. It also examines the conformity and extent of adherence of distribution with physical planning regulation. It further looks at the effects on adjoining land uses. By means of preemptive and counter-planning measures, Minna can optimize its economic benefits while averting possible menace arising from planning standards and managing its development in Minna.

Literature Review and Conceptual Framework

The debate on the theoretical exposition begins with the obnoxious facility location model, which categorizes facilities into desired and undesired, with desired facilities placed in close areas and undesired facilities in nearby areas. The location of a petrol filling station is a significant issue, requiring consideration of population, distance, and time for drivers to slow down (Rana and Garg, 2014).

Due to the need for software with intuitive user interfaces, the use of GIS in spatial analysis has grown in popularity in recent years. Research has demonstrated that GIS has a significant influence on the locational analysis of gas stations in urban areas. According to Camellia (2010), drivers in Abidjan look for solace in locating the closest gas station that appears to be accessible. The integration of GPS and GIS technology for database and digital mapping for effective and efficient information management served as the foundation for Emwandongo's (2013) research. However, it was shown that GIS-based technology was capable of analyzing the spatial distribution of service utilities such as PFS in a study carried out in Kaduna by Ayodele (2011). However, this study represents the initial attempt to use the application. According to Mohammed et al. (2007), location science dates back to Pierre de Fermat and his contemporaries, including Battista Cavallieri (1526–1597) and others, who theorized the Euclidean spatial median problem in the early seventies. Alfred Weber's theory sometimes referred to as the location triangle for industrial location, states that the best place to produce a good is where the point of production is closest to the market and the source of raw materials. Centrality is the quality and accessibility of being at the center of the transportation system (Inyang and Ogbonna, 2001). However, the model for the location of

annoying facilities was based on what was wanted and what was not, with facilities in livable areas being considered desirable and others capable.

METHODOLOGY

Minna is a city in the west-central Nigeria predominantly occupied by the major ethnic groups Hausa, Gwari, and Nupe. It is the capital of Niger State and the headquarters of Chanchaga local government since the creation of Niger State in 1976. It has an area of 884 hectares and a population of 304,113, with an estimated 513,491 by 2024. It is located on longitude 6o 33‘ 26‖ of the equator and latitude 9o 36‘ 45‖ of the Greenwich meridian. It houses all of a full-fledged local government's administrative and operational needs as the municipal council's headquarters. Minna extends from the North by its boundary with Bosso local government at 8 km and from the centre of the town is the Obasanjo shopping complex roundabout, and finally bounded on the east, south, and west with Bosso extensions (Census, 2006).

The sample population of this research is 79, which is the frame of all the petrol filling station in Minna metropolis of Niger state, as it includes the attendant of the each PFS. Since the population is of a high number, the entire population size would be used as it includes three (3) respondents (attendant) at each petrol filling stations therefore the population size of the respondents at the petrol filling stations is 237.

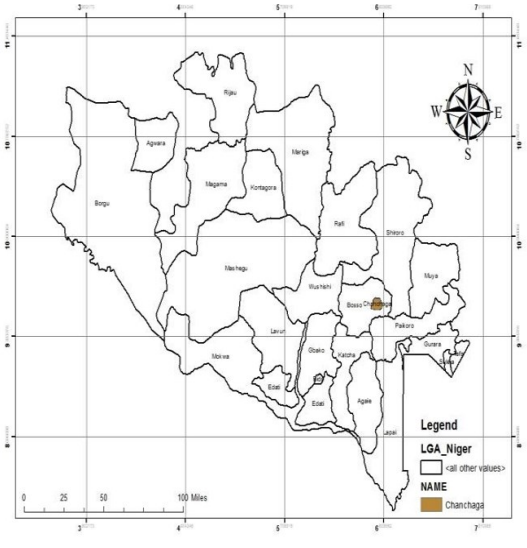


Figure 1: Map of Niger State showing The study area.



Figure 2: The study area

Objectives	Data Required	Instrument for collecting data	Methods of data analysis	Data presentation
To identify the existing spatial distribution and its characteristic pattern of PFSs.	Location; Number of pumps; Year of existence, Types of services	Physical Observation and use of GPS	Descriptive Analysis	Table, graphs and map
To assess the factors responsible for the pattern of distribution	Ownership preference, Socio- economic activities,	Questionnaire administration and Observation	Descriptive Analysis	Table, graphs and charts
Examine the effects on adjoining land use	Frequent free vehicles bottlenecking etc.	Questionnaire administration and Observation	Descriptive Analysis	Tables and charts
To determine the conformity and extent of adherence to planning regulation	Distance and Geographical Coordinates; Documented Standard for PFSs	Global Positioning System (GPS), measuring tap, and physical observation	Systematic approach using GIS (ANN)	Maps

RESULT AND DISCUSSION

Identification and Mapping of all the Petrol Filling Stations in the Study Area

Table 1, presents comprehensive coordinate of PFS captured with GPS and GIS was used to mapping; it is evident that there are 79 petrol filling stations in the study area as it can also be seen in figure 3 according to road/spatial distributions. However, out of these petrol filling stations, 5(6.33%) are yet to be fully constructed, 14(17.72%) have become abandoned whereas 60(75.95%) are fully functional.

Furthermore, the result of the transition mapping in figure 3 shows that PFS are majorly sited along major roads exit and entrance of the study area which cause environmental / traffic gridlock as some are isolated posing no threat to adjoining land use.

Table 1: Location, Status Geographic Coordinates of petrol Filling Stations

S/N	Name of Filling Stations	Location	Status	Easting	Northing
1.	Total	Chanchaga / City Gate Road	Functioning	232460	1061516
2.	Bovas	Chanchaga – City Gate road	Functioning	232472	1061474
3.	Conoil	City Gate Road	Functioning	232472	1061474
4.	Mubashir Investment LTD	Shango Road	Functioning	232909	1060378
5.	Asio and Sons Nigeria LTD	Shango Road	Abandoned	233095	1059878
6.	Azman Oil and Gas LTD	Shango Road	Abandoned	233187	1059683
7.	Saba Investment LTD	Shango Road	Abandoned	233213	1059662
8.	NNPC	Shango Road	Functioning	233495	1059013
9.	Oando	Western bypass, tunga	Functioning	233531	1059163
10.	Matrix	Western bypass, tunga	Functioning	233169	1059979
11.	Etasha Commercial Cons. Company	Opp. NECO, Dutsen kura	Functioning	232891	1059929
12.	NAPL	Off Nnamdi Azikwe Road	Functioning	232649	1059941
13.	NNPC	Western bypass, tunga	Functioning	232441	1059780
14.	Total	Western bypass, tunga	Functioning	232399	1059846
15.	Mobile	Western bypass, tunga	Functioning	232361	1059747
16.	Oando	Western bypass, tunga	Functioning	232218	1059811
17.	Gura Nigeria LTD	Western bypass, tunga	Functioning	232117	1059801
18.	Mobile	Bosso road	Functioning	231423	1060081
19.	Garima	Tudun Fulani	Functioning	231087	1060287
20.	Garisco Investment LTD	Tudun Fulani	Functioning	231039	1060314
21.	U.S Koko	Bosso road	Functioning	230936	1061558
22.	Gajere	Western bypass, tunga	Functioning	230974	1061615

23.	South Gate Investment LTD	Western bypass, tunga	Abandoned	231562	1062209
24.	Forte Oil	Western bypass, tunga	Functioning	229071	1062648
25.	A.A Butu and Sons Nigeria LTD	Tudun Fulani	Functioning	228934	1062649
26.	Ofyelagyi Petroleum	Tudun Fulani	Abandoned	228921	1062784
27.	Total	kafinTella	Functioning	228885	1062897
28.	Alh. Abdulkadir and Sons	kafinTella	Abandoned	228829	1063145
29.	Under construction	Dutsan Kura	Under construction	228909	1063468
30.	First El-Shabab Nigeria LTD	Western bypass	Functioning	228768	1063465
31.	Hajaratu Global Service LTD	Western bypass	Functioning	228731	1064337
32.	Nasfa Global Concept LTD	Western bypass	Abandoned	227531	1064460
33.	Salihi International Company LTD	Angwuan – Biri area	Functioning	226829	1065748
34.	First El-Duniyah Oil and Gas LTD	Angwuan – Biri area	Functioning	229716	1066805
35.	I.P Oil Company Nigeria LTD	Angwuan – Biri area	Functioning	229780	1067382
36.	Abu Hafsah Global Vent LTD	Angwuan – Biri area	Functioning	229912	1067342
37.	Under construction	Angwuan – Biri area	Under construction	229937	1067281
38.	One Links	Bida road	Abandoned	230174	1067122
39.	Under Construction	Bida road	Under construction	226565	1066555
40.	Muhabat Tunga Global Resource	Bida road	Functioning	226741	1060366
41.	Aug Petroleum	Bida road	Abandoned	226804	1060455
42.	Baura Global co. LTD	Bida road	Abandoned	227415	1060635
43.	Total	Bida road	Functioning	227799	1061110
44.	Jibeco Nigeria	Bida road		227895	1061374
45.	Adamu Iliyasu Petroleum Nigeria	Bida road	Abandoned	228449	1061407
46.	A.A. Rano Nigeria LTD	Bida road	Functioning	228579	1061592
47.	Aliyu Shehu Petroleum LTD	Bida road	Functioning	228629	1061637

48	Oando	kafinTella	Functioning	229209	1061656
49.	A.Y.M Shafa	kafinTella	Functioning	233791	1061774
50.	Reflex Oil and Gas Nigeria LTD	kafinTell a	Functioning	233813	1061074
51.	Solex Petroleum	Radio Niger Road	Functioning	233844	1061264
52.	A.S Petroleum	Radio Niger Road	Functioning	233757	1061447
53.	NNPC	Radio Niger Road	Functioning	234565	1061802
54.	A.A Erena	Radio Niger Road	Functioning	234503	1065302
56	NNPC	Radio Niger Road	Functioning	234461	1065872
57.	Garima Petroleum	Radio Niger Road	Functioning	234444	1065841
58.	Raji Petroleum	Radio Niger Road	Abandoned	234500	1065941
59.	Unibros Global	Maikunkele Road	Functioning	233239	1066001
60.	Conner Stone Oil CST	Maikunkele Road	Functioning	233126	1065645
61.	Muhabbat Tunga Global Resource	Maikunkele Road	Functioning	232432	1065523
62.	E.C.E Resource Nigeria LTD	Off Bosso Road	Functioning	232420	1065199
63.	First Jaaz Global Resource	Bosso Road	Functioning	232450	1065162
64.	Murmusa Nigeria LTD	Adjacent OBJ Compex	Functioning	232283	1065150
65.	First Al-Fijir Drime Concept LTD	Opp. OBJ Complex	Functioning	231036	1064878
66.	Forte Oil	Opp. OBJ Complex	Functioning	230747	1065560
67.	Total	Chanchaga Road	Functioning	230779	1064180
68.	AYM Shafal	Opp. Mobil Roundabout	Functioning	230787	1064034
69.	Conoil	F‘ Layout Road	Functioning	230984	1063972
70.	Mobile	Bahago Drive	Functioning	230880	1063924
71..	Underconstruction	Bosso Road	Underconstruction	234322	1063557

72.	Underconstruction	Western bypass Road	Underconstruction	233148	1063888
73.	S. Turke	Western bypass Road	Functioning	230169	1065126
74.	Gingah Oil Investment LTD	Western bypass Road	Functioning	228350	1066556
75.	Ashrab Energy Investment LTD	Kpakungun Road	Functioning	228917	1068845
76.	Matrix	Kpakungun Road	Abandoned	228111	1063460
77.	Total	Kpakungun Road	Abandoned	227415	1061396
78.	Mbel	Kpakungun Road	Functioning	231378	1061106
79.	Danmarna	Kpakungun Road	Functioning	232714	1060104

Source: Researcher Survey 2018

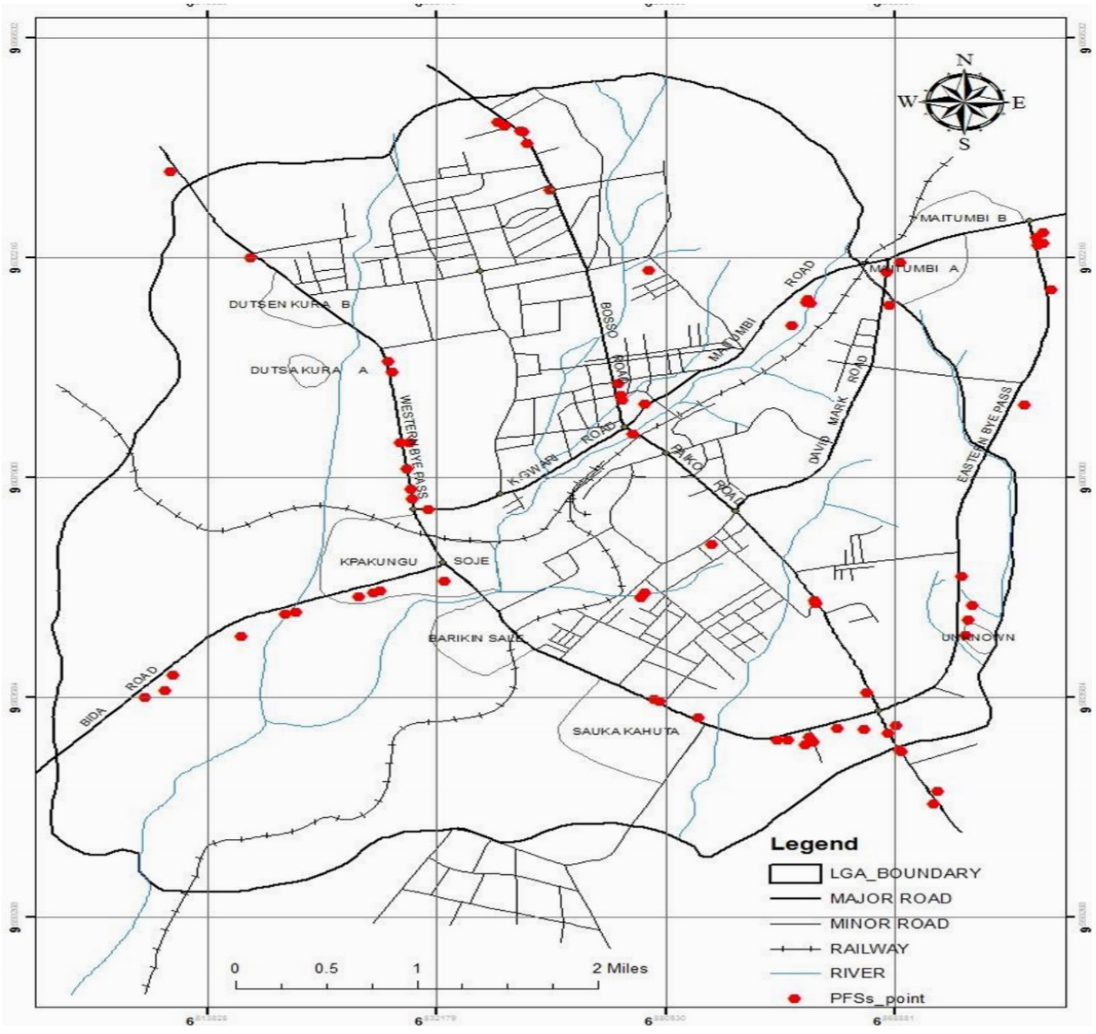


Figure 3: Spatial distribution of Petrol Filling Station in Minna Metropolis (Researcher Analysis, 2018)

Land area coverage of PFS

Illustrations and result analysis for land area coverage or size of PFS as seen in figure 4, reveals that 59 stations (representing 74.5%) of the 79 PFSs in the study area falls within the planning regulation of the DPR stipulation of 1089m^2 for PFS as 20 station (representing 25.3%) has less than the stipulated standard for PFS, thus increasing and posing problems to owners, user and other alike due to the unsuitable nature. The numerous nuclei theory like obnoxious facility location model that emphasis on desired facilities, postulates that siting of PFS have multiple development points from which its radiates, appears to be supported these data. However, one could argue that, among the 25.3% spread of PFS in the study area can cause environmental mishap.

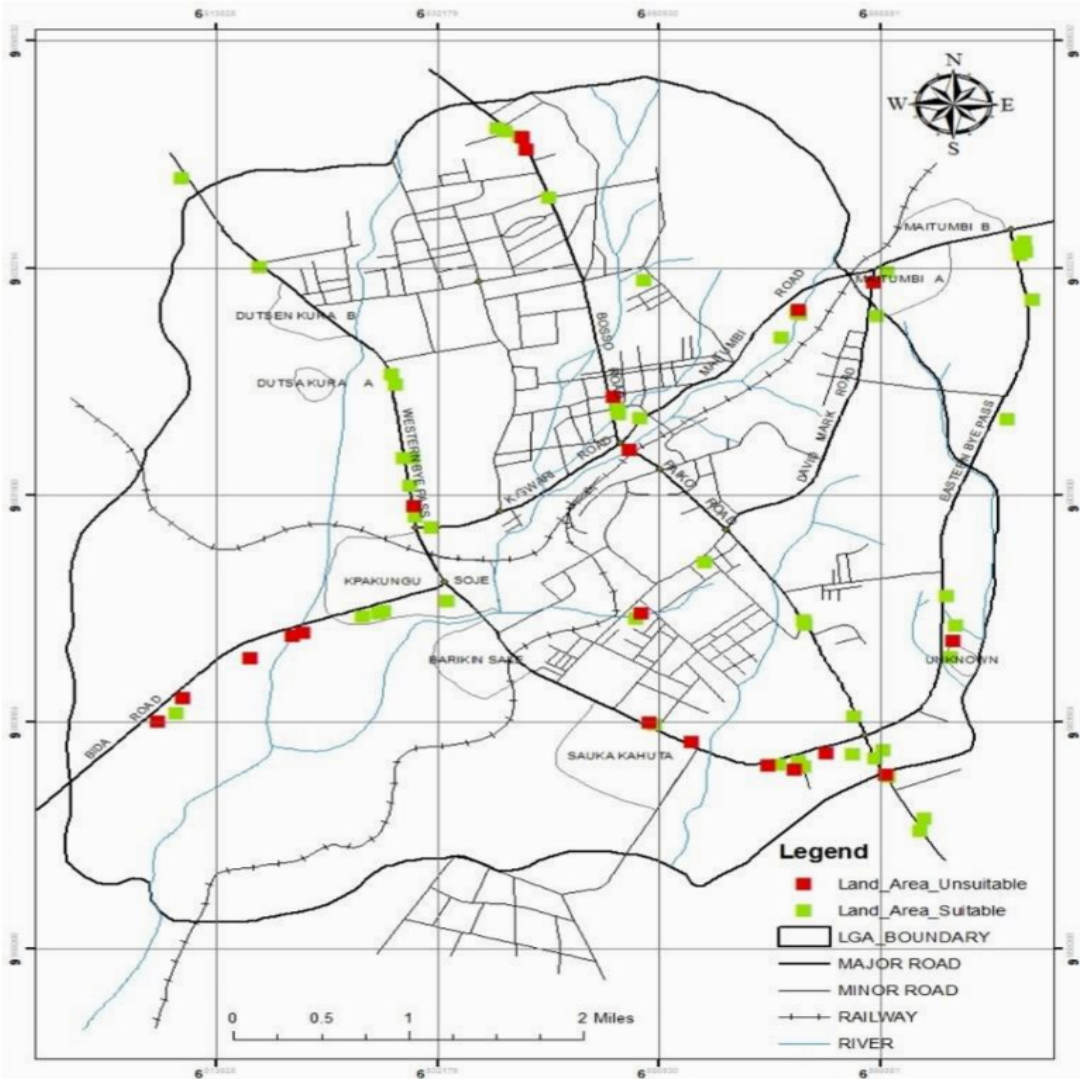


Figure 4: Standard and Sub-standard land area of PFSs
Researcher Analysis, 2018

Distance between Residential Land uses to PFS

Table 2, presents that are there more structure within the 50 metres radius of all petrol filling stations in Minna metropolis, of which it ranges from 77 (representing 32.1%) of six to ten metres and 3 (representing 1.6%) of twenty-one above metres, i.e. residential structures in the study share almost the same boundary with the petrol filling stations of which most do share such as 50 (representing 20.8%) of zero to five metres which is not in line with the regulation of DPR Decree 37of 1997 stating that PFS should be sited fifty metres away in all angles of built-up areas to create a buffer zone.

Table 2: Distance between the nearest Structures to PFS

Distance (m)	Frequency	Percent (%)
0-5	50	20.8
6-10	77	32.1
11-15	70	29.2
16-20	37	15.4
21- above	3	1.6
Total	237	100.0

Researcher computation (2018)

Figure 5: the outcome displays integration of planning regulation standard of 50 metres on which 90 percent of PFSs did not meet the criteria, thus increasing vulnerability of dwellers on risk associated with PFS. This further shows the non-adherence of developers and planning agency enforcement of standard.

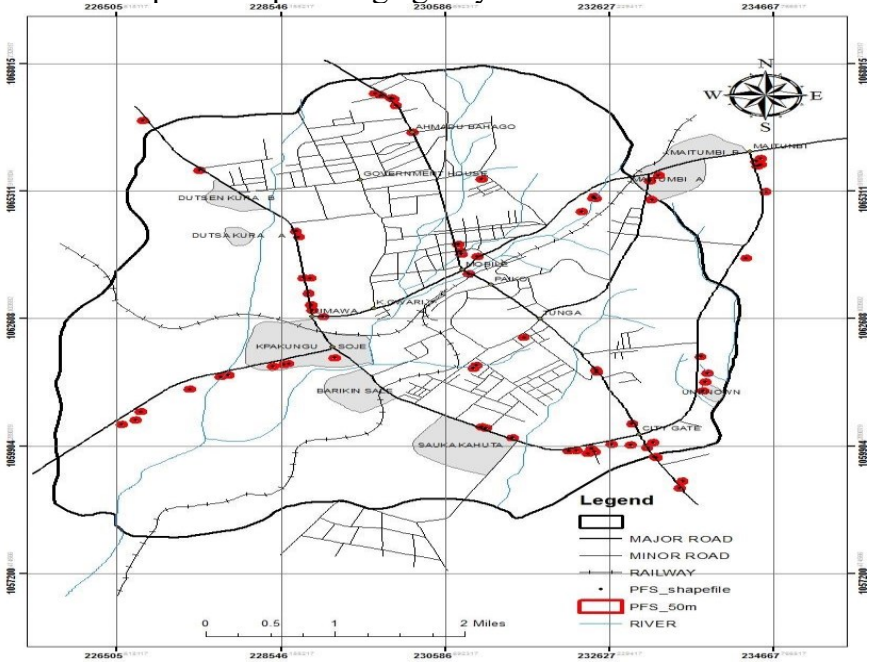


Figure 5: Buffer zone of 50 metre of PFSs to nearest structure

Researcher Analysis, 2018

Distance between two PFSs

The Department of Petroleum Resource act specified a standard distance of 400m as minimum interval between two PFSs on the same axis. The result analysis as integrate of the 400m PFS buffer as seen in figure 4.4 that only 12 (representing 15.2%) that falls within the range of DPR standard regulation as 66 PFSs (representing 84.8%) were below standard which implies that they are significantly clustered and can cause traffic gridlock under scarcity circumstances.

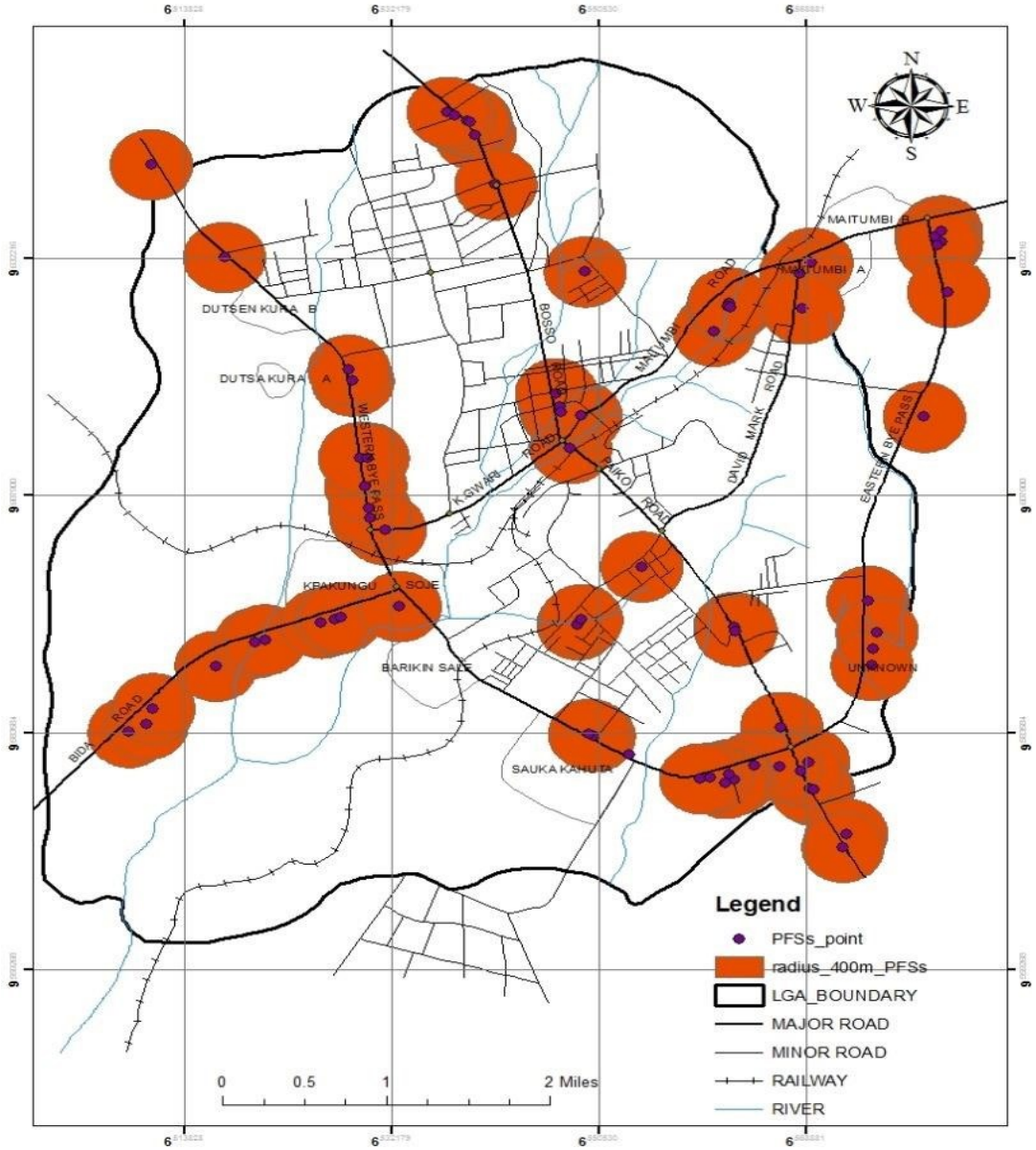
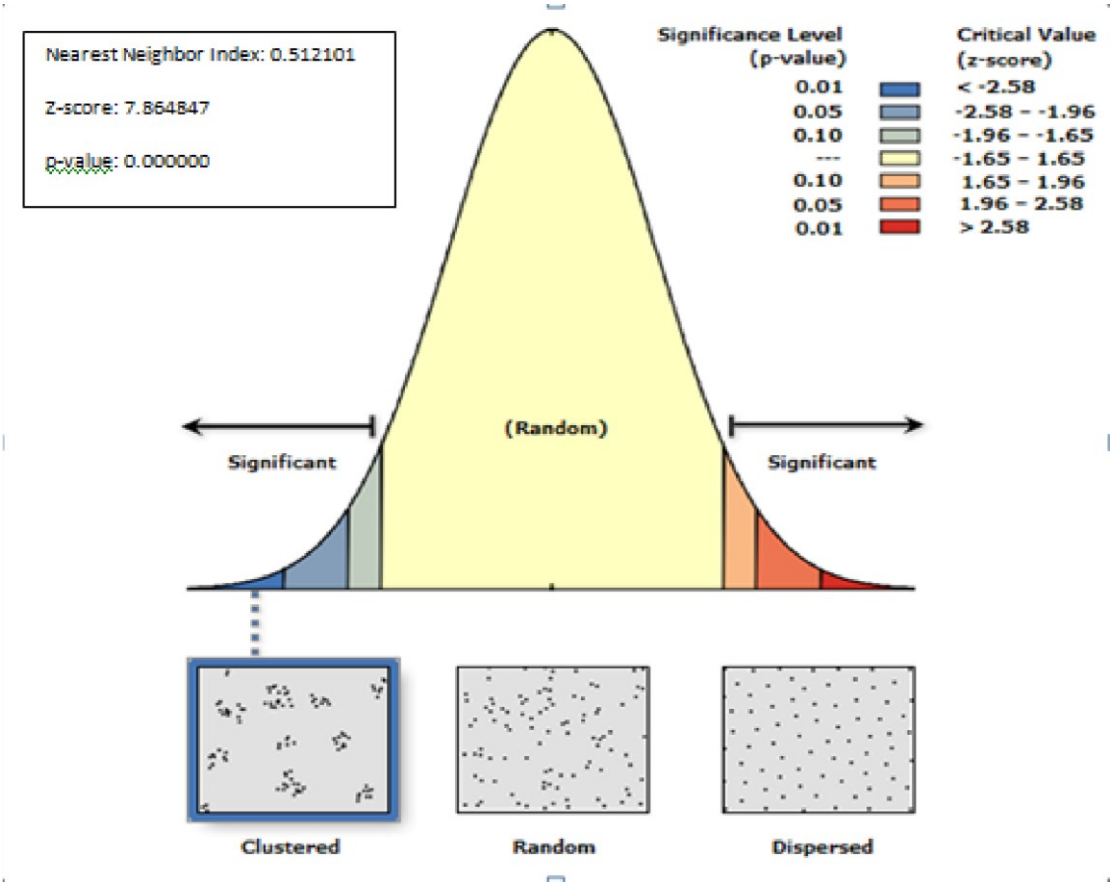


Figure 6: Buffer of 400m minimum interval between two PFSs
Researcher Analysis, 2018

Spatial Relationships on Pattern Distribution of PFSs

To determine the relationship of PFSs as to examine the nature of cluster in the area, PFS features were used. Figure 4.5 reveals the ANN analysis result as z-score is given as 7.864847 and p-value 0.000000; however the low value shows that the pattern of distribution of PFSs in the study area is significantly clustered. As the Nearest Neighbor index is less than 1 (0.512101), a pattern that reveals the clustering nature of PFSs as thus a little probability of that the features (PFSs) are randomly distributed



Given the z-score of -7.86484747678, there is less than 1% likelihood that this clustered pattern could be the result of random chance.

Figure 7: Spatial pattern of PFSs in Minna metropolis using Average Nearest Neighbor Researcher Analysis, 2018

CONCLUSION

From the foregoing, it is evident that all parameters for spatial distribution in the appropriateness of petrol filling stations are critically considered; little or none of the petrol filling stations in the study area will stand a chance of approval. It is also

important to note that their characteristics in terms of development hamper their functionality and are therefore an indictment of the agency responsible for managing spaces in the study area. The study recommends a moratorium on the approval of petrol filling station within the fully developed road corridors and other land use within the study area, as shown by the evidence that petrol filling station have greatly flouted planning standards the area. Certain standard discrepancies were spotted in the course of this study. For instance, while the DPR standard recommends a buffer of 50 meters and 400 meters from the nearest neighbor and other PSFs, respectively, which is in line with the Niger State Urban and Regional Planning Law of 1989 as amended in 2020. The study recommends that it should be made compulsory that a minimum of 400 m should be observed from one PFS to another so as to mitigate traffic gridlocks and increase convenience. It also recommends the need for more pro-activeness and effectiveness in the development control activities of the planning authority under whose jurisdiction the study area falls.

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Assessment of Geo-Spatial Tourism Facilities on Sustainable Development in Jos North Local Government Area of Plateau State

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Abstract

The study assessed Geo-spatial tourism facilities on sustainable development in Jos North Local Government Area. Specific objectives are to generate maps of public and private tourism facilities and to assess the location and the spatial distribution of the tourism facilities, determine the pattern of tourism distribution in the study area, model the accessibility to tourism facilities, and identify a suitable location of tourism facilities in the near future. This was carried out through the use of GIS to show the pattern of distribution of tourism facilities. A total of 30 tourism sites were considered at random. This includes accommodation, lakes, museums, parks and gardens. The finding reveals, spatial distribution of the tourism facilities on the plateau, the ownership of the tourism facilities and the pattern of distribution of the tourism facilities, that basically means they are mostly clustered, that they are owned by the government and the private sector, while the government tourism facilities it are 8 in number, that of the private facilities are 22 in number out of the 30. This suggest that government has little or no interest in tourism, while the private see tourism as a profit making ventures, that their pattern of distribution was found to have a spatial agglomeration pattern and an uneven distribution within Jos North Local Government, convention facilities and tourism were

closely spatial related, where facilities are scattered over space and linear, where facilities development follow straight line pattern usually along important roads. It is therefore, recommended, that the potentials of GIS as an analytical tool can be utilized to determine and measure access to tourism facilities, that all archived data in the tourism ministry's be updated, digitized and geo-referenced. That there is urgent need to train more experts in the field of tourism provision in the art of spatial data acquisition and management, this would increase the opportunities to realized the full social and economic potentials of the tourism industry. Sustainable tourism development creates the opportunity for government and all stakeholders in the tourism sector to aim at ensuring long-term prosperity and quality of life for future generation. Sustainable tourism development also creates opportunities to preserve natural and cultural heritages of tourist and local people in ways that address development problem and reduce risks to the environment and ways of life.

Keywords: Geo-Spatial, Tourism Facilities, Sustainable Development Sustainable Development, Jos North, Spatial Distribution.

Introduction

Background to the Study

Tourism industry is the biggest and largest industry in the world that is fast growing, tourism right now is a business institution that gives place for events to people when they want to relax or when they are on holiday. However, tourism is originally seen as sightseeing and for relaxation, with tourism effect, its basically a way of bringing people together from different parts of the word, by mutual interactions, apart from sightseeing and interactions, tourism also influences wealth creations and its a means of modifying values and behaviors, with the effects of behavior and values modification in way of enhancing social relationship among the visitors and the locals, this influence gives an impact on societal change, it has been proven by different authors that there is a big empirical evidence that exist between the society and tourism as a whole.

Tourism developments as a multidisciplinary nature influence the culture and other areas of the society (Bhatia, 1993). Tourism as a whole involve the activity of travel from one destination to another, visiting places, lodging in a hotel because tourism provides accommodation for guests and

also tour guides, with all these mentioned above, tourism industry has gone above buying and selling of gift items and aesthetics.

Tourism is defined by the world tourism organization (NSCB, 2004), as the act of travelling for the purpose of recreation and the provision of services for this act. It further explained that a tourist is someone who travels at least eighty kilometres (fifty miles) from home for the purpose of recreation. To an ordinary man on the street, tourism could be seen as just that act of visiting places for the purpose of sightseeing and enjoyment. But in real sense tourism is more than just sightseeing, tourism involves people travelling to a staying in place outside their usual locality or environment for not more than one consecutive year for business leisure and other purposes that relate to exercise of an activity reward from within the place visited.

Tourism is a major revenue generation sector that has not been fully harnessed in Nigeria. This is because we have failed to see the potentials in the tourism industry. Adedunrin (2002), proved through a research that tourism alone if its properly harnessed could earn the nation more than what the nation is currently earning from crude oil, Nigeria as a developing country in West Africa has much potentials of rich tourist attractions as it is blessed with a number of tourist attractions centres situated in hole of the country in the 36 states of the federation and the federal capital territory (FCT) Nigeria over the years has taken some bold steps to diversify its mono-cultural economy through the promotion of tourism. Some of these measures include the adoption of the National Institute for hospitality and Tourism (NIHOTOUR) in Bagauda Kano, and the National Travel Bureau (NTB), a tour operating company of NTDC, the adoption of a tourism master plan and the inauguration of the National Tourism Council with the president as the chairman (Ayeni, 2012).

The effort Government is putting in place will have just been a waste if the data of these tourist attraction centres were not properly captured, effectively stored updated and presented in a way that the tourist will understand. This information can only be generated, sored, updated, analysed and presented by information systems which is capable of managing spatially Geo-referenced data.

Geographic Information System (GIS) offers itself as a tool that support and helps stakeholders in the tourism industry to ensure a speedy and up-to-date production of tourism map, performs queries and analysis on complex and very large volume of spatial and non-spatial tourism data.

Statement of the Problem

Several problems have militated against the growth and development of tourist industry in Nigeria. It is quite obvious that since the discovery of oil (black gold) in the 50s, all eyes were only focused on petrol dollar. The easy money from oil which accounted for more than 90% of gross national income, any other sector of the economy was taken for granted. The money from oil was so huge in the 70s that it was said that the problem of Nigeria then was how to spend the money available. Of recent though, tourist industry has been receiving government attention, but the political will to set the ball rolling had been the greatest impediment. In Nigeria, government employment most often, are regarded as a share of national cake as no one is prepared to bake. Most people are employed in government service not that the individual is qualified, but based on Quota system that enable the federating state to bring individuals to fill vacant position not on merit. In Nigeria, federal characters, Quota system, Educational dis-advantaged areas; people with special consideration and Nepotism are some of the qualifications for employment and therefore tourist industry have had its fair share of those mundane considerations that have hindered its growth.

Many studies have addressed the recognition of tourism impacts when tourism is being evaluated. Mettueson and Wall (1982) suggested conceptually that tourism development generated economic, physical, and social impacts in the destination area. Liu, Sheldon, and Var (1987) justified the economic benefits and the cost of social, cultural and environmental impacts of tourism. There are a number of tourism facilities in Jos the Plateau State capital, but it has not been established whether these tourism facilities are equally distributed in terms of accessibility. The basis of the study is to establish whether these tourism facilities are adequately and equally distributed within the reach of the dwellers in the study area.

Finally, finance is another area of concern. The period of honey moon is over when money was not our problem but how to use it. Some politicians have shamefully siphoned the common wealth of the nation that salaries of over bloated, civil service could no longer be paid and woo of tourist industry continue to nosedive to the detriment of the common man.

Objectives of the Study

The broad objective of the study is to assess the spatial distribution of tourism facilities on sustainable development in Jos north LGA of Plateau State. The specific objectives are to:

i. Generate map of public and private tourism facilities and to assess the location and the spatial distribution of the tourism facilities.
ii. Determine the pattern of tourism distribution in the study are;
iii. Model the accessibility to tourism facilities and;
iv. Identify a suitable location of tourism facilities in the near future.

Study Area

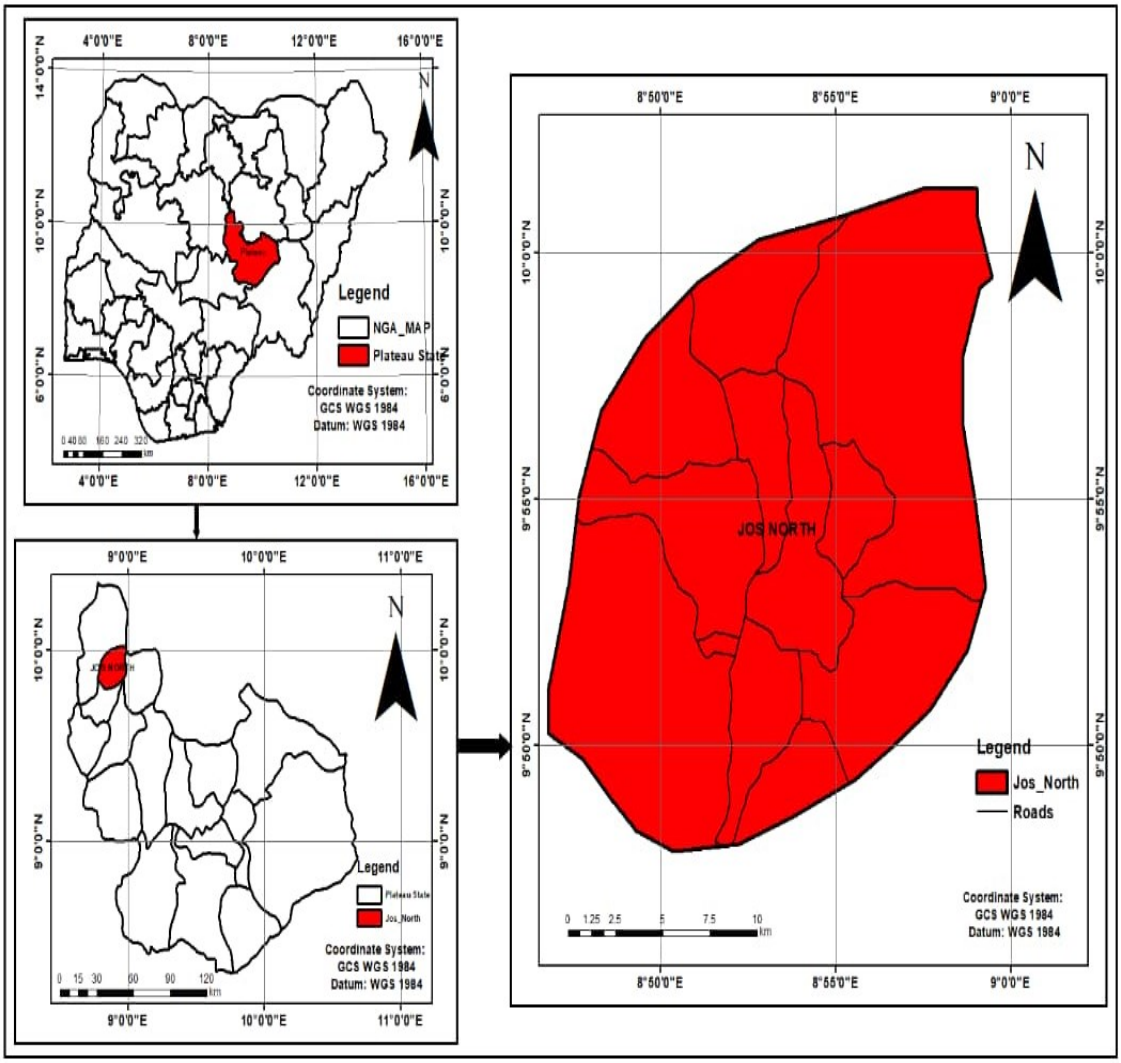


Figure 1: Map of Nigeria Showing Plateau State
Source: Ministry of Land Survey and Town Planning, Jos, Plateau State

Location and Size

The study area covers 2 L.G.A (namely Jos north and Jos south).Jos north has an area of 291 square km and a population of 492,300 at the 2006 census. Whereas

Jos south has an area of 5104 square km and a population of 306,716 at the 2006 census. Jos north lies on a geographical coordinates of latitude 9° *55"* N and longitude 8° *54"* E whereas, Jos south lies on latitude **90** 46" N and longitude 8° 48"E. It is called the Jos greater metropolis because of the developmental pattern and the urbanizing stretched linking the two local government areas.

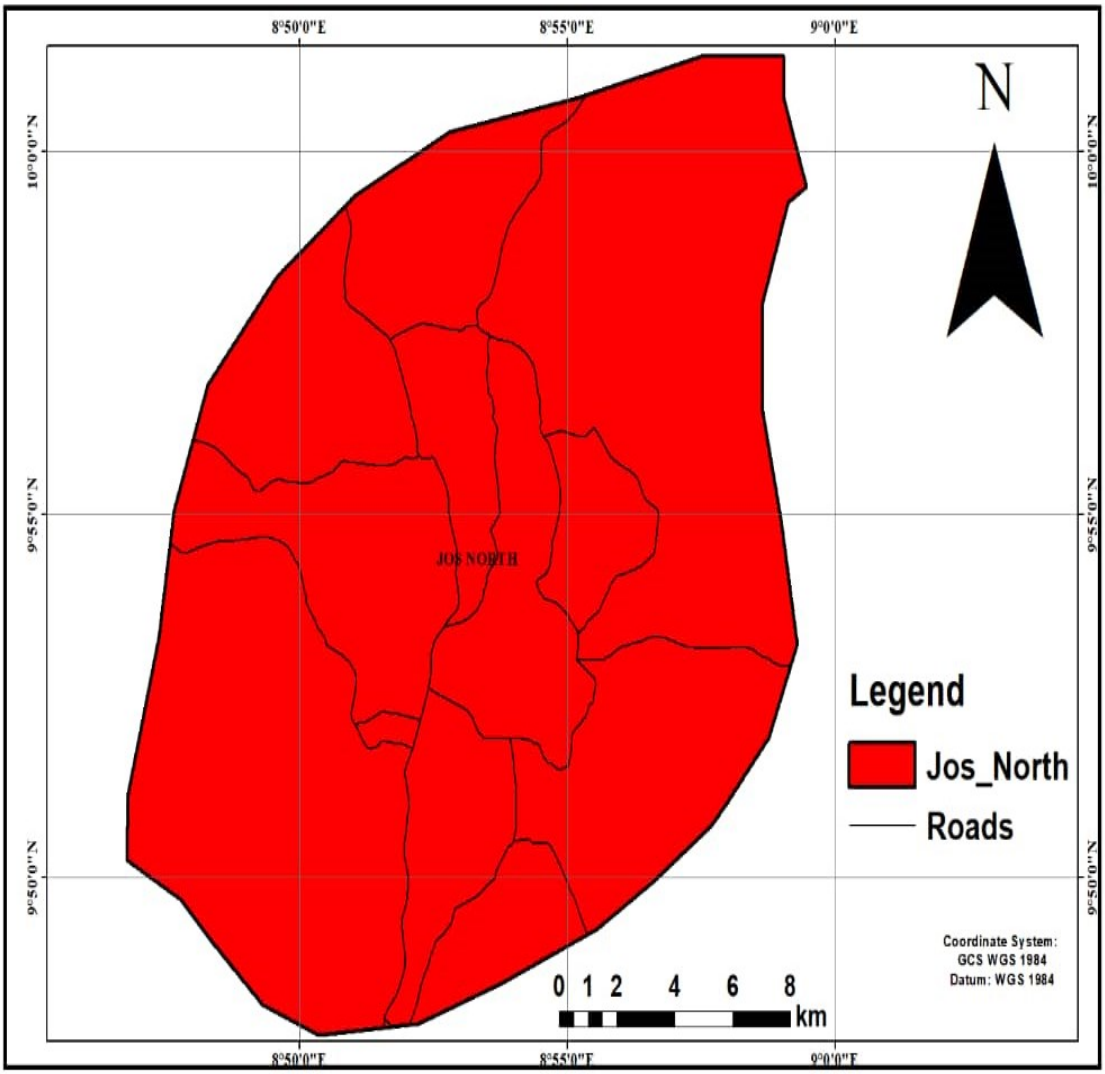


Figure 2: Map of Plateau State Showing Jos North
Source: Ministry of Land Survey and Town Planning, Jos, Plateau state

Research Methodology

Data Type and Source

This is the procedure adopted in this research work to achieve the overall result and findings.

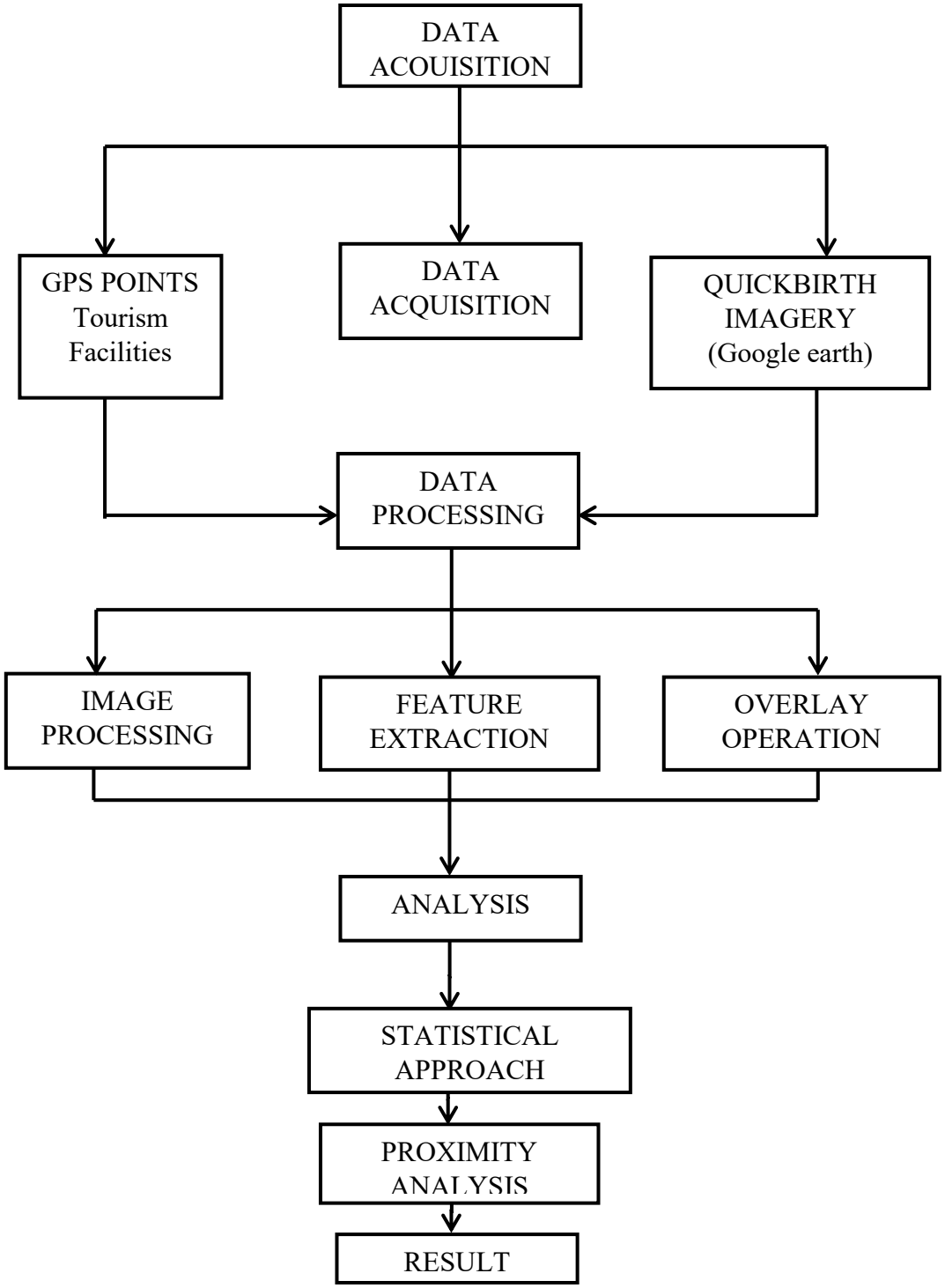


Figure 3: Cartographic Model

Data Acquired and Source

For this study, the administrative map of Jos was obtained from National Space Research and Development Agency (NASRDA), satellite image of Jos city

acquired from Google maps/ Google earth, for the assessment of tourism facilities on sustainable development in Jos North Local Government Area of Plateau State. Field work was also carried out to generate maps of public and private facilities and to assess the location and spatial distribution of the tourism facilities, determine the pattern of tourism distribution, model the accessibility to tourism facilities and; identify a suitable location of tourism facilities in the near future, using a hand held GPS as navigation tool to take point of the location of the facilities.

Table 1: Data Acquired and Source

S/N	Name	Scale	Format	Type	Source
1	Quick Bird	3m	TIFF	Secondary	Google Earth
2	Administrative	NA	.shp	Secondary	Ministry of Land Survey
3	Names of Tourist Centers	NA	Excel	Secondary	Plateau State Ministry of Tourism
3	GPS pont of Tourism Centers	NA	Excel	Primary	Field
4	Literature Review	NA	Txt	Secondary	Web, Journal, books, newspaper

Data Processing

The data gotten from Google earth was geo-referenced. This term is commonly used in GIS to describe the process of associating physical map or raster image of a map with spatial locations and the point were overlaid on the geo-referenced Google earth satellite image and administrative maps using ArcGIS 10.1 software. On screen digitization was carried out in ArcGIS 10.1 soft environment to generate vector model. Roads were digitized as line features, tourism facilities as point features. The spatial data was organized in layers to produce a single visual map of the tourism facilities containing all information that could be required by persons needing to visit a tourism facility.

GIS Database Development

Creation of spatial data Database tourism industry is rapidly becoming a leading destination for tourists. Government efforts are already under way through the institution of tourism to develop and maintain this sector to become a major source of revenue for development in the country. It is evident that the country's tourism potentials have not been fully explored and marketed. Verka and Angelina (2008).The importance of GIS database development is stemmed from data demands of database which are closely interrelated and this need to be structured

for easy integration and retrieval (Healey, 1991 as cited by Zubair, 2011). Thus, a well-designed spatial database will help in achieving reliable information, storage and retrieval at will, an up-to-date and well defined functions which allow (spatial) quary and reality modelling or simulation to be accomplished.

The design phase has three parts, which are; conceptual data modelling, logical design and physical design especially as explained below;

a. **Conceptual Model:** The conceptual design is a concise description of the data requirements of the users and includes detailed description of the data type, relationship and constraints.

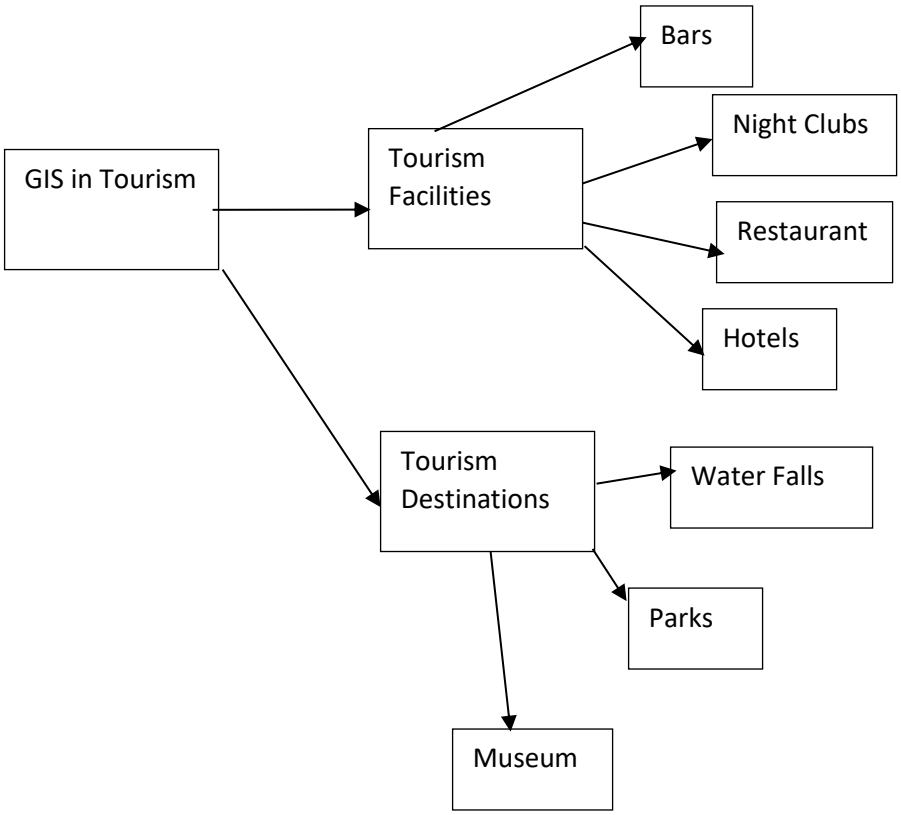


Figure 4: Conceptual data

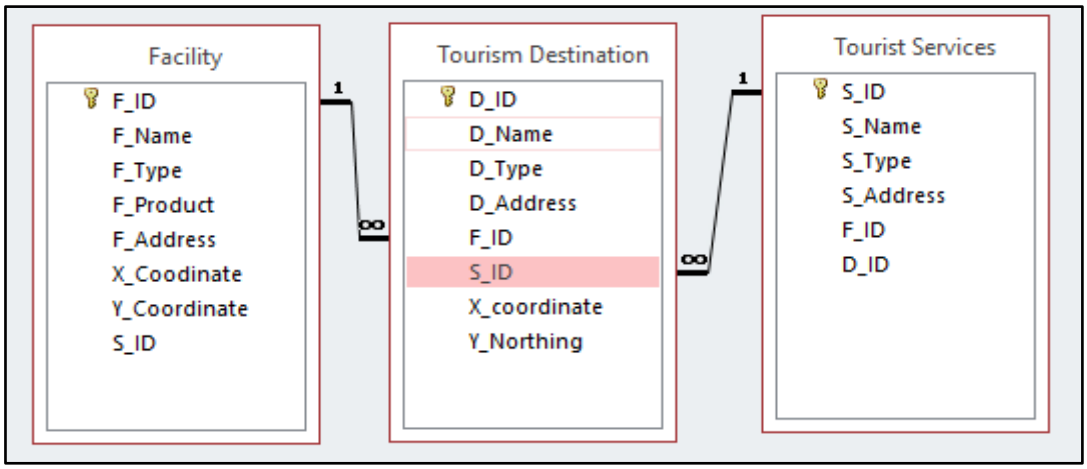
Table 2: Conceptual data modelling to tourism facilities

Conceptual Data Model	Description
Feature-id	Integer
Name of feature	Text
Address of feature	Text
Type of feature	Text

b. **Logical Model:** Logical design is a phase in database design, the conceptual data model is transformed into data structure capable of being represented in the computer. In a relational data model, the data are separated into tables, each table contains item called, field. Fields are object (attributes of entities). The logical design is meant to provide redundancy free dataset

Table 3: Logical data modelling for tourism facilities

	Logical Data Model	Description
Entity names		
Entity relationship		
Attributes		
Primary keys		



c. **Physical Data Model:** This is the stage of which the data is being mapped into the implementation software. It defines the specific storage structure and access paths to the database.

Table 4: Physical data modelling for tourism facilities

Attribute	Data Type	Width
Names of tourism	Text	30
Address of tourism	Text	40
Type of tourism	Text	10
Ownership	Text	10
Northings	Integer	10
Easting	Integer	10
Altitude	Integer	5

The data generated was analysed using descriptive analysis; this was employed to describe the main features of the data collected and to summarize the data set. Also, tables and charts were used to give overall sample size and number of tourism centers. GIS analysis employed cut across the overlay analysis and data integration. The map of the study area was over-laid with the distribution of the tourism facilities to all the key variables allows the study to view these relationships simultaneously in the geographic space of the study area.
The overlay analysis in GIS makes possible the integration of data having different geographies example, the road map of a city can be overlaid with the map showing districts where tourism centres exist.

Buffer Analysis

The buffer analysis was used to analyze the distance and to suggest future locations of tourism facilities. In GIS, a buffer is a zone that is drawn around any point, line or polygon that encompasses all of the area within a specified distance of the feature. This zone is drawn by a GIS in the form of a new polygon. So-called negative buffer may also be used for polygons to specify a distance inward from the boundaries of the area feature. Essentially, buffer analysis is tool which has been to find regions that are directly connected to specified object and useful for finding regions of space that are nearest to each of a set of irregularly distributed sample locations.

Tools and Software to be Used

A Geographic Information System (GIS Software) is designed to store, retrieve, manage, display and analyze all types of geographic and spatial data. GIS software lets you produce maps and other graphic display of geographic information for analysis and presentation. Materials and equipment that were used basically are; a hand held GPS Navigator, and three software's was used for this project viz.

a. **ArcGIS-:** Like many GIS software, ArcGIS creates map that requires categories organized as layers. Each layer is registered spatially so that when they're overlaid one on top of another, the program lines them up properly to create a complex data map. The base layer is almost always a geographical map, pulled out of a range of sources depending upon the visualization needed (satellite, road map, etc). This was used to geo-referencing, digitizing and overlaying of features to form a single visual map. It was used for carving out

Jos city center from the whole of the state using both the admin and local government map. This was also used to compliment the display and processing of the data.

b. **Microsoft Word:** MS Word enables users to do writer-ups, create documents resumes, contracts, etc. This is one of the most commonly used programs under the office suite was used basically for presentation of the research.
c. **Microsoft Excel: This is** a software program created by Microsoft that uses spreadsheets to organize numbers and data with formulas and functions. It was used to create a database which had parameters such as ownership and category, the parameters were entered into ArcGIS 10.1 software and was used to create an attribute table.

Statistical Approach

The statistical approach involves defining phenomena in terms of numbers and using the number to either implies or deduce causes and effects. Statistics are used to summarise and describe the data from studies where the data are collected in the form of numbers

Average Nearest Neighbor

The average nearest neighbor tool measures the distance between each feature centroid and its nearest neighbor's centriod location. It then averages all these nearest neighbor distances. If the average distance is less than the average for a hypothetical random distribution, the distribution of the features being analyzed is considered clustered. If the average distance is greater than a hypothetical random distribution the feature are considered dispersed. The average nearest neighbor ratio is calculated as the observed average distance divided by the expected average distance (with expected average distance being based on a hypothetical random distribution with the same number of features covering the same total area).
The average nearest neighbor ratio is given as:

$$ANN = Do/De$$

Where Do is the observed mean distance between each feature and its nearest neigbor and De is the expected mean distance for the features given in a random pattern.

Analysis of Ratio of Man to Facility

Ratio = population/facility

Jos = 437,217/30 = 14,574 persons

In this analysis, the value of population in a LGA and the number of tourism facility in the area is rationed. This gives the number of tourist that is a tourism facility in the city of jos can accommodate.

It can be seen that from the population and tourism facility data gathered, it is observed that in Jos a tourism facility can provide service to about 14,574 persons. In the distribution of tourism facilities, population figure is a major factor to be considered. The implication of this is that some of the tourism facilities in Jos city will suffer more usage and may collapse in the shortest time. The available manpower working in these tourism facilities will also be overloaded with too much workload which means that not all tourist may be attended to, thus death awaits some emergency patients before medical attention is given.

Data Presentation

The findings obtained from data presentation, analysis and interpretation is the major thrust of any research work. Therefore, the researcher has put in place an appropriate mechanism to ensure that data are presented logically in order to facilitate proper analysis and interpretation of results obtained from GIS.

Spatial distribution of Tourism Facilities on the Plateaus

The spatial distribution of tourism facilities was considered in order to examine the pattern of their distribution in the area. Figure 4:1 shows that 30 tourism facilities attractions were captured for the study across Jos North Local Government. This includes accommodations, lakes museums, parks and gardens. In looking at all these tourism facilities, 22 are private owned, while 8 are government owned. Basically they are mostly clustered.

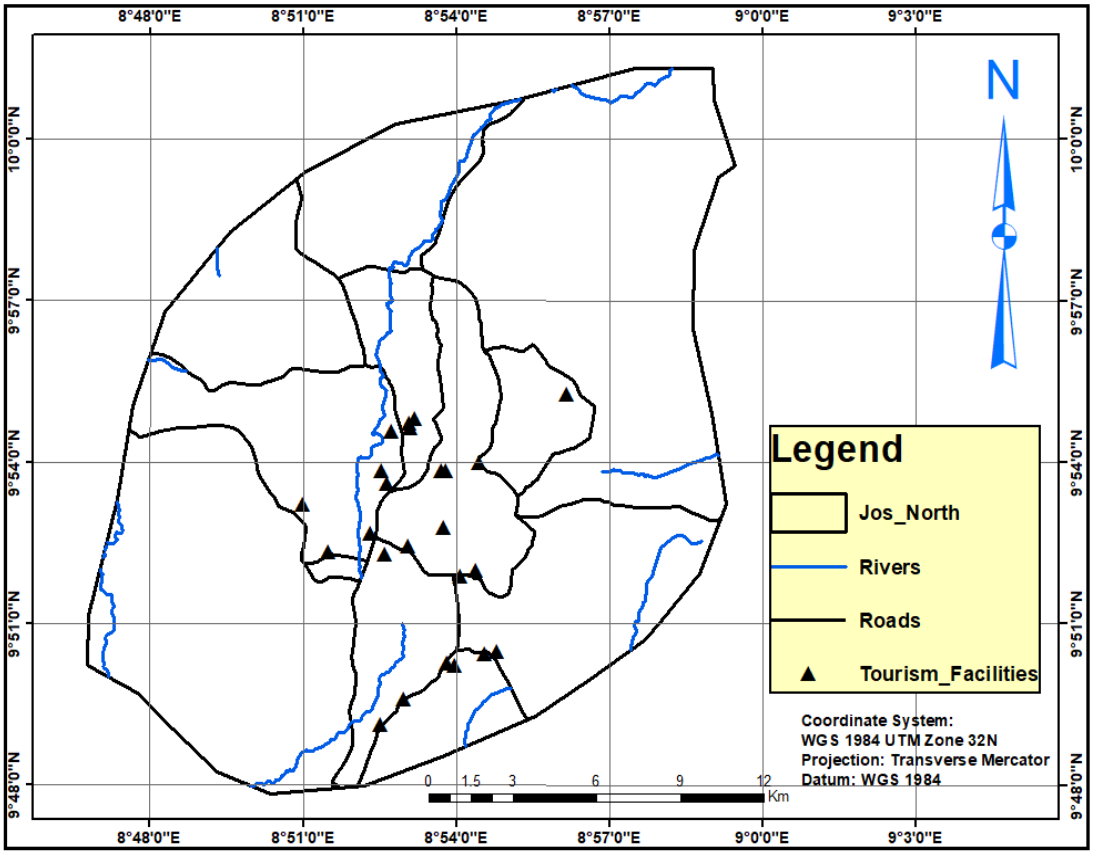


Figure 5: Jos North local Government Area showing the study area and some tourism sites

Source: Authors Field survey (2019)

Availability Factor

Availability refers to the extent to which a system provides facilities (which is the structural form) and services (which refers to process) that meet the needs of the people (Cambell, Roland et al. 2000).

In order to achieve the set objectives of this study, some tourism facilities were taking into consideration, about 30 functional tourism facilities in Jos Local Government Area; as at the time this research was conducted. Government tourism facilities sampled were eight (8) and about twenty-two (22) private. Table 4.1 below shows the inventory list of tourism facilities in the study area as at 2019.

Point Pattern Analysis

The concept of point pattern analysis can be best expressed using Zero-dimensional points. Which are used for geographical features that can best be expressed by a single point reference; in other words, simple location. For example, the locations

of wells, peak elevations, feature of interest or trailheads. Points convey the least amount of information of these file types. Points can also be used to represent areas when displayed at a small scale. For example, cities on a map of the world would be represented by points rather than polygons (Wikipedia, the free encyclopedia, 2011). In GIS, point maps are used to indicate locations of structures, towns, facilities, it is created as a layer that with all the relevant attributes attached to each point. This study employs the use of point maps to display tourism facilities in the study area.

Figure 4.2 below shows 30 tourism facilities in the study area. Eight (8) of the tourism facilities are owned by Government and about twenty-two (22) Private. Area with high social and economic groups of people has high concentration of tourism centers. This is because, they maximize profit and also likely to reside where basic infrastructures such as electricity supplies, portable water supplies, and good road network are readily available. Jos town has the highest concentration of tourism facilities.

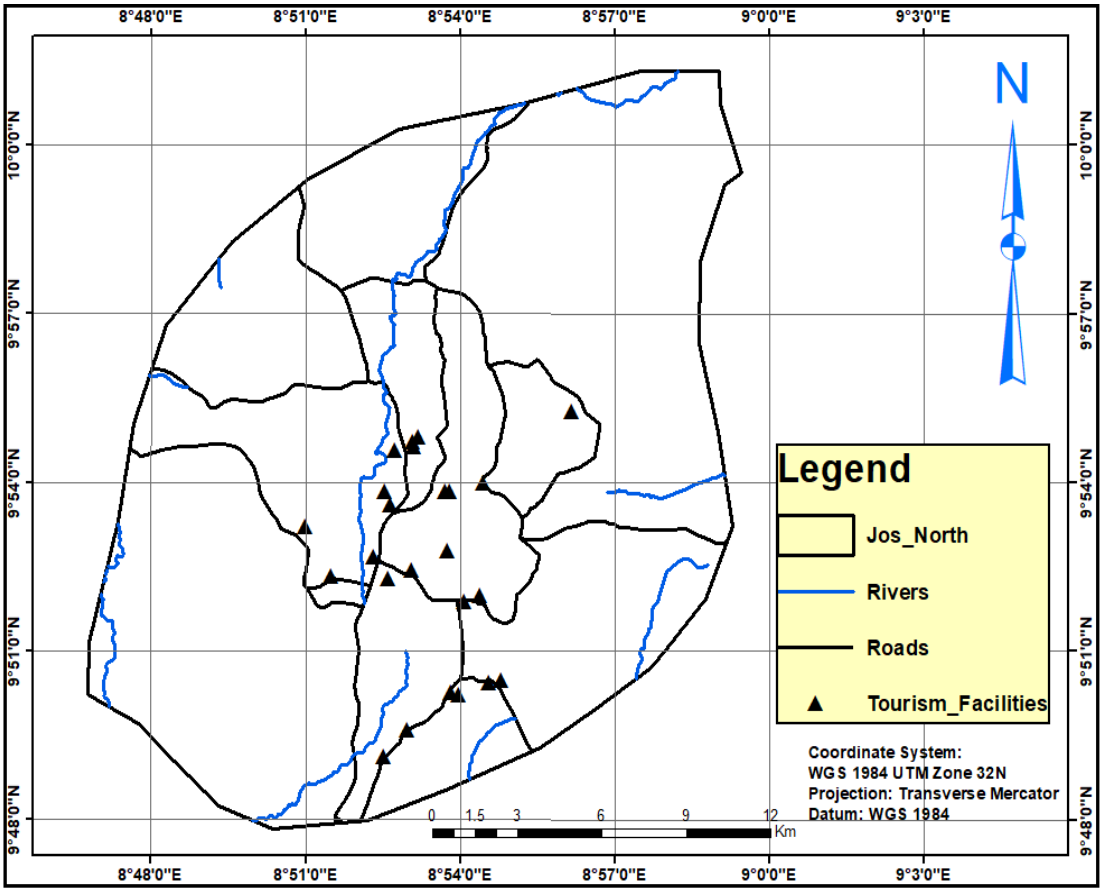


Figure 6: Jos North Local Government Area showing all tourism facilities
Source: Authors Field Survey. (2019)

Ownership

The ownership arrangement for constructed facilities not only generate the capital and requirements for new facilities, but also influence the management of the construction and operation of these facilities. While it is difficult to conclude definitely that one or another organizational or financial arrangement is always superior, different organizations have systematically chosen the ways in which constructed facilities are financed, designed and constructed. Moreover, the selection of alternatives investments for constructed facilities is likely to be affected by the type and scope of the decision-making organization. Some of the these systematic differences, particularly with regards to public versus private organization are considered. An extended example shows that tax shields high public borrowing costs and private financial leverage may be sufficiently advantageous for private firms to overcome the effects of partial capital subsidies and lower required rates of return for public organizations. Thus, private ownership and operation of infrastructure may prove to be a desirable social alternative to public ownership under some circumstances even without considering difference in the w\efficiency of operation.(Chris and Tung 1985) There are two types of ownership of tourism facilities in the study area. They include

a. Government tourism facility

b. Private tourism facility

Government Tourism Facility

At the opposite end of the spectrum from privately owned tourism facilities is the 'government owned tourism facilities. These facilities are operated as a branch of government. They include. Hotels, parks and gardens, recreational centers among others. As a result, these types of centers are very sensitive to the needs of the community; some would say they are overly sensitive or politicized. They try to maximize the 'direct' benefit of the center to local residents (public service) rather than maximizing the 'economic' benefits for the local economy (economic development). This can be accomplished in many ways including: subsiding, making the place free to assess for gate events with civic activities such as meetings of non-profit groups or political rallies; hiring only local residents so that the economic benefit stays in the community; requiring vendors to be local businesses; and employing more, rather than fewer, people relative to their size. In figure 4.3 below, there are 8 Government tourism facilities in the study area. This suggests Government has little desires on tourism

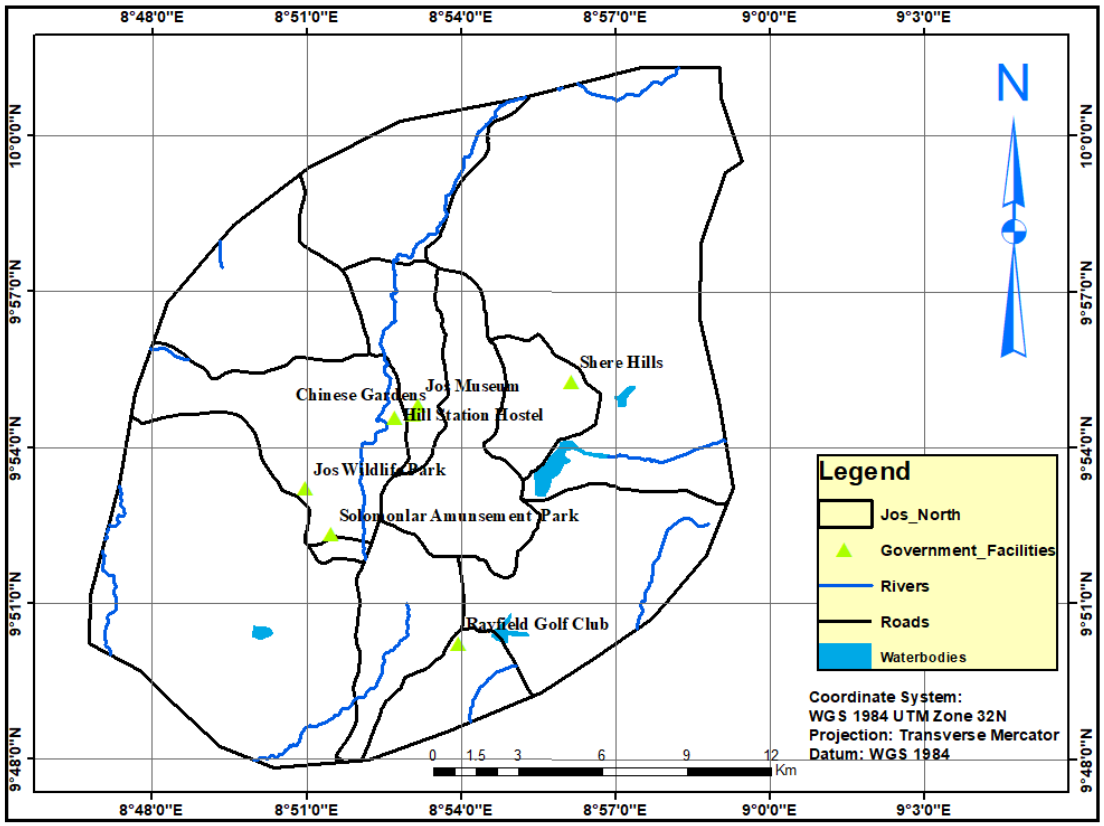


Figure 7: Jos North Local Government Area Showing Government tourism facilities

Source: Authors Field Survey (2019)

Private Tourism Facilities

These are set of tourism facilities that are privately owned either by individuals, groups, or communities. They are usually located where population is high, social activities is active and sometimes areas where basic amenities such as good roads, electricity and water supply are available. This form is operated like a business enterprise with profit being its primary objective while utilizing an entrepreneurial strategy to reach this objective. Private facilities seek to bring business to the masses that will yield the greatest revenues and, thus, profits. Competing in a field of contenders that are heavily subsidized, private facilities leverage efficient staffing, flexible booking policies, and value added services to minimize their cost and maximize revenues. Private tourism facilities tend to attract a greater proportion of consumer shows and social functions such as wedding gathering, parties or gate events such as concerts. These types of events are more profitable for private tourism facilities than government owned tourism facilities, because

they are willing to pay higher rant. This suggests that, they are profit making ventures. The research revealed that about twenty-two (22) private tourism facilities were sampled. This is shown in figure 4.4 below.

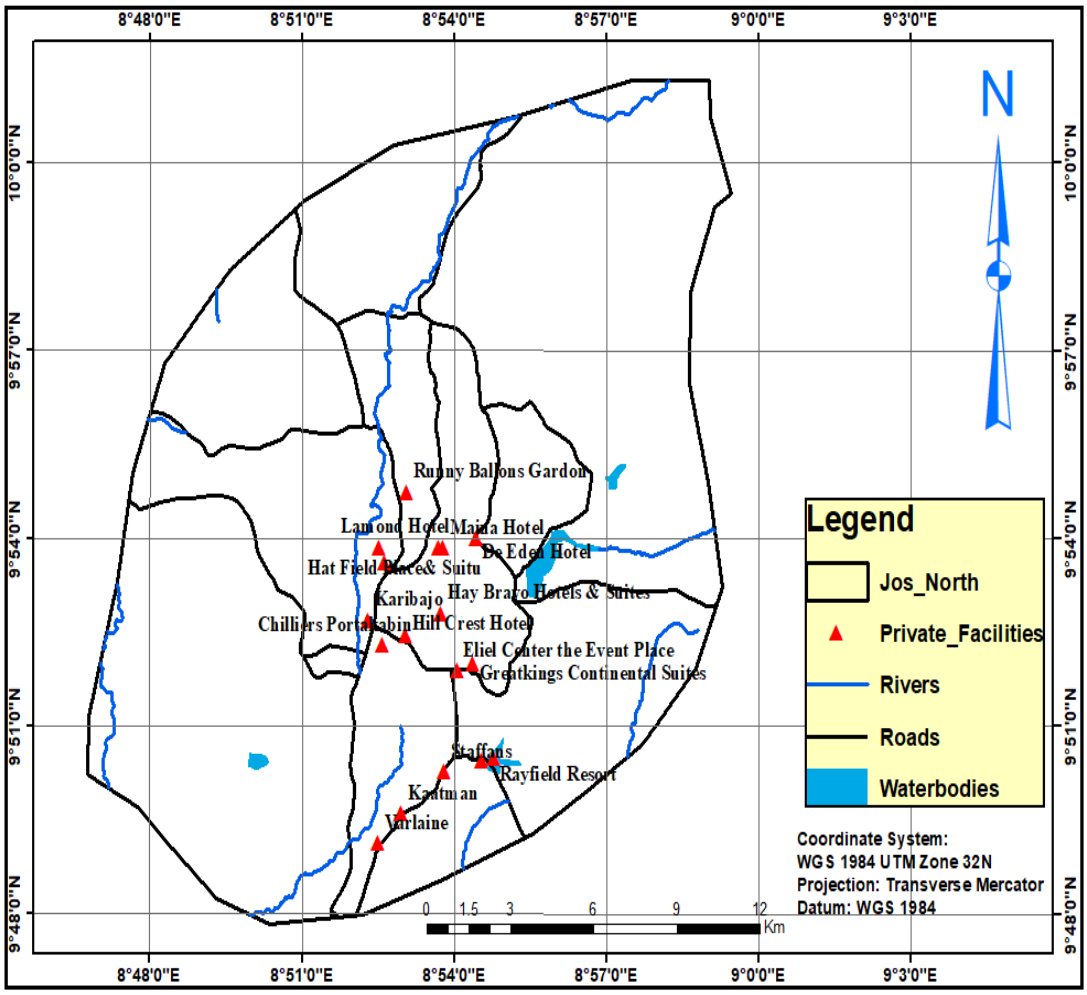


Figure 8: Jos North Local Government Area Showing Private tourism facilities

Source: Authors Field Survey (2019)

Data analysis

Prior to the derived data sets about prevailing tourism facilities in the study area, various geospatial analyses were carried out on the derived data sets to determine the following:

- The pattern of the distribution of tourism facilities in Jos city
- The proximity of selected Communities to available tourism Facilities within a reasonable distance of 2km,

The number of persons to each tourism Facility based on 2006 LGAs population figures

The Pattern of Distribution of Tourism Facilities

This research describes the spatial layout of convention facilities with tourism facilities in Jos north local government of plateau state through the application of ArcGIS analysis software, over space. It is usually in response to number of location factors. This could be, easy access to/from nearby settlement, availability of good roads, and social amenities among others. This study revealed the following patterns; tourism facilities were found to have a spatial agglomeration pattern and an uneven distribution within jos north local government, plateau state. Convention facilities and tourism were closely spatial related where facilities are scattered over space and linear: where facilities development follow straight line pattern usually along important roads.

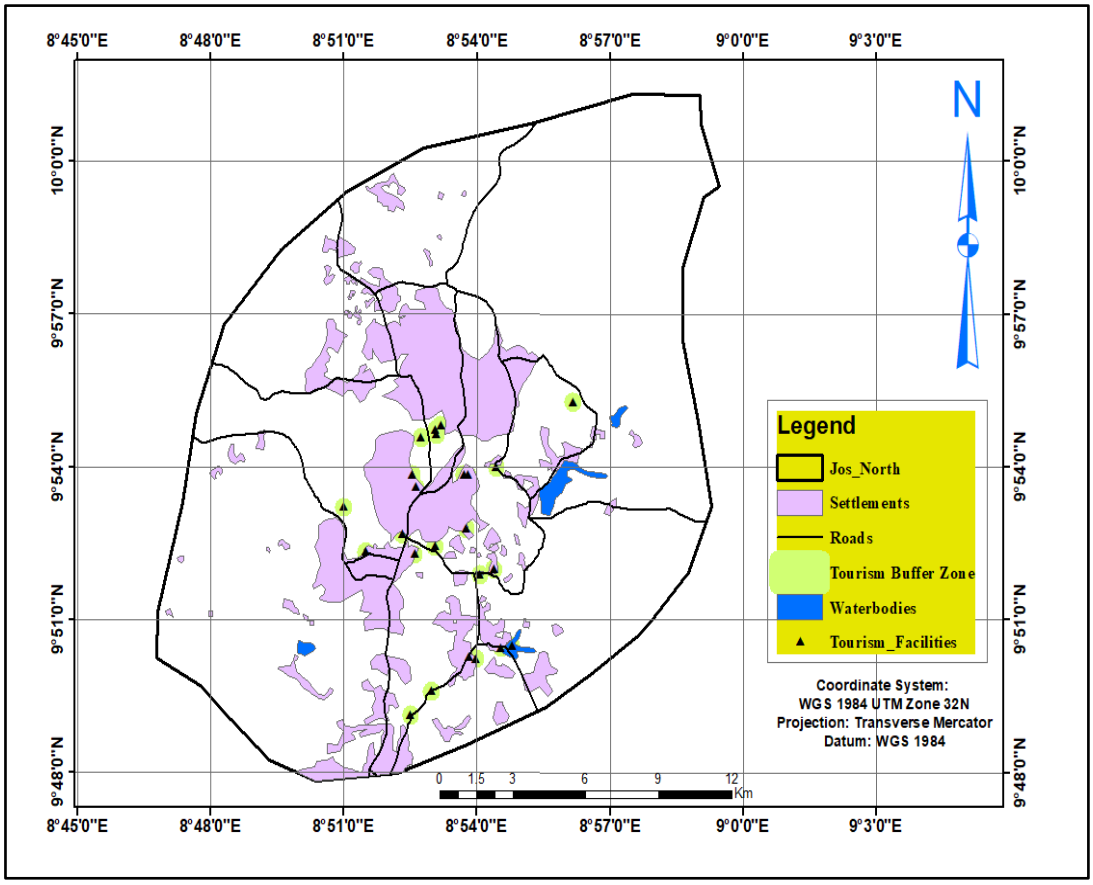
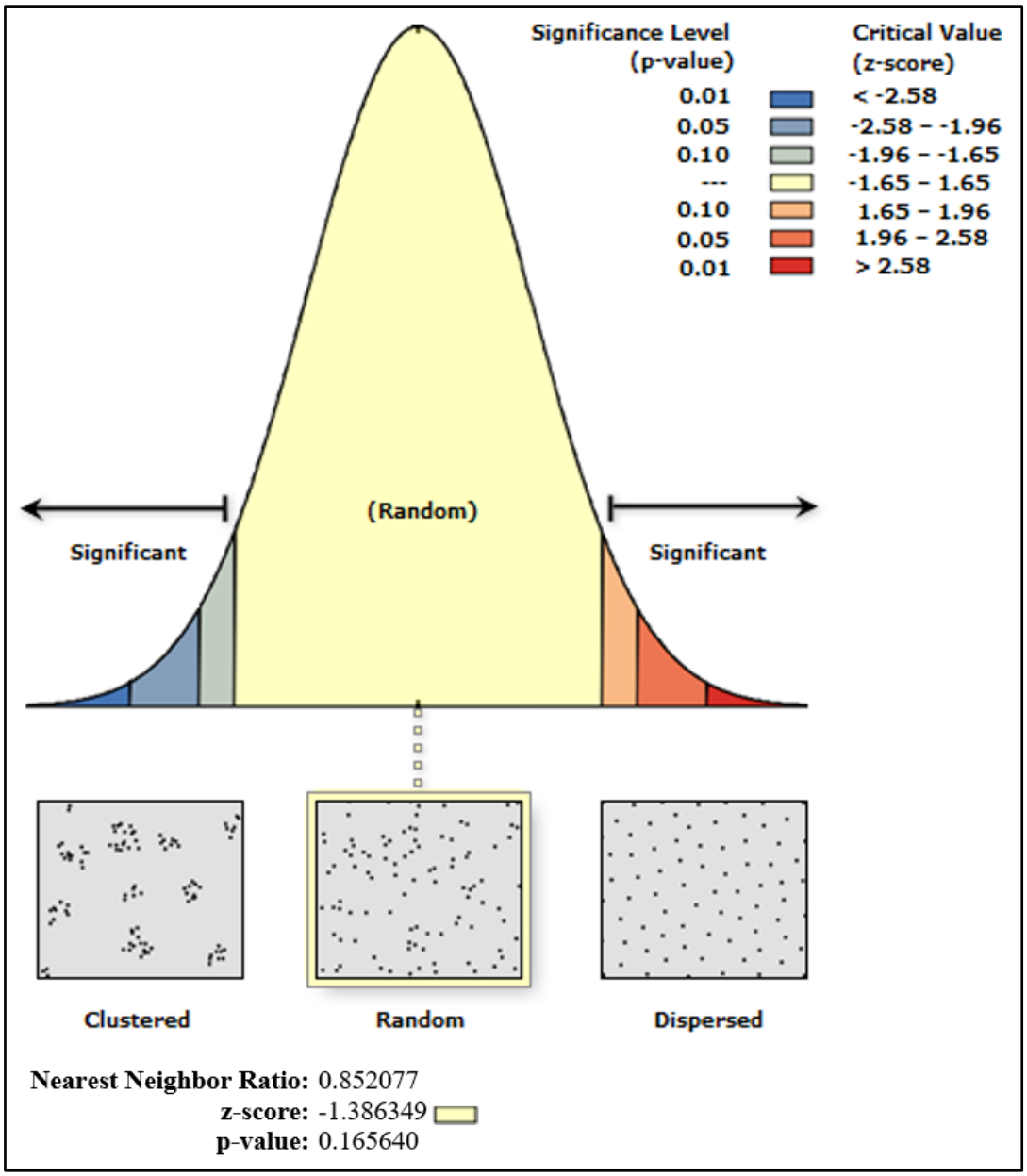


Figure 9: Show the distribution pattern of tourism facilities in the study area. Source: Authors Field Survey (2019)

Average Nearest Neigbor

This is used to analyse the statistical data of point. Specifically this test is used to determine if a point pattern is dispersed, Random or clustered. This analysis only look at spatial pattern of point it does not look at their values stored on the point. If the index is 1 then we have a random pattern, if the index is less than 1 then we have a clustering meaning that Do is less than De. If the index is greater than 1 then our point is dispersed. The average nearest neighbor is given as: ANN= Do/De. In figure 4.6: given the Z-score of -1.3863488715, the pattern does not appear to be significantly different than random. This can then be said to be randomly clustered.



Source: field work survey (2019)

Database of Tourism Facilities in Jos Local Government Area

Database is an organized system that allow data storage, manipulation and retrieve data from the system. GIS database provides comprehensive framework and organization of spatial as well as non-spatial data and has become a focused tool to help planning and decision making (WHO, 2004).

The study identified both Public and Private Tourism facilities that are spatially distributed on the field. The geographical coordinates of tourism facilities were established. Attributed data were collected and a GIS-database was generated as displayed.

Table. 5: Database of Tourism Facilities in Jos Local Government Area

Table

Tourism Facilities

FID	Shape *	X	Y	Z	DESCRIPTIO
0	Point ZM	487363	1095555	121	Chinese Gardens
1	Point ZM	492981	1096709	130	Shere Hills
2	Point ZM	485374	1089578	0	Azi Nyako Youth Center
3	Point ZM	487531	1095881	119	Jos Museum
4	Point ZM	484456	1091294	128	Solomonlar Amunsement Park
5	Point ZM	488971	1087429	130	Rayfield Golf Club
6	Point ZM	486725	1095431	124	Hill Station Hostel
7	Point ZM	483543	1092916	132	Jos Wildlife Park
8	Point ZM	487324	1095714	121	Runny Ballons Gardon
9	Point ZM	486178	1095146	0	Country Home Hotel
10	Point ZM	485967	1091944	129	Karibajo
11	Point ZM	486464	1091211	129	Chilliers Portakabin
12	Point ZM	486292	1085389	124	Varlaine
13	Point ZM	490024	1087827	130	Mee's Palace Events Centre
14	Point ZM	490468	1087905	129	Rayfield Resort
15	Point ZM	487146	1086256	125	Kaatman
16	Point ZM	488693	1087491	129	Staffans
17	Point ZM	489825	1094362	124	De Eden Hotel
18	Point ZM	488656	1094066	122	Maina Hotel
19	Point ZM	488483	1094092	122	Hat Field Place& Suitu
20	Point ZM	488591	1092143	128	Hay Bravo Hotels & Suites
21	Point ZM	489724	1090678	128	Greatkings Continental Suites
22	Point ZM	489151	1090469	128	Eliel Center the Event Place
23	Point ZM	487303	1091507	129	Hill Crest Hotel
24	Point ZM	486534	1093629	125	Usiju World Event Center
25	Point ZM	486369	1094088	125	Lamond Hotel
26	Point ZM	485780	1083425	0	Yelwa Club
27	Point ZM	487990	1094192	0	Shawarma and Grills
28	Point ZM	485374	1083425	0	Jossy Royal Hotel
29	Point ZM	485362	1096252	0	Netcafe Restaurant and Bakery

1 (0 out of 30 Selected)

Tourism Facilities

Community-Based Proximity to Tourism Facility

The proximity analysis intends to determine the number of tourism facilities within 2km radius from the dwellers. This gives an insight into which facility, members of a community can quickly visit in the shortest distance in times of need. As a result, relevant GIS software tool has been used to identify the number of tourism facilities that are within 2km radius to the dwellers. This can easily be achieved through a transformation operation known as buffering. Given any set of objects, which may include points, lines, or areas, a buffer operation builds a new object or objects by identifying all areas that are within a certain specified distance of the original objects,

Proposing New Tourism Facilities

Having carried out analysis on the existing tourism facilities in Jos North Local Government Plateau State, it would be worthwhile to assess the need of establishing other tourism facilities in Jos with the growing population. The population of the city is increasing due to the rural-urban migration and influx of people that have been on the increase in recent years. Therefore, existing facilities won't go round for all, and the necessity of establishing others is essential. Although, proximity of the existing facilities to the users and access to road and water is to some extent satisfying the criteria of WHO (Worl d Health Organisation), but population is not. The WHO (1997) set out a criterion for sitting tourism facilities based on population. An area with a population of 500 people should have access to at least one tourism facility with the main equipment. Although there are some facilities equiped to the standard required, the population of the city is growing dramatically between 2006 and 2015. Considering this population increase, we suggest additional facilities be made. However, our proposition here have considered some areas with high population such as Tudunwada and Nasarawa areas that have grown dramatically. Significant population increase due to new settlements have been observed in these areas recently compared to other parts of the town.

The new proposed tourism centres should be government owned due to the ratio of government to private tourism centres. The proposed site for the new tourism facilities is shown on the map below alongside the existing tourism facilities of both public and private.

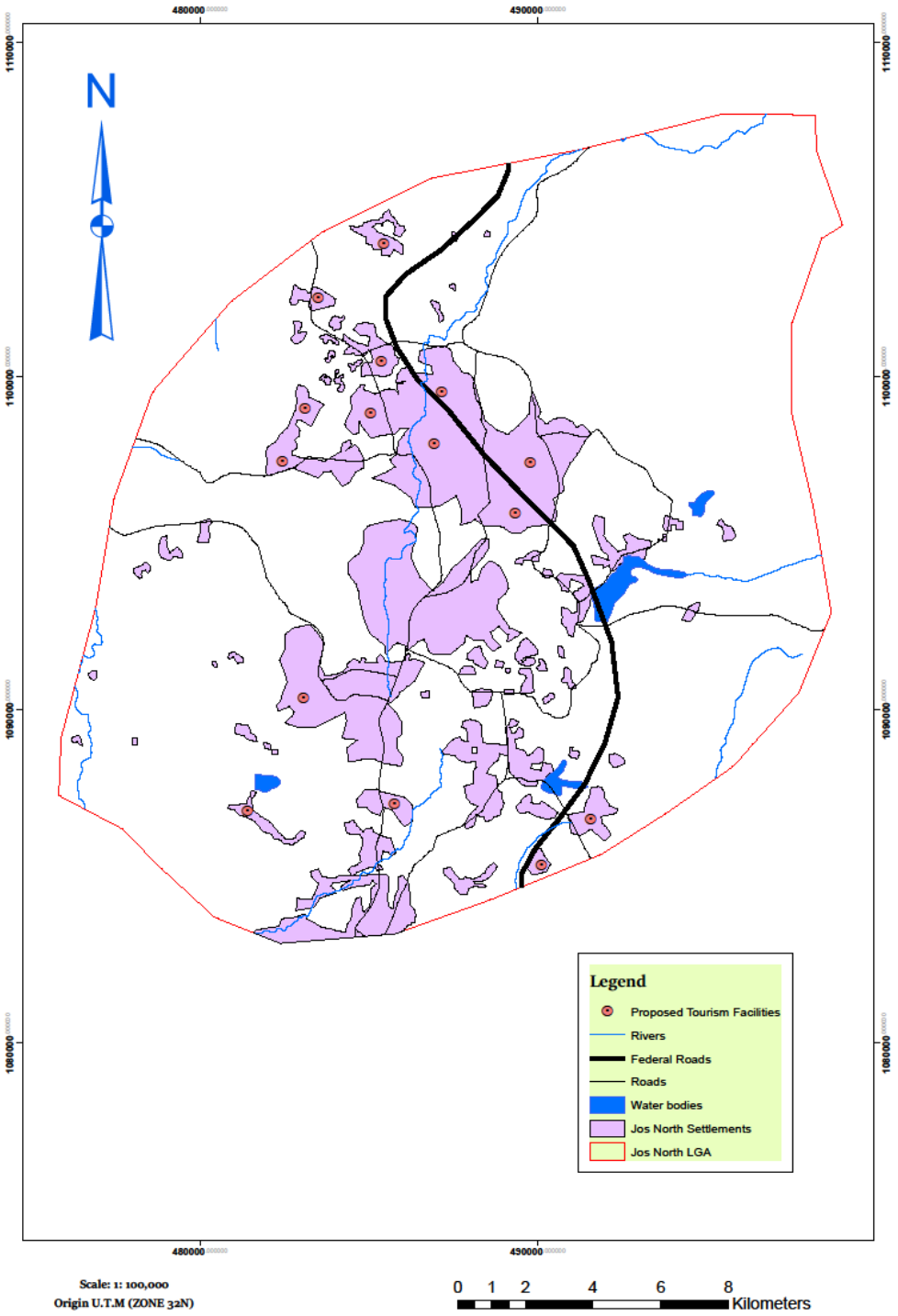


Figure 11: Map of Jos North Local Government Showing Suggested Proposed Tourism Sites

Source: Field Work Survey (2019)

Conclusion

In conclusion the result of the various analysis carried out in this research have show that, the spatial; distribution of tourism facilities was considered in order to examine the pattern of their distribution in the area. Out of 30 tourism facilities 22 where private owned 8 were government owned, that the study revealed the following patterns; tourism facilities were found to have a spatial agglomeration pattern and an uneven distribution within jos north local government, plateau state. Conventional facilities and tourism were closely spatial related where facilities are scattered over space and linear; where facilities development follows straight line patterns usually along important roads. Having carried out analysis on the existing tourism facilities in jos north local government, plateau state, it would be worthwhile to assess the of establishing other tourism facilities in jos with the growing population.

Recommendations

The most important challenge for sustainable tourism development concerns the perspective and expectations that all stakeholders, particularly government policy-makers, have about tourism's contribution at the local, regional and national levels. Many developing countries view tourism as a vehicle for economic development, given its potential to earn foreign exchange, create employment, reduce income and employment disparities, strengthen linkages among economic sectors and help to alleviate poverty.

1. The challenge facing policy-makers is to have a broader perspective and better understanding that there can be both positive and negative effects from tourism development.
2. That the potentials of GIS as an analytical tool can be utilized to determine and measure access to tourism facilities.
3. That all archived data in the tourism ministry be updated, digitized and geo-referenced.

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Novel Assessment of Drill Cuttings in Ionic Liquid

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Abstract
The drill cuttings management process has consistently been reviewed to identify safer treatment methods that reduce environmental impact while improving recovery of residual chemicals to enable the reuse of the oil-free cuttings. Recycling and disposal are key waste management options that are of concern to the oil and gas industry. As significant quantities of drill cuttings are produced during drilling operations, there is an increased need for drill cuttings management solutions. This study investigates the novel use of ionic liquids to separate drilling fluid from cuttings. The findings from the laboratory research showed that the drilling fluid on the cuttings can be separated from the cuttings with the recovery of the extraction solvent for reuse in the recovery process. This approach emphasises the potential of ionic liquids in an integrated waste management approach to enhance material recovery.

Keywords: Drill cuttings, Ionic liquid, oil and gas, sustainable development, waste management.

Introduction
Drilling fluids are used during oil and gas well drilling to lubricate and cool the drill bits and aid the transportation of the drill cuttings, which are rock

debris, to the surface for treatment and
disposal. (Bendi et al., 2024). Drilling
fluid increases the high performance and success in drilling complex wells and is essential in well construction (Deville, 2022). Though oil and gas play a key role in the global economy, the hazardous wastes generated during the exploration and production process such as drilling fluids and cuttings are complex to manage due to aromatic compounds (Kazamias & Zarpas, 2021). Wastes from oil and gas drilling operations contain physical and chemical components that can be hazardous to the environment (Onwukwe & Nwakaudu, 2012). The toxicity of the substances in the drill cuttings can impair the health of animals and biotic communities and increase the risks of pollution of air, water bodies, and humans (Ahammad et al., 2017). Following the increase in environmental pollution worldwide, the sustainable livelihood approach has become paramount in identifying the factors affecting communities' socioeconomic aspects. Thus, sound scientific analysis is needed to address those aspects that may be negatively impacted (Briggs et al., 2015).

DRILLING WASTE VOLUME

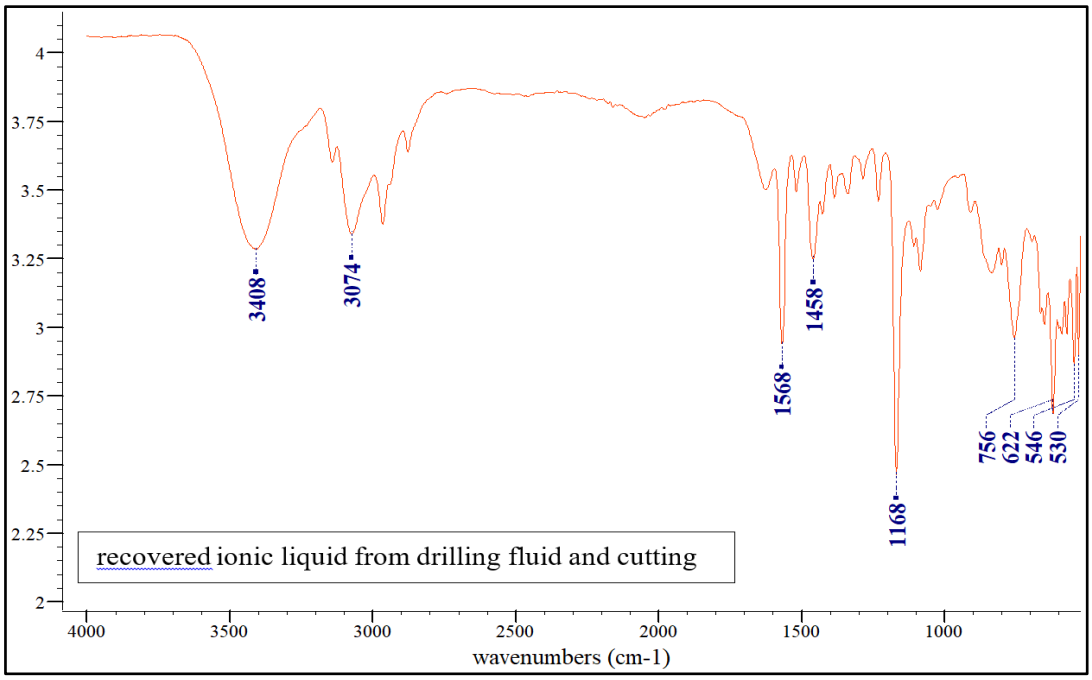
A significant problem facing the oil and gas industry is waste management. With technological advances, waste management concepts provide a proactive treatment of large volumes of waste through the life cycle of oil and gas wells (Onwukwe & Nwakaudu, 2012). Drilling fluid is critical to drilling operations to remove cuttings continuously (Paulauskiene, 2018). The drill cutting volume depends on the type of base fluid used and the size or depth of the well. Further, with the increasing demand for cleaner technologies, drilling waste estimation and management considerations have increased (Dabo, 2023).

MATERIALS AND METHODS

0.2g of treated drill cuttings and 0.1g of synthetic oil-based fluid were mixed thoroughly in 2g of 1-propyl-3-methylimidazolium bromide (propylMIMBr ionic liquid) in a test tube. During the experiment, the mixture was observed to separate into a three-phase mixture: the top layer of oil, the ionic liquid layer, and the solid cutting bottom layer. The top layer was separated through decanting, while filtration was used to separate the ionic liquid from the drill cuttings. The drill cuttings were washed with water to remove the traces of ionic liquid. The recovered oil and the ionic liquid were characterised using Fourier-transform infrared (FTIR).

RESULT

The results showed that synthetic drilling oil can be recovered from drill cuttings with only residual traces of oil on them. The recovered ionic liquid from the drilling fluid, cuttings, and ionic liquid simulated mix in **Figure 1** showed minimal changes in the recovered ionic liquid. Meanwhile, the recovered drill cuttings from the drilling fluid, cuttings, and ionic liquid mixture in **Figure 2** showed that the propylMIMBr ionic liquid could extract a significant amount of oil from the cuttings.



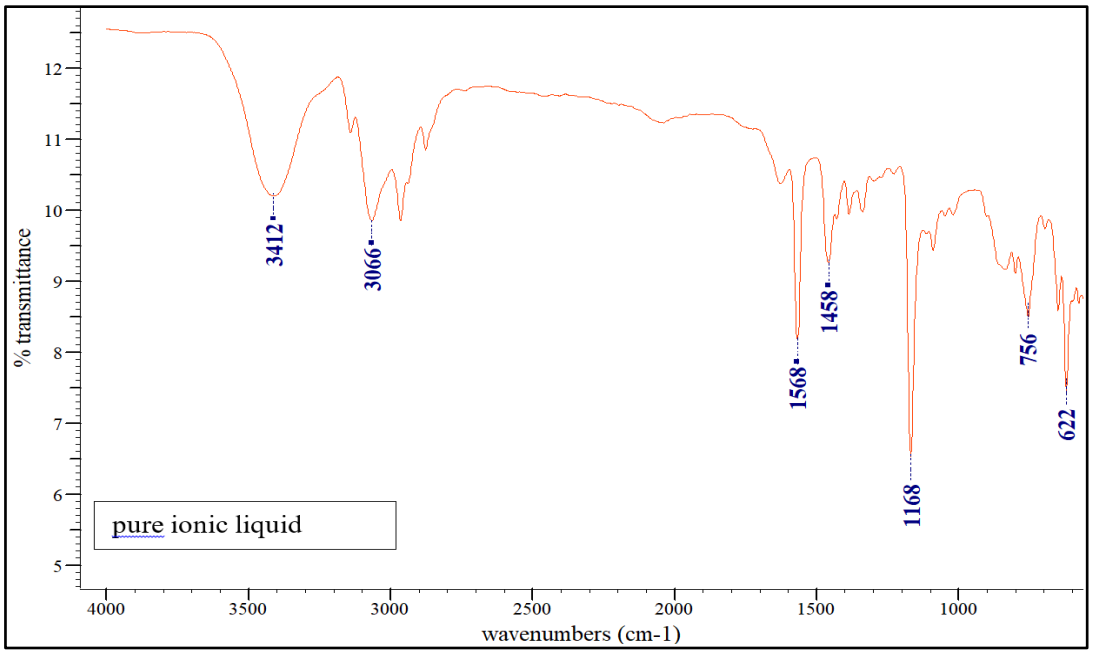
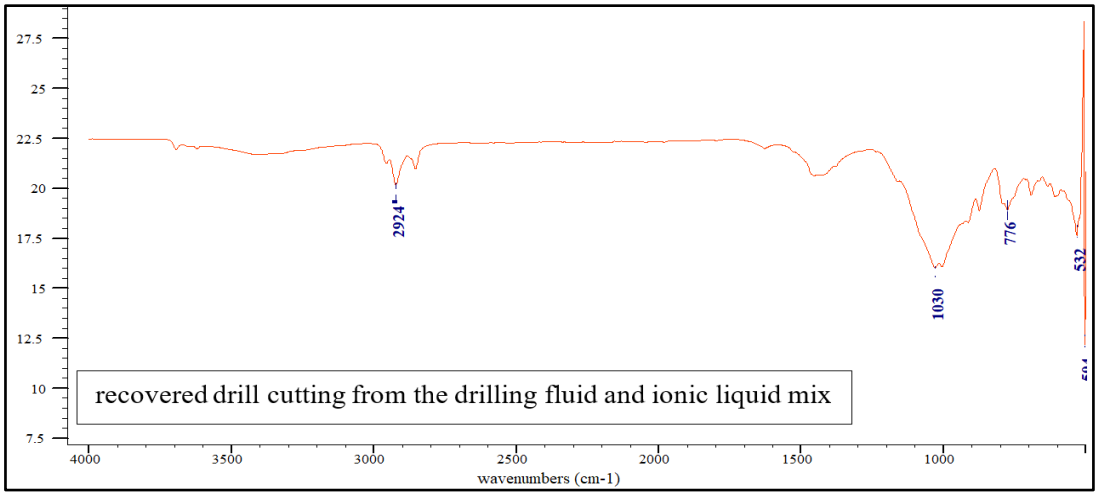


Figure 1: Recovered ionic liquid from drilling fluid, cuttings and ionic liquid simulated mix



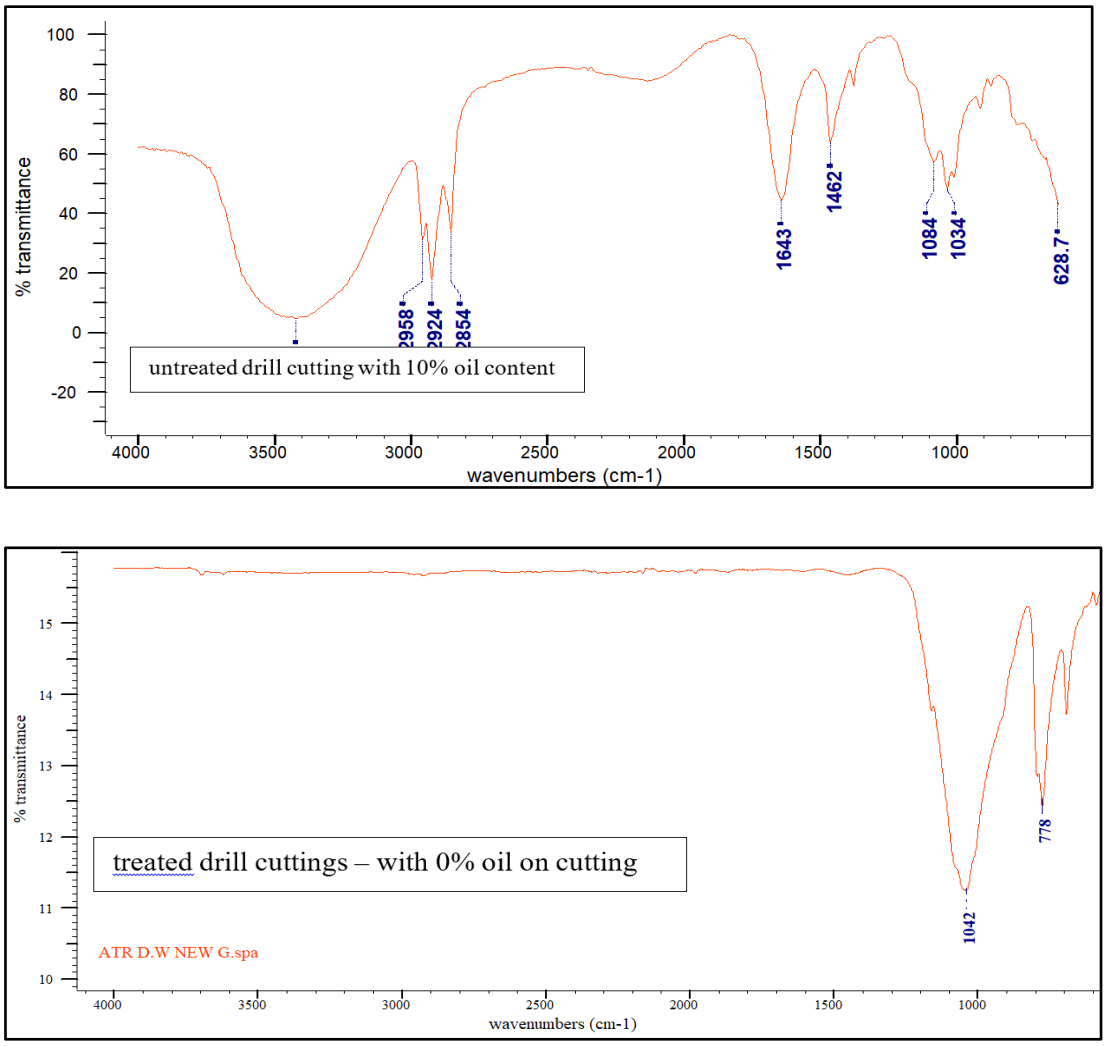


Figure 2: Recovered drill cuttings from drilling fluid, cuttings, and ionic liquid simulated mix

DISCUSSION

It is paramount that waste minimisation processes reduce the impact of the volume of drilling wastes generated. This also depends on the amounts of drilling waste generated so that the required treatment technology can be adapted to minimise disposal options (Dabo, 2023). It is known that the treatment of drill cuttings constitutes a significant expense in drilling waste management. Thus, other improved options that can enable the removal of the oils on the cuttings, which also meet the regulatory requirements, are considerations that will allow the reuse of waste materials from drilling (Davarpanah, 2018 & Sayyadnejad et al., 2008).

Oil and gas operators are open to novel technologies that can help them achieve their material recovery goals and minimise the volume of waste despite other

proven technologies in use (Gaurina-Medimurec et al., 2020). Globally, drilling waste management companies have advanced their treatment efforts in adaptive alternative technologies and reagents to isolate the contaminants in the drill cuttings to solidify the inert material for recycling (Ilinykh et al., 2022). Hence, the use of ionic liquid in isolating the residual drilling fluid from the drill cuttings is an approach that can be explored to help waste managers decide if this is a viable option with the most economical and environmental benefits (Veil et al., 2003).

CONCLUSION

The generation of waste from the drilling waste management process has led to improvements in methodologies for sustainable management of wastes from drilling operations, focusing on reducing localised impacts. As legislative drivers continue to enforce resource recovery and best practices, the chemistry of the drilling fluid and cuttings has attracted the attention of scientists investigating value recovery methods to explore conditions to maximise reuse.

RECOMMENDATION

The management of drill cuttings is of particular interest to the petroleum industry. Crucial to sustainable development goals is recycling of waste to meet other reuse purposes. Hence it is recommended that a range of other ionic liquids especially in the imidazolium group be investigated to determine the most effective in recovering oil on drill cuttings.

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Conceptual study on Green Manufacturing and Waste Management in Nigeria's Industrial Sector

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Abstract
Nigeria's industrial sector faces significant environmental challenges including industrial waste generation and pollution. These problem can be solved using green manufacturing integrating waste management practices. This paper explores the concept and current adoption of green manufacturing in Nigeria. Its importance for sustainable development was also highlighted. Challenges such as limited infrastructures, high cost weakness in regulation were also identified. Opportunities for expanding green manufacturing such as waste energy projects renewable energy integration and training were also outlined. The paper concludes by emphasizing the need for a cultural shift towards sustainability in waste management. It recommends that policymakers, stakeholders, producers should endeavour to promote green manufacturing.

Keywords: development, green manufacturing, waste management, industrial sector, Nigeria

Introduction
The industrial sector in Nigeria has been growing considerably, contributing to economic development, job creation, and infrastructure growth. However, this expansion has come with significant environmental challenges, including industrial waste generation and the release of pollutants into the

environment. Addressing these issues is crucial for Nigeria's journey toward sustainable development. Green manufacturing—a process of designing products and operating facilities in ways that minimize environmental impact has emerged as a potential solution. According to International Organization for Standardization (2011), green manufacturing is an approach to manufacturing that aims to minimize environmental impacts, reduce waste and emissions and promote sustainable development. By integrating waste management practices with green manufacturing principles, Nigerian industries can reduce their environmental footprint, improve resource efficiency, and contribute to a healthier environment.

This chapter explores the concept of green manufacturing in Nigeria's industrial sector, examining its principles, current adoption levels, and potential benefits. It aims to highlight how green manufacturing, when integrated with effective waste management strategies, can address the environmental impacts associated with industrial activities. The chapter delves into key drivers, such as government policies, international standards, and rising consumer demand for sustainable products, which are encouraging the shift toward more eco-friendly production practices. It also considers the specific challenges facing Nigeria's industrial sector, such as limited infrastructure, high costs of green technology, and regulatory barriers.

Furthermore, this chapter discusses the role of waste management in achieving sustainable industrial practices, focusing on how innovative waste-to-energy projects, recycling, and material reuse can create a circular economy within Nigeria. The integration of these approaches in the manufacturing process can reduce waste output, conserve natural resources, and lower emissions, contributing to a greener and more resilient industrial sector.

Finally, the chapter concludes by presenting the future outlook for green manufacturing and waste management in Nigeria, suggesting actionable recommendations for policymakers, industry leaders, and stakeholders. By advancing green practices, Nigeria's industrial sector can position itself as a leader in sustainable development in Africa, paving the way for a more sustainable economy that aligns with global environmental goals.

This study employed qualitative research method. A systematic literature review was conducted to identify and synthesize existing research on green manufacturing. The review focused on academic articles, industry reports and publications. A case study of a manufacturing company that has implemented green manufacturing practices was also conducted by analysing company documents and reports.

Overview of Green Manufacturing in Nigeria

Green manufacturing is the practice of designing products and operating production facilities in ways that minimize environmental impact, maximize resource efficiency, and promote sustainability throughout the lifecycle of products (Vangeri et al., 2024). In Nigeria, green manufacturing is an emerging field driven by increasing environmental awareness, economic pressures to optimize resource use, and international standards for sustainable development. Given Nigeria's rapid industrialization, which has come with significant environmental consequences, the adoption of green manufacturing practices is becoming essential to balance economic growth with environmental degradation.

Definition and Principles of Green Manufacturing

Green manufacturing encompasses a range of practices and principles aimed at reducing waste, lowering emissions, and conserving resources (Okunuga, et al., 2022). In a Nigerian context, green manufacturing can be defined as the adoption of processes that aim to:

(i) **Minimize Waste and Pollution:** Reducing waste generation at all stages of production, from raw materials to the final product, is fundamental. Pollution reduction, particularly in terms of emissions, is also prioritized.

(ii) **Optimize Energy and Water Usage:** Green manufacturing emphasizes the efficient use of energy and water resources, helping to lower production costs and reduce environmental impact.

(iii) **Promote the Use of Sustainable Materials:** Industries are encouraged to replace harmful chemicals and materials with environmentally friendly alternatives.

(iv) **Encourage Recycling and Reuse:** Green manufacturing seeks to establish a circular economy by encouraging the recycling and reuse of materials, thus reducing the dependency on virgin resources.

(v) **Enhance Product Lifecycle Sustainability:** From design to disposal, green manufacturing considers the entire lifecycle of products, ensuring they are designed to be resource-efficient, durable, and ultimately recyclable.

The Importance of Green Manufacturing in Nigeria

The shift toward green manufacturing in Nigeria is motivated by both domestic and international factors. Domestically, the environmental impact of industrial activities has raised concerns among communities and environmental agencies,

particularly due to pollution and waste management issues in urban centres and industrial hubs like Lagos, Port Harcourt, and Kano. Internationally, global trade is increasingly influenced by environmental standards, and Nigerian manufacturers must adapt to these standards to remain competitive in global markets (Adekunle & Dakare, 2020; Adubor et al., 2022). The importance of green manufacturing in Nigeria's industrial sector cannot be overstated, as it serves as a cornerstone for sustainable economic development and environmental preservation. Below is an explanation of the key reasons why green manufacturing being vital for Nigeria:

(i) **Mitigating Environmental Impact:** Nigeria's industrial sector, heavily dependent on oil, gas, and resource-intensive manufacturing, is a primary source of pollution, contributing to soil degradation, water contamination, and air pollution. Green manufacturing addresses these issues by minimizing waste and emissions and using environmentally friendly materials and processes. By implementing cleaner production practices, industries can significantly reduce their carbon footprint and lessen the damage to Nigeria's fragile ecosystems, ultimately promoting biodiversity and environmental resilience. This shift is especially important given the country's vulnerability to climate change, where reduced emissions can help in the fight against rising temperatures and shifting weather patterns.

(ii) **Improving Resource Efficiency and Cost Savings:** Green manufacturing emphasizes the efficient use of raw materials, energy, and water, resulting in reduced consumption and waste. Through techniques such as recycling, reusing by-products, and adopting energy-efficient technologies, businesses can achieve substantial cost savings. For example, energy-efficient machinery reduces electricity expenses, while optimized production processes lower raw material costs. These savings improve profitability over time, allowing businesses to invest in innovation and growth. Additionally, the reduction in resource dependency helps safeguard against fluctuations in global commodity prices, creating a more resilient industrial sector.

(iii) **Enhancing Market Competitiveness:** As global demand for environmentally responsible products grows, adopting green manufacturing practices gives Nigerian industries a competitive advantage in both domestic and international markets. Green certification and eco-labeling make Nigerian products more appealing to consumers who prioritize sustainability, as well as to investors seeking to fund eco-friendly ventures. Moreover, alignment with international environmental standards, such as ISO 14001, opens new export

opportunities and enhances Nigeria's reputation on the global stage. With the African Continental Free Trade Area (AfCFTA) facilitating cross-border trade, green manufacturing can help Nigerian products stand out in a competitive market, ultimately boosting the country's export potential and contributing to economic diversification.

(iv) **Supporting Public Health:** Industrial pollution has a direct impact on the health and well-being of Nigerians, especially for communities located near manufacturing hubs. Pollutants released into the air, water, and soil can cause respiratory issues, waterborne diseases, and other health problems. Green manufacturing reduces the release of harmful pollutants and promotes cleaner production practices, thereby improving air and water quality. This shift translates into better public health outcomes, reduces healthcare costs, and enhances overall quality of life. By prioritizing public health through green manufacturing, Nigeria can alleviate the socio-economic burden of pollution-related health issues and create a healthier, more productive workforce.

(v) **Promoting Sustainable Economic Growth:** Green manufacturing is essential for sustainable industrialization—a critical component of Nigeria's long-term economic development. By reducing environmental impact, enhancing efficiency, and supporting public health, green manufacturing fosters a more sustainable economy. It aligns with Nigeria's national development goals and international commitments, such as the United Nations Sustainable Development Goals (SDGs), particularly Goal 9 (Industry, Innovation, and Infrastructure) and Goal 12 (Responsible Consumption and Production). Green manufacturing drives innovation, encourages skill development in sustainable practices, and creates jobs in areas like waste management, renewable energy, and eco-friendly product development, laying the groundwork for a diversified and resilient economy.

(vi) **Encouraging Corporate Social Responsibility (CSR) and Attracting Foreign Investment:** Green manufacturing encourages industries to adopt a responsible approach to production, demonstrating a commitment to environmental stewardship and corporate social responsibility (CSR). By integrating eco-friendly practices, companies build positive relationships with local communities and demonstrate accountability, enhancing their public image. Additionally, Nigeria's alignment with global green practices makes the country more attractive to foreign investors who prioritize sustainability and seek investment opportunities in responsible industries. Green manufacturing

can thus act as a magnet for environmentally conscious investors and multinational corporations looking to expand their operations in Nigeria, boosting foreign direct investment and technological transfer in the process.

Current Landscape of Green Manufacturing in Nigeria

Nigeria's journey toward green manufacturing is still at an early stage, with efforts largely concentrated in specific industries and often led by multinational companies with global sustainability commitments. However, awareness of green practices is gradually spreading within the domestic manufacturing sector as the benefits of reduced environmental impact, cost savings, and enhanced competitiveness become evident. Below is an overview of the main industries where green manufacturing practices have started to gain traction:

Some of the key industries where green manufacturing practices have gained traction include:

(i) **Cement Production:** The cement industry is one of Nigeria's major industrial sectors, contributing significantly to both the economy and greenhouse gas emissions. Leading cement manufacturers in Nigeria have taken substantial steps to lower their carbon footprint, focusing on innovations like co-processing, which involves substituting a portion of fossil fuel usage with alternative fuels derived from waste materials. By using this technique, companies can reduce reliance on conventional energy sources and lower emissions, aligning with green manufacturing principles. Furthermore, some producers have begun incorporating recycled materials, such as fly ash and slag, into cement, reducing both resource consumption and waste (Oseremen, 2019). These efforts signal a positive shift toward sustainable practices in a traditionally resource-intensive industry.

(ii) **Textile and Apparel Manufacturing:** The textile and apparel sector is another industry in Nigeria making headway in green manufacturing. Known for its high water and energy demands, the textile industry has started adopting environmentally friendly practices to address these challenges. For example, some manufacturers now prioritize eco-friendly materials, like organic cotton, which requires fewer pesticides and chemicals compared to conventional cotton. Moreover, water-saving technologies are being introduced, particularly in the dyeing and finishing processes, which are typically water-intensive. These initiatives not only help conserve water—a critical resource—but also

improve wastewater quality, thereby reducing pollution and making the textile industry more sustainable (Oyedokun, 2019).

(iii) **Food and Beverage Processing:** The food and beverage industry in Nigeria has seen increasing adoption of green manufacturing practices, particularly in areas like sustainable packaging, energy-efficient production, and waste recycling. Recognizing the environmental impact of plastic waste, some companies are shifting toward biodegradable and recyclable packaging solutions, thus reducing landfill contributions and supporting a circular economy. Additionally, energy-efficient machinery is becoming more common in food processing, reducing operational costs and emissions. Waste recycling efforts are also gaining momentum, with food manufacturers' increasingly repurposing organic waste, such as turning food scraps into animal feed or compost. These practices reduce waste, conserve resources, and contribute to an eco-friendlier production cycle (Ezeudu et al., 2019).

Challenges of Green Manufacturing in Nigeria

Despite growing interest and some progress in green manufacturing practices, Nigeria faces several significant challenges that slow the widespread adoption of sustainable methods. These challenges highlight areas where policy intervention, infrastructure improvement, and capacity-building efforts are needed to advance the green manufacturing landscape.

(i) **Limited Infrastructure for Waste Management:** A significant barrier to green manufacturing in Nigeria is the limited infrastructure for efficient waste management and recycling. Circular manufacturing, a key component of green manufacturing, requires robust systems to recover, recycle, and repurpose waste materials. However, Nigeria's waste management infrastructure is underdeveloped, with only a few urban areas equipped with adequate facilities. This deficiency makes it challenging for manufacturers to adopt circular practices, such as closed-loop production, where materials are continuously recycled back into the production cycle. Additionally, the absence of a well-organized waste collection and sorting system hinders the ability of industries to efficiently separate and recycle their waste, resulting in higher disposal costs and environmental impact (Onwuzu & Nnamani, 2023).

(ii) **High Costs of Sustainable Technology:** Investing in green manufacturing technologies requires substantial financial resources, which can be prohibitive for many Nigerian manufacturers, especially small and medium-sized

enterprises (SMEs). Energy-efficient machinery, renewable energy installations, and sustainable materials often come with a high upfront cost. Limited access to affordable financing options exacerbates this issue, as financial institutions may be hesitant to provide loans for green technology investments due to perceived risks and a lack of understanding of green manufacturing benefits. As a result, the cost barrier restricts the ability of many businesses to make the initial investments needed to transition to sustainable practices, slowing the adoption of green technology across industries (Nwankwo, 2022).

(iii) **Weak Regulatory Framework:** Although Nigeria has environmental policies and regulations, enforcement is inconsistent and often inadequate, undermining efforts to encourage green manufacturing. Existing regulations, such as those governing emissions, waste disposal, and resource usage, are not always enforced effectively, which limits their impact. Without strict enforcement, manufacturers may lack the incentive to adopt green practices, opting instead for cost-saving measures that may be environmentally detrimental. Additionally, the absence of targeted incentives or clear guidelines for green manufacturing further discourages businesses from adopting sustainable practices. Strengthening regulatory oversight and introducing incentives for green manufacturing, such as tax breaks or subsidies for eco-friendly technology, could help overcome this barrier (Fayomi et al., 2019).

(iv) **Low Awareness and Expertise:** Another significant challenge is the low level of awareness and technical expertise regarding green manufacturing practices, especially among SMEs. Many business owners and managers in Nigeria are unfamiliar with the benefits and processes involved in green manufacturing, and there is limited availability of local training programs to build this knowledge base. The lack of expertise hinders industries from effectively implementing sustainable practices, as many do not know where to begin or how to measure and improve their environmental impact. Additionally, the shortage of local experts and consultants in green manufacturing means that businesses often lack access to the technical support needed to adopt sustainable practices. Addressing this challenge requires investments in education and capacity-building initiatives focused on green manufacturing principles and skills (Solaja et al., 2020).

(v) **Inconsistent Power Supply and Infrastructure Limitations:** Nigeria's inconsistent power supply poses another obstacle to green manufacturing.

Frequent power outages force manufacturers to rely on backup diesel generators, which increase production costs and contribute to pollution. Although renewable energy options like solar power could help address these issues, the initial costs and the lack of supportive infrastructure make it difficult for many manufacturers to make this transition. Infrastructure limitations, including poor transportation networks and inadequate access to reliable utilities, further complicate efforts to implement green manufacturing practices. These issues increase operational costs and reduce the overall efficiency of manufacturing processes, making it harder for companies to adopt sustainable technologies and practices (Abanyam et al., 2020).

(vi) **Cultural and Societal Barriers:** Cultural perceptions and societal norms can also impact the adoption of green manufacturing in Nigeria. Some manufacturers and consumers may not yet view environmental responsibility as a priority or may not be aware of the potential economic benefits of sustainable practices. This mindset can affect market demand for green products and the willingness of companies to invest in eco-friendly initiatives. Encouraging a cultural shift toward sustainability requires education and public awareness campaigns to highlight the importance of environmental responsibility and showcase the benefits of green manufacturing (Fayomi et al., 2019).

Key Drivers of Green Manufacturing in Nigeria

Green manufacturing is gaining momentum in Nigeria, driven by various influential factors that underscore the importance of sustainable practices in the industrial sector. These drivers are crucial for pushing Nigerian industries toward eco-friendly production processes, which help to mitigate environmental impact, enhance resource efficiency, and align with global sustainability goals (Ogbo et al., 2020).

(i) **Government Initiatives and Policies:** The Nigerian government has introduced several policies aimed at promoting sustainable industrial practices. One key regulatory body, the National Environmental Standards and Regulations Enforcement Agency (NESREA), has established environmental guidelines that encourage industries to reduce their ecological footprint. NESREA's policies focus on minimizing waste, controlling pollution, and implementing efficient resource use in manufacturing processes. Furthermore, the Nigerian Energy Support Program (NESP) works to enhance energy

efficiency in the industrial sector by encouraging the adoption of renewable energy sources and energy-saving technologies. Programs like NESP not only help reduce emissions but also offer long-term cost savings for businesses. Other government initiatives provide incentives or support for companies that adopt green practices, creating an enabling environment that encourages manufacturers to shift toward sustainability.

(ii) **International Standards and Certifications:** For Nigerian manufacturers engaged in international trade, compliance with global environmental standards is essential. Certifications such as ISO 14001 (Environmental Management) and ISO 50001 (Energy Management) require businesses to adhere to stringent environmental and energy-efficient practices. Compliance with these standards helps Nigerian manufacturers enhance their reputation in the global market, attracting international clients who prioritize sustainability. These certifications also motivate companies to implement systematic approaches to managing their environmental impacts, which often involves reducing waste, minimizing emissions, and optimizing energy usage. As more Nigerian companies aim to export goods, the demand for international certifications becomes a significant driver for adopting green manufacturing practices.

(iii) **Consumer Demand for Sustainable Products:** There is a growing global demand for eco-friendly products, and Nigerian companies are recognizing the competitive advantage of meeting these preferences. Consumers, especially in export markets, increasingly prioritize products made through sustainable processes. To attract environmentally conscious consumers and secure a foothold in international markets, Nigerian manufacturers are investing in green manufacturing practices, such as reducing emissions, using recyclable materials, and ensuring ethical sourcing of raw materials. Additionally, domestic consumer awareness is rising, and more Nigerians are beginning to value products made sustainably. As this trend continues, Nigerian companies are likely to further embrace eco-friendly production processes to appeal to both local and global markets.

(iv) **Corporate Social Responsibility (CSR) Commitments:** Multinational corporations (MNCs) operating in Nigeria often have corporate social responsibility (CSR) frameworks that emphasize environmental sustainability. These MNCs typically implement green practices within their own operations and extend these principles to their supply chains, which include Nigerian suppliers and manufacturers. CSR commitments often include policies to

reduce waste, lower carbon emissions, and support recycling and renewable energy usage. As these MNCs require their local suppliers to align with sustainability standards, Nigerian manufacturers are motivated to adopt green manufacturing practices to retain their partnerships with MNCs. The influence of MNCs, combined with their global reach, makes CSR a powerful driver for encouraging sustainable practices in the Nigerian industrial sector.

(v) **Technological Advancements and Innovation:** Technological advancements also play a critical role in driving green manufacturing. New technologies, such as energy-efficient machinery, waste-to-energy systems, and water recycling equipment, enable companies to reduce their environmental impact while optimizing resource use. Innovations in renewable energy, like solar and biomass energy, are becoming more accessible in Nigeria, allowing industries to reduce reliance on traditional fossil fuels. As technology becomes more affordable and available, more Nigerian manufacturers are able to adopt these solutions to minimize energy consumption and reduce waste, thus supporting their sustainability goals. The role of innovation in green manufacturing is pivotal, as it not only improves environmental outcomes but also enhances production efficiency and reduces operational costs.

(vi) **Financial Incentives and Access to Green Financing:** Access to green financing and financial incentives is another driver of green manufacturing in Nigeria. Financial institutions are increasingly offering green bonds, grants, and low-interest loans to support businesses investing in environmentally friendly technologies. Additionally, international organizations, such as the World Bank and the African Development Bank (AfDB), provide funding for green projects in Nigeria, particularly those focusing on renewable energy and sustainable infrastructure. Green financing provides companies with the necessary capital to implement sustainable practices that might otherwise be financially out of reach. By offering targeted financial support, these organizations encourage Nigerian manufacturers to adopt green technologies and processes, thereby promoting sustainability in the industrial sector.

Opportunities for Expanding Green Manufacturing in Nigeria

The shift towards green manufacturing in Nigeria opens a range of opportunities that not only benefit the environment but also promote economic growth, innovation, and resilience in the industrial sector. By embracing sustainable practices, Nigeria can capitalize on its unique resources, create jobs, and position

itself as a leader in sustainable manufacturing within Africa (Popoola & Popoola, 2024). Key opportunities include the following:

(i) **Renewable Energy Integration:** Nigeria's solar potential offers a tremendous opportunity for industries to incorporate renewable energy into manufacturing processes. With an abundance of sunlight, especially in the northern regions, integrating solar energy can substantially reduce fossil fuel dependency, lower greenhouse gas emissions, and enhance energy security for manufacturers. Solar-powered manufacturing facilities can help stabilize production costs and ensure more predictable energy expenses. Additionally, harnessing renewable energy can help manufacturers meet global environmental standards, making their products more competitive in international markets.

(ii) **Waste-to-Energy Projects:** Industrial waste, particularly from agricultural, organic, and chemical sources, can be a valuable resource if converted into energy. Waste-to-energy technologies, such as anaerobic digestion and incineration with energy recovery, provide industries with renewable energy sources while addressing waste management challenges. For example, organic waste from food and beverage production can be converted into biogas, which can then be used to generate electricity or heat. By transforming waste into an asset, Nigerian industries can reduce landfill dependence, lower emissions, and contribute to a circular economy model. Waste-to-energy projects also present investment opportunities for both local and international stakeholders interested in sustainable development.

(iii) **Development of Recycling and Circular Economy Models:** Establishing robust recycling networks and circular economy systems could enable Nigerian industries to reclaim materials, extend the life cycle of products, and minimize waste. For example, the recycling of plastics, glass, metals, and electronic waste can reduce the need for virgin materials, thus conserving resources and reducing production costs. Furthermore, the adoption of circular economy principles—such as designing products for durability and recyclability—can stimulate local economies by creating new job opportunities in the recycling and waste management sectors. Encouraging reuse and recycling not only aligns with green manufacturing goals but also offers environmental benefits, such as reduced pollution and resource conservation.

(iv) **Partnerships and Collaboration:** Collaboration is essential for overcoming the challenges associated with green manufacturing, including funding, infrastructure, and technical expertise. Partnerships between Nigerian

industries, academic institutions, non-governmental organizations (NGOs), and international organizations can foster the research, development, and adoption of sustainable technologies. For instance, collaborations with universities can drive research into innovative green manufacturing methods, while partnerships with international organizations can facilitate access to funding and technological resources. Moreover, government-industry partnerships can also play a significant role in providing incentives for green manufacturing and creating an enabling environment. Knowledge exchange and capacity-building initiatives arising from these partnerships can empower local manufacturers with the skills and tools needed to implement and sustain green practices.

(v) **Local Production of Eco-friendly Materials:** There is significant potential for developing eco-friendly raw materials within Nigeria, such as biodegradable packaging, sustainable textiles, and plant-based plastics. By promoting the local production of such materials, Nigeria can reduce its reliance on imports, decrease transportation emissions, and support local industries. Developing eco-friendly materials also enables industries to offer greener products, which can attract both domestic and international markets looking for sustainable options.

Future Outlook for Green Manufacturing in Nigeria

The outlook for green manufacturing in Nigeria is optimistic, particularly as awareness and support for sustainable industrial practices continue to grow. To fully realize the potential of green manufacturing, Nigeria must address critical areas that will lay the groundwork for broader adoption and impact. If these foundational elements are developed, green manufacturing could become a driving force for sustainable economic growth, environmental resilience, and social well-being in Nigeria. Key factors that could enhance the growth of green manufacturing include:

i. **Strengthening of Environmental Regulations:** Enforcing robust environmental regulations is essential for motivating industries to embrace sustainable practices. While Nigeria has established several environmental policies, the effectiveness of these policies often falls short due to inadequate enforcement. Strengthening the regulatory framework with clear guidelines, regular inspections, and stricter penalties for non-compliance would encourage industries to adopt green manufacturing methods. Moreover, incorporating incentives for compliant industries—such as tax breaks or

priority for government contracts—could further enhance motivation to adopt green practices. Such regulatory advancements would create a more level playing field where companies that prioritize environmental responsibility are rewarded for their efforts.

ii. **Investment in Green Technology:** The development and deployment of green technology are crucial to advancing Nigeria's sustainable manufacturing agenda. Investment from both the government and private sectors will be essential in establishing the infrastructure and resources needed for green manufacturing. This includes renewable energy installations, energy-efficient machinery, waste-to-energy facilities, and recycling plants. By prioritizing green technology, Nigeria can reduce dependency on polluting fossil fuels and pave the way for cleaner, more resilient industries. Targeted subsidies, grants, or loans for purchasing green technology can help industries—especially SMEs—overcome the initial financial barriers associated with sustainable transformation. This investment not only promotes green practices but also fosters local job creation in emerging sectors related to green technology and waste management.

iii. **Education and Training Programs:** For green manufacturing to become widespread, Nigerian industries, particularly small and medium-sized enterprises (SMEs), need to be equipped with the knowledge and skills necessary to implement sustainable practices. Government agencies, industry associations, and academic institutions can play a significant role by developing training programs that cover topics such as energy efficiency, waste reduction, and sustainable sourcing. Specialized education on green manufacturing can also be incorporated into technical and vocational training institutions to prepare the future workforce. Furthermore, collaborative workshops and knowledge-sharing platforms can enable manufacturers to learn from best practices within and outside Nigeria. As awareness grows, industries will be better prepared to make informed decisions that align with sustainability goals, resulting in a greener and more responsible industrial sector.

iv. **Development of Green Financing Mechanisms:** Access to financing is one of the major challenges for Nigerian businesses looking to adopt green manufacturing. Developing green financing mechanisms—such as government grants, subsidies, low-interest loans, or green bonds—can alleviate financial constraints for companies committed to sustainable

practices. By establishing green finance options, the government can attract foreign investments, as many international investors are increasingly prioritizing environmental, social, and governance (ESG) criteria. Financial support can also enable industries to take on large-scale green projects, such as transitioning to renewable energy or installing energy-efficient machinery. Encouraging financial institutions to establish green lending products or partnering with international climate funds can provide additional financial avenues for companies committed to green manufacturing, ensuring that financial barriers do not hinder progress toward sustainability.

v. **Fostering a cultural shift towards sustainability:** Finally, achieving lasting change in Nigeria's industrial sector will require a cultural shift towards sustainability. By raising public awareness about the environmental and economic benefits of green manufacturing, consumers, industry leaders, and policymakers alike can be encouraged to support and prioritize sustainable practices. Educational campaigns, industry awards for sustainability, and media coverage of green manufacturing success stories can help cultivate a culture of environmental responsibility. As sustainability becomes embedded in Nigeria's social and business ethos, industries will find it increasingly advantageous to adopt green manufacturing practices to align with societal expectations and market demands.

Conclusion

Green manufacturing is still in the early stages of adoption in Nigeria's industrial sector, but it holds immense potential for environmental, economic, and social benefits. By transitioning to green manufacturing, Nigerian industries can minimize their environmental impact, lower operational costs, and improve their market competitiveness. Addressing challenges such as limited infrastructure, high costs, and regulatory weaknesses will be essential to accelerating this transition. With supportive policies, investments, and partnerships, Nigeria's industrial sector can embrace green manufacturing, paving the way for a more sustainable and resilient economy.

Recommendations

Government should expend on infrastructures and give training on transition to green manufacturing. Adequate waste management facilities should be provided in both urban areas and rural areas equipped with adequate facilities.

Stake holders and policy makers should create wide awareness on green manufacturing and its importance to consumers and produces

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Regulatory Framework for Land Banking by Private Estate Developers in South West Nigeria

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Abstract

The purpose of this paper was to analyse the legal framework governing land banking by private property developers in South West Nigeria, pointing out any inefficiencies or gaps that impede the development of sustainable urban areas. The study aimed to provide useful suggestions for improving land banking strategies in the area. Using a qualitative research design, the methodology entails a thorough analysis of academic databases, literatures, industry reports, legal papers, and government laws. The study uses thematic content analysis to compare best practices from different regions and find common themes and patterns in the regulatory environment. The results show that there are no special provisions for land banking in the current regulatory framework. This results in corruption, inefficient administration, and inadequate alignment with urban planning. A price hike prices, speculative land holding, and obstacles to real development initiatives are all caused by these problems. The study concludes by highlighting the pressing need for changes to bolster the laws governing land banking. Among the suggestions are modifying current legislation, promoting public-private partnerships, and increasing transparency through digital land registers. By tackling these issues, the region can encourage sustainable urban growth, increase private estate developers' operational effectiveness, and eventually help South West Nigeria reach its larger objectives for social and economic development.

Keywords: Land Banking, Regulatory Framework, Private Estate Developers, Sustainable Development, Urban Planning.

Introduction

Land banking is the planned purchase and retention of undeveloped property for potential future investment or usage (Sasu et al., 2022). This approach is crucial to urban development because it guarantees land availability for commercial, residential, and infrastructure projects, all of which support the creation of an organized society. Long-term planning is made possible by land banking, which is essential for maintaining real estate markets, encouraging economic growth, and reducing housing shortages. In Southwest Nigeria, which is home to rapidly expanding cities like Lagos, Ibadan, and Abeokuta, private estate developers have primarily responded to the increased need for commercial and residential areas (Adenaike, 2023; Ugwuejim & Otegbulu, 2024). In order to buy property at a lower price in expectation of future value gains, these developers commonly employ land banking. The area does, however, experience difficulties, such as insufficient regulatory frameworks that have resulted in conflicts, land abuse, and inefficiency (Babalola, 2023). In order to maximize the advantages of land banking and guarantee sustainable urban development, these problems must be resolved.

In Southwest Nigeria, unregulated land banking activities pose serious obstacles to urban planning and real estate development. Land purchase frequently happens randomly in the absence of strong regulatory frameworks, which can result in ownership disputes, unauthorized encroachments, and inefficient land usage. These actions jeopardize the thoughtful distribution of land for vital urban development initiatives including infrastructure, housing, and business areas. Additionally, the lack of oversight encourages speculative behaviour, inflating land prices and creating barriers to entry for genuine developers. For private estate developers, the absence of clear regulations increases operational risks, prolonging project timelines and escalating costs (Bagenda & Ndevu, 2024). The consequences for urban planning are equally dire, including uncontrolled urban sprawl, inadequate infrastructure provision, and

environmental degradation. These issues exacerbate the region's housing deficit and compromise sustainable development goals.

However, a thorough regulatory framework is needed to address these issues, encourage open land banking, and guarantee controlled urban growth in Southwest Nigeria (Ogundipe et al., 2024). Examining Southwest Nigeria's current land banking regulatory frameworks and their efficacy in supporting sustainable urban growth is the main goal of this study. It aims to identify gaps and inefficiencies within these regulations that hinder transparent and efficient land banking practices. Furthermore, the study seeks to propose practical and innovative solutions for developing a more robust regulatory framework. These recommendations will be tailored to address the challenges faced by private estate developers and enhance the overall effectiveness of land banking in promoting orderly urban planning and economic growth in the region.

This study holds significant value for policy development by offering insights into the regulatory challenges surrounding land banking in Southwest Nigeria and proposing actionable solutions to address these issues. By strengthening the regulatory framework, the study aims to promote transparency, reduce land-related disputes, and foster efficient land use. Estate developers stand to benefit through reduced risks, streamlined land acquisition processes, and lower costs, ultimately enhancing their capacity to contribute to urban development. Regulatory bodies will gain a clearer understanding of existing gaps and the tools needed to enforce policies effectively. The findings will also support sustainable urban planning; ensuring that land banking aligns with broader economic and social development goals for the region.

Literature review

The Concept of Land Banking

Land banking is a practice widely adopted by private estate developers, governments, and individual investors as a means of securing land at relatively low prices with the expectation of its value appreciating over time (Wu, 2022). It entails finding and acquiring parcels of land in a place like South-West Nigeria with the intention to utilize them for different reasons such as urban development, infrastructural projects, agriculture, or conservation. One instrument that works particularly well for addressing the problem of land dissolution is land banking. Individuals, businesses, and governments frequently use this method to benefit on potential rises in land value as time progresses. Land banking has become a popular

investment option in South West Nigeria as a result of the region's fast urbanization and population increase (Awuah & Abdulai, 2022).

Nigeria's housing and urban development policies and programs have undergone several stages, which can be divided into three periods: colonial, post-independence, and post-military (Morakinyo et al., 2012). According to Home (2021), Nigeria's Land Use Act (1978) abolished any remaining private ownership upon the country's independence in 1960 and distributed land rights through certificates of occupancy, which are the equivalent of 99-year leases. Minerals, however, continued to be a federal affair. State governors held authority over these certificates, which date back to earlier colonial policies (19 in 1976, and 36 by 1996, plus a Federal Capital Territory).

Table 1: The evolution of the policies and programs in housing and urban infrastructure sector in Nigeria (Obianyo et al., 2021)

Nigerian Building Society	**1956**	**Defunct**
Regional Housing Corporation	1959	Defunct
National Provident Fund (NPF)	1961	Replaced
National Council on Housing	1971	Functional
Federal Housing Authority (FHA)	1973	Functional
Federal Mortgage Bank of Nigeria (FMBG)	1977	Functional
Land Use Decree (LUD)	1978	Functional
Nigerian Building and Road Research Institute (NBRRI)	1978	Functional
Infrastructure Development Fund (IDF)	1985	Defunct
Federal Housing Authority Act	1990	Functional
1st National Housing Policy	1991	Replaced
Urban and Regional Planning Decree	1992	Defunct
National Housing Fund	1992	Functional
Infrastructure Bank Plc	1992	Functional
Urban Development Bank of Nigeria	1992	Defunct
Nigeria Social Insurance Trust Fund (NSITF)	1993	Functional
National Urban Development Policy	1997	Defunct
Nigeria State Urban Development Programme (NSUDP)	1997	Defunct
Housing and Urban Development Policy	2002	Functional
Abuja Geographic Information Systems (AGIS) and other State GIS	2003	Functional
Federal Ministry of Housing and Urban Development	2003	Functional
2nd National Housing Policy	2004	Replaced
3rd National Housing Policy	2006	Functional
Housing for All under Vision 20:2020	2008	Functional
Road Map for Housing Development	2012	Functional
Family Homes Fund (Economic Recovery & Growth Plan: 2017–2020)	2017	Functional
Presidential Infrastructure Development Fund (PIDF)	2018	Functional
Executive Order 7 of 2019 on the Road Infrastructure Development and Refurbishment Investment Tax Credit Scheme	2019	Functional

However, as regards practices and models regarding land banking globally, there are two land systems in China: urban and rural. While the State owns land in urban districts, peasants collectively hold land in rural and suburban areas, unless the State provides for a different arrangement (Zhou et al., 2021). Also, apart from Belarus, where all property is still controlled by the state, most rural areas in Europe have private land ownership (Jiang et al., 2022). Although South West Nigeria has made significant advancements in bringing its policies into accordance with the demands of sustainable development, there are still underlying issues. Because of their profound historical and socio-political origins, these issues require an integrated strategy to effectively mitigate.

Regulatory Frameworks for land banking in Nigeria

The regulatory framework for land banking in Nigeria is primarily governed by the **Land Use Act of 1978**, which centralizes land ownership under state governors, holding it in trust for citizens (Goodfellow et al., 2024). The Act provides the legal basis for land acquisition, allocation, and use, requiring individuals and organizations to obtain a Certificate of Occupancy (C of O) to secure land rights. However, the Act lacks provisions specific to land banking, leaving gaps in addressing speculative land holding and long-term land management practices. Additional regulatory oversight is provided through urban and regional planning laws, which aim to guide land use and prevent uncontrolled urban sprawl (Koroso & Zevenbergen, 2024). At the municipal level, local government bodies are responsible for overseeing land distribution. Despite these frameworks, issues including ineffective enforcement, corruption, and administrative hurdles still exist. Due to these problems, land banking cannot be effectively regulated, which frequently results in conflicts, wasteful land usage, and environmental damage.

Globally, effective land banking practices are underpinned by comprehensive regulatory frameworks that promote transparency, sustainability, and strategic land use. In countries such as the United States and the Netherlands, land banking is supported by well-established land banks or public entities that acquire, manage, and repurpose vacant or underutilized land (Floris, 2024). These frameworks emphasize clear ownership rights, streamlined acquisition processes, and public-private collaboration to ensure equitable and efficient land use. The Land Use Act of 1978 serves as the main foundation for Nigeria's land banking regulations, which are unclear and do not take into account the complex nature of contemporary land

banking operations. There are many problems, including unsustainable landholding, poor land management regulations, and ineffective enforcement systems. Effective land banking techniques can help Nigeria improve its regulatory environment, cut down on inefficiencies, and encourage sustainable urban growth by incorporating aspects of international best practices, such as digitalized land registries, more robust institutional oversight, and policies supporting sustainable development.

Furthermore, the Land Use Act is supplemented by regional urban planning laws, which direct development and land use in particular areas. These regulations highlight environmental sustainability, infrastructure development, and zoning. However, they frequently lose their effectiveness due to poor enforcement, a lack of centralized resources, and a lack of alignment with national programs. This regulatory fragmentation hampers coordinated urban planning and sustainable land banking.

Challenges in Land Banking Regulation

Land banking regulation in Nigeria faces significant legal and institutional barriers that hinder its effectiveness. The Land Use Act of 1978, which consolidates land ownership under state governors, acts as one of the fundamental obstacles. Although the Act was intended to simplify land management, it has unintentionally led to corruption and regulatory challenges, which have complicated the processes of land purchase and development. Furthermore, the absence of precision in addressing land banking practices has led to ownership disputes, opportunistic ownership of land, and legal difficulties (Shukla, 2021). These issues are made worse institutionally by fragmented governance and poor enforcement measures. Local government councils, which play a crucial role in land allocation, often lack the capacity, resources, and transparency needed to manage land banking effectively. Inadequate digitization of land records and inefficient land registration systems create gaps that promote fraud and land mismanagement (Rahman, 2023). These inefficiencies undermine urban planning efforts, discourage private sector investment, and contribute to uncontrolled urban sprawl and environmental degradation.

Transparency and accountability remain critical challenges in land banking regulation in Nigeria (Ugonabo et al., 2023). In addition to the lack of a centralized and digital land registry, which makes it difficult to track ownership and land transactions, the land administration process is frequently ravaged by translucent

practices that encourage corruption at all levels of governance, including land allocation and the issuance of Certificates of Occupancy (C of O). This lack of accountability discourages private estate developers, who must deal with lengthy process delays and exorbitant costs. The absence of robust mechanisms for monitoring and regulating speculative landholding further widens the regulatory gaps. In addition to interfering with urban planning initiatives and fostering untamed urban development, these inefficiencies undermine the general trust in the system. In order to promote sustainable land banking techniques and efficient urban growth, these issues must be resolved.

Implications for Private Estate Developers

Weak regulations governing land banking in Nigeria have significant implications for private estate developers, particularly in land acquisition and urban planning. Uncertainty in land ownership is caused by unclear legal frameworks and ineffective land registration procedures, which can result in disagreements and project execution delays (Mberema, 2022; Koroso & Zevenbergen, 2024). Due diligence is made more difficult by the lack of a centralized, digital land register, which raises the possibility of fraudulent transactions and several claims on the same property (Bakar et al., 2022). In terms of urban planning, the absence of strong rules encourages speculative landholding, which raises land prices and reduces the amount of reasonably priced land available for development. These difficulties show how urgently extensive regulatory changes are needed to promote sustainable land banking and improve urban growth.

Methodology

This study adopts a qualitative research design, utilizing secondary data to explore the regulatory framework for land banking by private estate developers in Southwest Nigeria. The research draws on an extensive review of existing literature, including government policies, legal documents, journal articles, industry reports etc. The study will be desk-based, investigating many different sources to get conclusions about the regulatory framework for land banking by private estate developers in South West Nigeria.

The data collection process involves sourcing relevant materials from academic databases, government archives, and institutional publications. Key documents such as the Nigerian Land Use Act, regional urban planning laws, and reports from estate development agencies are analysed to assess the current regulatory

landscape. These materials will serve as the foundation for the study's theoretical framework and main arguments.

Data analysis is conducted using thematic content analysis, which involves identifying recurring themes, patterns, and gaps within the existing regulations. The analysis also includes a comparative evaluation of best practices in land banking regulations from other regions or countries. This approach ensures a comprehensive understanding of the challenges and opportunities within the regulatory framework for land banking in Southwest Nigeria. By combining theoretical analysis with verifiable cases, the study intends to provide useful insights into regulatory framework for land banking by private estate developers in South West Nigeria as well as feasible and strategic recommendations for applications in the future.

Result & Discussion

Overview of the Existing Regulatory Framework

Table 2: Overview of existing regulatory framework

Category	Details
Laws Governing Land Banking	Land Use Act of 1978: Centralizes land ownership under state governors, requiring a Certificate of Occupancy (C of O) for land rights. Establishes a framework for land administration but lacks specific provisions for land banking practices.
Policies	Urban and regional planning policies aim to guide land use and promote sustainable development. Policies are intended to facilitate orderly urban growth and infrastructure development.
Institutional Framework	Local government councils are responsible for land allocation and management. Various regulatory bodies exist, including state ministries and land agencies, to oversee land administration and development processes.
Regulatory Objectives	To ensure efficient land use and promote sustainable urban development. To provide a legal framework that supports private estate developers in securing land for development projects.
Land Administration Processes	Involves procedures for land acquisition, registration, and allocation. Requires compliance with legal requirements, including obtaining necessary permits and approvals for development activities.

Source: Author's Compilation, 2025

Gaps and Challenges Identified

Table 3: Gaps & challenges in existing regulatory framework

Gap/Challenge	Description
Regulatory Gaps	Lack of specific provisions in the Land Use Act of 1978 addressing land banking practices. Ambiguities in the law lead to speculative landholding and ownership disputes.
Weak Enforcement Mechanisms	Ineffective enforcement of existing laws and regulations. Corruption and bureaucratic bottlenecks hinder the land acquisition and development processes.
Fragmented Governance	Local government councils often lack the capacity, resources, and transparency needed for effective land management. Poor coordination among various regulatory bodies hampers urban planning efforts.
Inefficient Land Registration	Inadequate digitization of land records creates gaps that promote fraud and land mismanagement. Slow and cumbersome land registration processes discourage private sector investment.
Transparency Issues	Opaque practices in land administration make it difficult to track ownership and land transactions. Lack of accountability in land allocation processes leads to disputes and mistrust among stakeholders.
Impact on Urban Development	Uncontrolled urban sprawl and inadequate infrastructure provision result from ineffective land banking regulations. The region's housing deficit is exacerbated by these regulatory challenges.
Alignment with National Policies	Existing regulations often lack alignment with broader national development goals and programs, leading to disjointed urban planning efforts

Source: Author's Compilation, 2025

Impact of Regulatory Gaps on Private Estate Development

Table 4: The Impact of gaps in existing framework on Private Estate Development

Impact	Description
Increased Operational Risks	Regulatory gaps lead to uncertainty in land ownership, making it difficult for developers to secure land rights. Heightened risks of fraudulent transactions and multiple claims on the same property.
Project Delays	Ambiguities in legal frameworks and ineffective land registration processes result in significant delays in project execution. Developers face prolonged timelines due to bureaucratic hurdles.
Escalating Costs	Increased operational risks and project delays contribute to higher costs for private estate developers. Developers may incur additional expenses in legal disputes and navigating complex regulatory environments.
Limited Access to Affordable Land	Speculative landholding driven by weak regulations inflates land prices, reducing the availability of reasonably priced land for development. This limits opportunities for developers to engage in affordable housing projects.
Undermined Urban Planning	Ineffective land banking regulations contribute to uncontrolled urban sprawl and inadequate infrastructure provision. Disjointed urban development efforts compromise sustainable growth and planning objectives.
Decreased Investor Confidence	The lack of a transparent and accountable regulatory framework discourages private sector investment. Investors may be hesitant to engage in projects due to fears of legal disputes and regulatory uncertainties.
Environmental Degradation	Poorly regulated land development can lead to environmental harm, including loss of green spaces and inadequate infrastructure for waste management. This undermines sustainable development goals in the region.

Source: Author's Compilation, 2025

Comparative Analysis with Global Practices

Table 5: Comparative analysis with global practices

Aspect	Southwest Nigeria	Global practices
Regulatory Framework	Governed primarily by the Land Use Act of 1978, which lacks specific provisions for land banking.	Many countries have comprehensive land banking laws that specifically address land acquisition and management.
Land Ownership	Centralized under state governors, creating bureaucratic bottlenecks.	Varies by country; many have decentralized systems allowing for private ownership and easier transactions.
Land Acquisition Process	Cumbersome and often plagued by corruption and inefficiencies.	Streamlined processes in many countries, often supported by digital platforms for transparency and efficiency.
Transparency and Accountability	Opaque practices in land administration hinder tracking of ownership and transactions.	Many countries implement transparent land registries and public access to land records to enhance accountability.
Urban Planning Integration	Limited integration of land banking with urban planning efforts, leading to uncontrolled sprawl.	Effective integration of land banking with urban planning in many regions, promoting sustainable development.
Private Sector Involvement	High operational risks and project delays discourage private investment in land development.	Strong public-private partnerships in many countries facilitate investment in land banking and urban development.
Environmental Considerations	Insufficient regulations to address environmental impacts of land development.	Many countries incorporate environmental assessments and sustainability criteria into land banking practices.
Technological Adoption	Inadequate digitization of land records and registration systems.	Advanced use of technology, including GIS and online platforms, to manage land banking and streamline processes.

Source: Author's Compilation, 2025

Recommendations

Strengthen Legal Framework: The Land Use Act of 1978 should be modified to reflect special provisions for land banking, which would cover long-term approaches to land management and opportunistic property ownership.

Enhance Transparency: Implement a digital land registry system to promote openness in property transactions and ownership records, allowing developers to easily verify land titles and eliminate illicit transactions.

Simplify Land Acquisition Processes: Reduce administrative obstacles and create specific guidelines for acquiring Certificates of Occupancy (C of O) and other required permits to improve efficiency and speed up the land acquisition process.

Promote Public-Private Partnerships: To promote investment in land banking and urban development projects, government organizations and private estate developers should work together, guaranteeing mutual benefits and joint responsibility.

Integrate Urban Planning with Land Banking: Create thorough urban planning guidelines that take land banking strategies into account, making sure that land use satisfies housing shortages and sustainable development objectives.

Conclusion

In conclusion, the study emphasizes the vital need for a comprehensive regulatory framework governing land banking by private estate developers in South West Nigeria. While current legal and administrative mechanisms lay the groundwork for land management, important gaps remain that impede successful land acquisition and sustainable urban growth. By resolving these weaknesses through targeted reforms such as amending the Land Use Act, implementing open land registries, and promoting public-private partnerships, the region may create a more conducive environment for investment and growth. Furthermore, integrating urban planning with land banking practices will ensure that development aligns with the broader goals of sustainability and community welfare. Ultimately, strengthening the regulatory framework will not only enhance the operational efficiency of private estate developers but also contribute to the realization of sustainable development objectives, addressing the pressing housing deficit and promoting orderly urban growth in South West Nigeria.

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Assessing Accessibility to Educational Facilities in Yola South Local Government Area, Adamawa State: A Spatial and Socioeconomic Perspective

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Abstract

This study evaluates the accessibility of educational facilities in Yola South, Adamawa State, Nigeria, with a focus on primary and secondary schools. The research employed a mixed-methods approach, combining both primary data from a field survey and secondary data from official records. Data collection involved a structured questionnaire administered to 145 participants from primary and secondary schools, including teachers, principals, and head teachers, to assess the accessibility to key facilities such as classrooms, libraries, toilets, staff rooms, and electricity supply. Geographic Information Systems (GIS) software was used for spatial analysis to determine the accessibility to educational facilities across the study area. A reconnaissance survey was first conducted to map out the study area, followed by the collection of spatial data using satellite imagery and GPS coordinates. The data were analysed using descriptive statistics and GIS tools, including buffering and hotspot analysis, to identify areas with limited access to educational resources. The results highlight significant disparities in the accessibility of educational facilities between different wards in the region, with implications

for educational planning and policy. The study calls for a more strategic approach to improving access to educational opportunities.

Keywords: Accessibility, Educational Facilities, GIS, Yola South, Spatial Analysis

Introduction

Education serves as the foundation for societal development, acting as a regulated medium for transferring socially significant experiences across generations (Dagar, 2017). It is a comprehensive process encompassing the acquisition of knowledge, skills, and character development, enabling individuals to make informed decisions in various circumstances (Idris, 2012). The term "education" is derived from the Latin word educare, meaning "to bring up" or "nourish," underscoring its fundamental role in fostering human conduct and societal advancement. In Nigeria, education is pivotal to the nation's aspiration to rank among the world's largest economies. However, the current educational landscape in the country is fraught with challenges that necessitate urgent reforms to position education as a robust tool for national development.

The equitable distribution and accessibility of educational facilities are critical to achieving sustainable development goals (SDGs). Despite the acknowledged importance of education, disparities persist in the allocation and accessibility of educational resources, particularly in underserved regions such as Yola South Local Government Area in Adamawa State. Geographic Information Systems (GIS), a powerful tool for spatial analysis, present innovative solutions for evaluating and optimizing the distribution of educational resources (Parveen I & Awan, R.2019). GIS integrates spatial data with relevant attributes, facilitating evidence-based decision-making to enhance educational planning and management.

Previous studies have demonstrated the spatial inequities in educational resource allocation. For example, Haruna and Banki (2012) analyzed the distribution of primary and secondary schools in Bida City, Nigeria, revealing that the distribution often failed to align with population density, resulting in inequitable access. Similarly, Deniz (2023) investigated the spatial distribution of secondary schools in Salihli city, Turkey, identifying significant disparities, including

shortages in northern regions and overcrowding in primary schools. These studies highlight a global challenge: unequal spatial distribution of educational facilities that limits accessibility and efficiency. However, there is limited research addressing how factors such as proximity, population density, and infrastructure quality influence access and utilization of educational facilities in specific Nigerian contexts like Yola South Local Government Area.

The Federal Government of Nigeria recognizes the shortage of qualified teachers as a significant impediment to improving educational standards. Approximately 23% of the over 400,000 primary school teachers lack the Teachers' Grade Two Certificate, even though the National Certificate of Education (NCE) is the minimum required qualification for teaching at this level (Africa Union Analysis, 2019). In remote areas, however, holders of the Teachers' Grade Two Certificate are still employed due to a lack of alternatives (Better Future Foundation Amodu [BFFA], 2014). Global standards for teacher-pupil ratios also vary, with UNESCO (2019) recommending a ratio of 1:25 for primary schools, whereas Nigeria's Universal Basic Education Plan (2010–2019) adopted a more relaxed ratio of 1:35 to accommodate resource constraints.

In terms of accessibility, the Federal Ministry of Education (FMoE, 2009) recommends that primary schools should be within a 3–4 km walking distance for children. Similarly, the Revised Yola Metropolitan Plan (RAMP, 1980) established a service radius of 5 km for public primary schools, with a maximum class size of 50 pupils and a teacher-pupil ratio of 1:25 pre- primary, primary 1:35, for secondary school 1:40. (Ogunode 2020). These benchmarks are critical for guiding equitable resource distribution, but effective implementation requires robust tools such as school mapping (SM). School mapping, as described by Mercy (2024), integrates technical data like population density and settlement patterns into the planning of school locations, enhancing resource allocation.

The use of GIS in education planning offers numerous advantages. Studies have demonstrated its efficacy in identifying disparities and optimizing resource distribution. For example, Ahmed et al. (2013) used thematic maps and buffer zone analyses to evaluate the distribution of police stations in Yola Metropolis, while Kibon and Ahmed (2013) applied similar methods to healthcare facilities, uncovering clustered distributions. In the educational sector, Sule, Abdullahi, and Bungwon (2012) and Aliyu (2013) employed GIS to assess school distribution in Kaduna and Yola North Local Government Areas, respectively. Their findings

revealed uneven resource distribution, with some areas underserved while others experienced facility clustering.

GIS further enhances educational planning by integrating spatial data with educational statistics, such as teacher-pupil ratios and infrastructure quality (Eray, 2012). This integration supports evidence-based decision-making, as demonstrated by Olubadewo, Abdulkarim, and Ahmed (2013) in Fagge Local Government Area, where thematic mapping and buffer zone analyses were used to improve resource allocation. However, several barriers to effective education delivery remain, including inadequate infrastructure, insufficient funding, and unqualified teaching staff is a barrier to education access (Johnson & Wasiu 2016). Addressing these challenges requires innovative strategies, such as leveraging GIS technology to ensure equitable access and improved resource management.

Modern GIS applications offer advanced features such as attractive data visualization, precise spatial analysis, and scenario planning. These capabilities allow for the projection of tabular data onto thematic maps, uncovering patterns that facilitate more effective planning, Ibrahim (2019). By integrating GIS into educational micro-planning, stakeholders can optimize resource distribution, improve infrastructure management, and ultimately enhance student outcomes.

This study evaluates the accessibility and spatial distribution of educational facilities in Yola South Local Government Area, Adamawa State, using GIS. The findings aim to provide actionable insights into the alignment of educational infrastructure with population needs, identify gaps, and offer recommendations for more effective planning and resource allocation.

Materials and Methods

Study Area

Yola South, situated in Adamawa State, Nigeria, forms part of the state's administrative capital. It shares boundaries with Jimeta, a major commercial hub, and is located at latitude 9°14'N and longitude 12°28'E. The area exhibits diverse land uses, including administrative, residential, institutional, industrial, and commercial. Among these, residential land use predominates and is further categorized into low, medium, and high-density zones. High-density areas are particularly notable for their intense commercial activities (Ilensanmi, 1999). The major ethnic groups include the Fulani, Verre, Laka, and Hausa, with Fulfulde and Hausa serving as the primary languages (Fakuade, 1999).

The population of Yola South was recorded as 196,197 in the 2006 census, with an estimated annual growth rate of 2.8% (Federal Republic of Nigeria, 2009). This study focused on the 11 wards of Yola South, employing stratified random sampling to select 145 participants, comprising teachers, principals, and head teachers from primary and secondary schools.

Reconnaissance Survey

A reconnaissance survey was conducted to evaluate the study area and locate key facilities in primary and secondary schools. A descriptive survey design was adopted, and data collection was carried out using a structured questionnaire titled "School Facility Inventory." This inventory documented information on available facilities such as classrooms, libraries, staffrooms, playgrounds, and utilities.

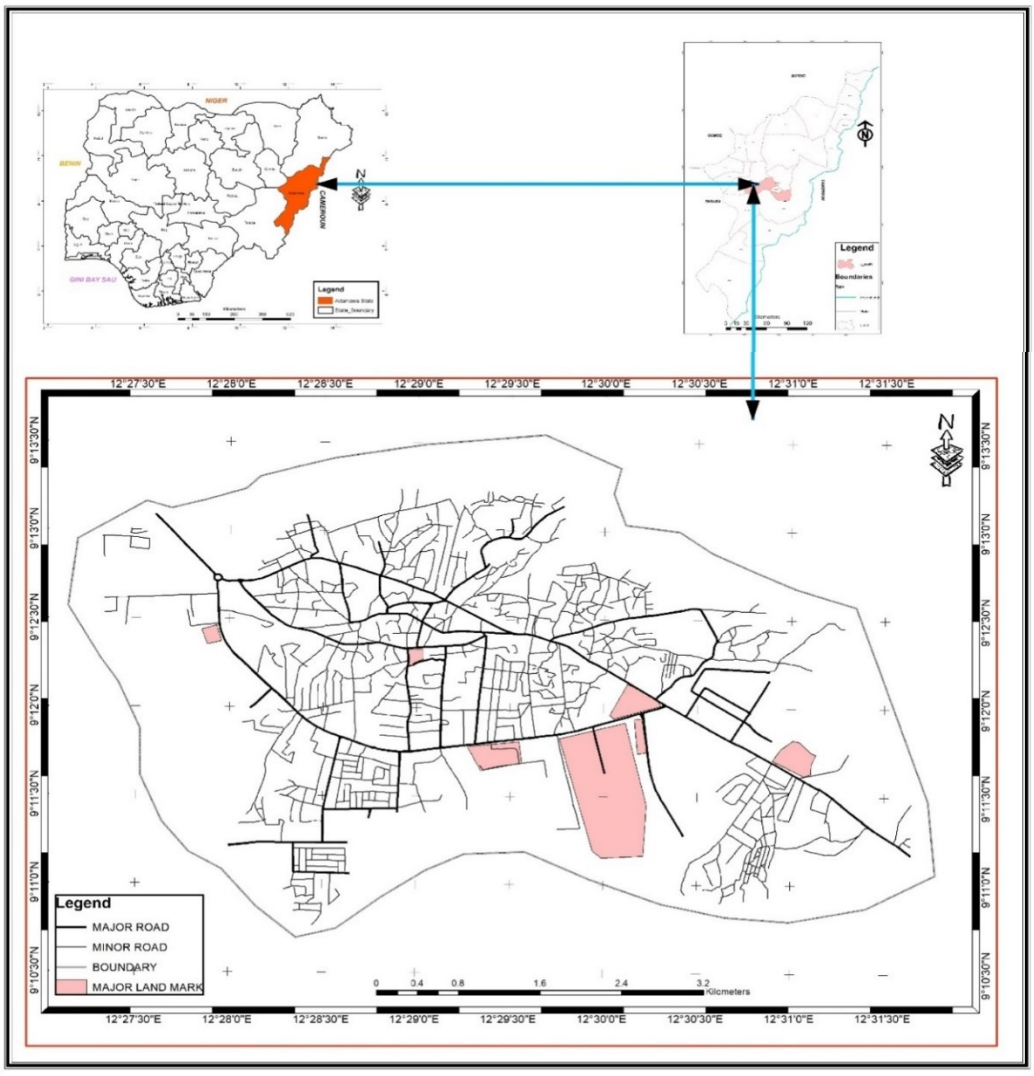


Fig: 1, Map of the study Area:

Types and Sources of Data

The study utilized both primary and secondary data to evaluate the accessibility of educational facilities in Yola South. Primary data were collected through field observations, GPS coordinates, and satellite imagery. Tools such as Google Earth Pro 7.4 were employed for spatial data acquisition, while an Etrex 10 Garmin GPS receiver was used to collect precise geospatial data. Additionally, a 5-point Likert scale questionnaire was administered to gather respondents' perceptions of access to educational facilities. Secondary data were sourced from textbooks, journals, government publications, and various datasets, including WorldView-2 high-resolution satellite imagery and digital administrative maps of Nigeria. Other key secondary data included educational enrollment records and teacher qualification data obtained from the Yola South Local Education Authority. Specifically, school enrollment data from 2020 and records of teacher qualifications and school facilities from 2021 were digitized and analyzed using Excel to create a database table, enhancing the comprehensiveness of the analysis.

Methods of Data Analysis

The methods of data analysis and presentation employed a combination of spatial and statistical techniques, with ArcGIS 10.8 serving as the primary analytical tool. The methodology was organized into three phases.

In the first phase, data input, satellite images were georeferenced using the Universal Traverse Mercator (UTM) Zone 33N coordinate system. Spatial features, including roads, schools, and public facilities, were digitized to construct a comprehensive geospatial database. In the second phase, digitization, shapefiles were created to classify and analyze spatial features, with attributes assigned to datasets for road networks, buildings, and other significant landmarks.

The third phase involved analysis and results, encompassing spatial and statistical analyses. GIS tools, such as buffering and hotspot analysis, were employed to examine the distribution patterns of educational facilities. Descriptive statistics, including mean and frequency analyses, were applied to field data to complement the spatial analysis. The findings were visualized through maps and charts, providing insights into the accessibility of educational facilities and their compliance with standards set by UNESCO (2015) . Buffering analysis played a critical role by creating buffer zones around educational facilities, which helped

evaluate their accessibility within specific distance thresholds. This analysis also identified areas in need of improved infrastructure and service delivery.

Statistical Analysis

The data were analyzed using a Likert scale, measuring levels of agreement across the following categories: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). A threshold mean of 2.50 indicated agreement.

The integration of spatial and statistical methods provided a robust framework for assessing the distribution and accessibility of educational facilities in Yola South.

Results and Discussion

The results from the survey on the accessibility of educational facilities in Yola South present a mixed picture. Both primary and secondary schools face significant challenges in terms of infrastructure, which affects their accessibility and, consequently, the quality of education provided.

Primary Schools

Table 1 highlights the results for primary schools, where several critical issues were identified. For instance, the survey indicated that a majority of respondents disagreed with statements regarding the adequacy of classroom blocks, libraries, staff rooms, playgrounds, and utilities ($M \leq 2.0$). The results showed that facilities like toilets for both male and female students, staff rooms, and organized playgrounds were inadequate, with most responses falling under the "Disagree" category. These findings align with studies that report the poor state of school infrastructure in many developing regions (Ihebon &Uko, 2020). The lack of these basic amenities could lead to an environment that is not conducive to learning, negatively impacting students' academic performance and overall well-being.

However, it was noted that headteachers' offices were deemed adequate, with an average agreement score of 3.1, suggesting that administrative facilities may be slightly better maintained compared to other educational amenities. This could be attributed to the prioritization of administrative needs over student-focused infrastructure in some schools (Jokodole, 2021).

Table 1: School facilities inventory (primary schools)

S/N	Items	SA	A	D	SD	M	REMAKS
1.	Does the school have enough class room blocks?	2	10	28	45	1.6	Disagree
2.	Does the school have the following facilities?						
	Library	4	10	21	50	1.6	Disagree
	Staff room	7	11	20	47	1.9	Disagree
	Head teachers office	49	21	9	6	3.1	Agree
3.	Does the school have toilets for?						
	Male	5	17	23	40	1.6	Disagree
	Female	3	20	23	39	1.9	Disagree
	Male teachers	5	12	27	41	1.8	Disagree
	Female teachers	12	15	21	37	2.0	Disagree
4.	Does the school have organized playing fields?	10	16	12	42	1.8	Disagree
5.	Does the school have electricity supply?	11	9	14	51	1.8	Disagree
6.	Do you have male teachers in this school?	20	53	10	2	3.1	Agree
7.	Do you have female teachers in this school?	4	10	21	50	1.5	Disagree
8.	Does the school have enough furniture's?	5	6	19	56	1.6	Disagree

M= Mean; N= 85

Secondary Schools

Similarly, the secondary school data presented in Table 2 revealed that the accessibility of educational facilities in these schools was also suboptimal. Items such as classroom blocks, playing fields, electricity supply, and furniture all received negative assessments, with agreement scores consistently falling below 2.5 ($M \leq 2.1$), signaling a significant gap in these facilities. The absence of adequate infrastructure in secondary schools is consistent with previous findings that indicate infrastructural deficits as a key challenge in Nigerian education (Tsohon Kanifani 2018). The inadequacies in these schools could have profound

effects on students' ability to perform academically, as the lack of proper learning environments is known to correlate with reduced student performance (Osher, 2020).

However, some aspects, such as the availability of libraries, staff rooms, and male teachers' toilets, were rated more positively, reflecting some areas where progress has been made. These positive responses could suggest targeted efforts to improve administrative and basic welfare facilities in these schools, potentially due to the allocation of resources towards maintaining these services (LEAP Africa, 2023).

School facilities inventory (Secondary Schools)

S/N	Questions (items)	SA	A	D	SD	X	REMAKS
1.	Does the school have enough class room blocks?	12	5	18	25	1.4	Disagree
2.	Does the school have the following facilities?						
	Library	26	4	4	16	2.9	Agree
	Staff room	21	10	8	21	2.9	Agree
	Principal office	49	5	__	6	3.6	Agree
3.	Does the school have toilets for?						
	Male		17	23	40	2.1	Disagree
	Female	3	20	23	39	2.3	Disagree
	Male teachers	21	13	5	21	2.6	Agree
	Female teachers	26	15	2	17	2.8	Agree
4.	Does the school have organized playing fields?	9	13	11	27	2.1	Disagree
5.	Does the school have electricity supply?	11	9	30	2	2.2	Disagree
6.	Do you have male teachers in this school?	40	8	2	10	3.3	Agree
7.	Do you have female teachers in this school?	5	4	42	8	2.1	Disagree
8.	Does the school have enough furniture's?	5	2	10	43	1.5	Disagree

M= Mean; N= 60

Accessibility and Spatial Distribution

The accessibility of educational facilities was further analyzed using GIS-based methods, including Euclidean distance and weighted overlay analysis. The Euclidean distance analysis revealed that the most suitable sites for future secondary schools were located within 200-400 meters of existing settlements, suggesting that proximity to residential areas is a critical factor in ensuring educational accessibility. The weighted overlay analysis considered factors such as proximity to roads, schools, and built-up areas, with settlements given the highest weight, indicating that new schools should be located near densely populated areas to ensure maximum accessibility. The resulting suitability map (Figure 2) suggests that areas within 200-400 meters of built-up areas and road networks are the most suitable for new school locations.

These findings are consistent with previous studies that highlight the importance of school location in determining educational accessibility. Proximity to schools significantly influences student enrollment and attendance, especially in rural and underserved areas (Limaye,S. 2016). Furthermore, it is essential to consider factors such as the avoidance of water bodies and terrain challenges when selecting suitable locations for new schools, as this will ensure that the infrastructure remains sustainable and accessible to all students.

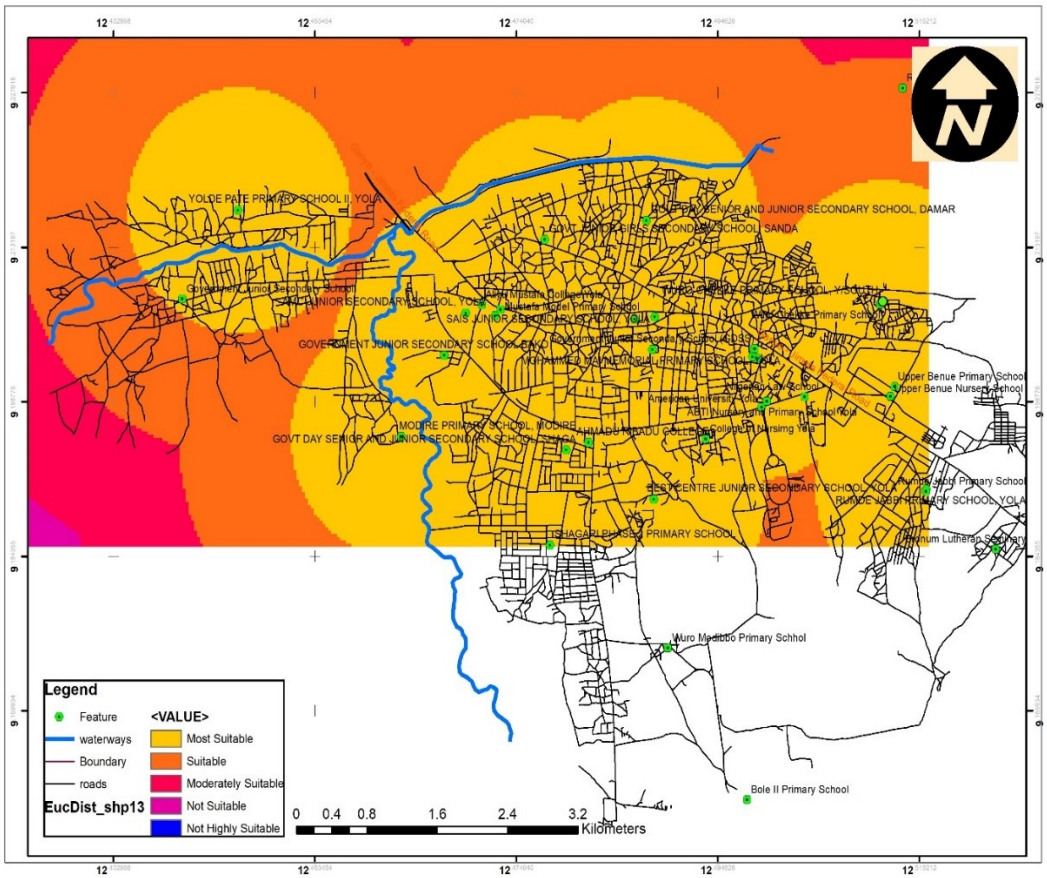


Fig 2 The range for the weighted overlay Map

Conclusion

The study reveals significant challenges in the accessibility of educational facilities in Yola South, both in primary and secondary schools. The lack of essential infrastructure such as adequate classrooms, toilets, electricity, and furniture poses serious barriers to quality education. These issues are compounded by spatial distribution challenges, as evidenced by the GIS analysis, which suggests that many areas lack sufficient proximity to educational facilities. However, targeted improvements in specific areas, such as administrative facilities, offer hope for incremental progress. To improve educational outcomes, there is a need for a comprehensive approach that prioritizes the development of critical educational infrastructure while also ensuring that new schools are located in accessible areas to cater to the growing population. The following recommendations were:

- Government should integrate Geographic Information System (GIS) into educational micro planning.
- Government should improve infrastructural management
- Government should improve on effective resource allocation
- Government should observed standard on walking distance to school when approving school plan
- Teachers should be trained on modern skills and technological innovation.
- Government should provide facilities, utilities and services (FUS) for the smooth running of schools in Yola South Local government Area (LGA).

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Factors Influencing Safety Management Practices Among Public Health Workers in Ado-Ekiti, Ekiti State, Nigeria

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Abstract
Safety at work is one key issue in public hospitals. Effective safety management practices help public health workers fight against infections, injuries and accidents in public hospitals. This study aims to assess the factors influencing safety management practices among public health workers in Ado-Ekiti, Ekiti State, Nigeria. A survey research design which involves the use of structured questionnaire was used to collect data. The study obtained a sample size of 322 participants from a population of 1639 health institution employees from Ekiti State University Teaching Hospital (EKSUTH) and Oba Adejuyigbe General Hospital (OAGH) in the study area, the selection of the participants was based on stratified random sampling technique. The data collected were analysed using descriptive statistics. Findings indicated that the top factors influencing safety management practices among public health workers are personal adherence to safety protocols, organizational support, and adequacy of safety equipment. The study concludes that personal adherence to safety protocols, organizational support for reporting safety concerns, and the provision of adequate safety equipment play crucial roles in shaping effective safety management. Additionally, comprehensive safety training was found to

increase workers' awareness, confidence, and preparedness for handling emergencies, ultimately leading to enhanced job performance. Hence, this study recommends that managers of healthcare organizations should focus on improving safety training programs by ensuring that training sessions are comprehensive, practical, and relevant to the specific risks encountered by health workers; by designing training modules that address real-world scenarios, encourage active participation, and include regular refreshers to keep workers up-to-date with the latest safety protocols.

Keywords: Safety, management, practices, public health, public health workers

Introduction

Public health workers such as physicians, nurses, community health workers, laboratory technicians and support staff are personnel who play an important role in helping and maintaining the well-being of individuals and communities. However, the kind of work they engage in exposes them to different types of occupational hazards, which can seriously affect, their health, safety, and overall performance negatively (Iavicoli *et al.,* 2018).

Occupational hazards in the healthcare setting are of many aspects and can include exposure to infectious diseases, musculoskeletal disorders, workplace violence, and psychological stress (Jehu *et al.*, 2021; Oladeinde *et al.,* 2015). These dangers can have several consequences for public health workers, leading to absenteeism, decreased productivity, burnout, and increased healthcare costs (Mossburg *et al.*, 2019; Ulutaşdemir *et al.,* 2015)**.** In Nigeria, the public health sector faces a lot of challenges which includes lack of sufficient funding, limited number of public health workers, and limited equipment needed in various public hospitals. (Summit *et al.,* 2003)**.** These situations are compounded by the presence of occupational hazards, which can further limit the performance and well-being of public health workers (Asaolu & Abionna, 2023). Ensuring occupational health and safety remains the biggest challenge for practitioners and theorists alike (Clarke, 2010; Rahmania Lestari *et al.,* 2022; Zohar, 2010).

Safety management consist a range of strategies and interventions aimed at identifying, assessing, and controlling

potential risks, as well as fostering a culture of safety within the workplace (Bautista-Bernal *et al.*, 2024). Safety management practices can include risk assessment, implementation of hazard, effective control measures, provision of personal protective equipment (PPE), safety training and education, and the establishment of good reporting and monitoring systems (Liu *et al.*, 2023). The importance of safety management practices in curbing occupational hazards and promoting a safe work environment cannot be overemphasized.

However, the implementation of safety management practices in the Nigeria public health sector has been impeded by various factors, such as limited resources, inadequate training, and a lack of comprehensive safety policies and regulations (FGN & ILO, 2016). As a result, so many public health workers in Nigeria continue to face serious occupational risks, which can reduce their performance and the quality of healthcare services rendered to the populace. Based on this, while connecting safety management with public health workers in the health sector, it is crucial to carry out a study in this regard to assess the factors influencing safety management practices among public health workers in Ado-Ekiti, Ekiti State, Nigeria.

Statement of the Problem

Public health workers are at the forefront of promoting and safeguarding the well-being of communities. However, their ability to perform their duties effectively can be significantly impacted by various occupational hazards and inadequate safety management practices (Jehu et al., 2021; Tinubu et al., 2010). In developing countries like Nigeria, the public health workers often grapple with challenges in implementing comprehensive safety measures, which can have far-reaching consequences for healthcare workers, the quality of service delivery, and ultimately, public health outcomes. Infectious diseases is a significant risk to public health workers, particularly in resource-constrained settings where personal protective equipment (PPE) and proper infection control measures may be lacking. Exposure to pathogens such as HIV, hepatitis B and C, and tuberculosis can have severe consequences for the health and well-being of workers, potentially leading to absenteeism, decreased productivity, and increased healthcare costs (McDiarmid, 2014; Mossburg et al., 2019).

Musculoskeletal disorders, such as back pain, neck pain, and repetitive strain injuries, are also prevalent among healthcare workers due to the physically demanding nature of their work, which often involves lifting, transferring, and

positioning patients (Tinubu et al., 2010). These injuries can lead to chronic pain, disability, and reduced work performance, ultimately impacting the quality of care provided to patients. Workplace violence, including physical assault, verbal abuse, and emotional harassment, is another significant concern for public health workers around the world (Lim et al., 2022; Rossi et al., 2023). Such incidents can have profound psychological effects, contributing to stress, anxiety, and burnout, which can further compromise the performance and well-being of healthcare workers.

Therefore, this study assessed factors influencing safety management practices among public health workers in Ado-Ekiti, Ekiti State, Nigeria with a view to improving their performance.

Aims and Objectives

The general objective of the study is to assess factors influencing safety management practices with a view to improving the performance of public health workers in Ado-Ekiti, Ekiti State, Nigeria. The specific objective of the study is to:

i. assess the factors influencing safety management practices among public health workers in Ado-Ekiti.

Literature Review

Concept of Safety Management Practices

Safety management practices are the procedures, policies and actions that organizations put in place to make sure their workers are safe from getting injured or sick when carrying out their responsibilities at their workplace. (Wacter & Yorio, 2014). The main goal is to identify possible dangers or hazards in the workplace and then find solution to get rid of those dangers and make them less risky. Safety management practices enable organizations to reduce the chances of accidents, injuries, and near misses (Vinodkumar & Bhasi, 2011).

In practice, the process of ensuring safety management is pretty wide. It involves activities such as checking for risks and hazards on a regular basis (risk assessments), training workers on how to discharge their responsibility safely and making available proper protective equipment like hard hats, goggles, gloves etc. (Chen & Reniers, 2020; Kritzinger, 2006). Others include putting in place clear safety rules, policies and procedures that workers must adhere to, investigating accidents or near-misses to find out what went wrong, and promoting an overall culture of safety within the organization (Chen & Reniers, 2020; Kritzinger, 2006; Rajapakse, 2017).

Depending on the occupation and workspace, safety management practices are provided to combat different hazards. In the public health sector, such hazards include biological, chemical, physical, ergonomic, psychosocial and environmental hazards (McDiarmid, 2014b). Biological hazards include exposure to infectious diseases like HIV, hepatitis, tuberculosis from contact with patients' bodily fluids, and contaminated instruments while chemical hazards are exposure to hazardous drugs, chemicals used for cleaning, disinfecting, and sterilization procedures. Physical hazards such as injuries from needles/sharps, slips, trips and falls, musculoskeletal issues from lifting patients, fire risks, radiation exposure are also possible in public health work environment. Others are ergonomic hazards such as injuries from poor workplace design like awkward postures, repetitive motions and psychosocial hazards which include but not limited to workplace violence, stress, burnout, long work hours. Environmental hazards like exposure to air contaminants and poor ventilation systems are part of the challenges facing public health workers. These hazards not only threaten workers' physical safety, it also reduces their mental and emotional wellbeing by causing stress, thereby leading to low work efficiency and increased risk in community health (Ali Sabri *et al.*, 2022; McDiarmid, 2014b).

Public Health Workers

A public health worker is a professional who focuses on the overall health of communities rather than being satisfied with treating just individual patients (Otok *et al*., 2018). Their role involves various aspects of public health, including education, prevention, and advocacy (Otok *et al.*, 2018; Yusriani *et al.*, 2019). Public health workers mostly work for government agencies or healthcare providers and some of their works involves educating individuals, families, and groups of people about health issues and preventive measures. They also give suggestions and tell patients about the best support services for their problem(s). Their work includes a wide range of settings and responsibilities, all aimed at improving the well-being of the populace. They are committed to promoting health, preventing diseases and enhancing the quality of life for entire communities (Otok *et al.*, 2018).

Empirical Review

The study of Magalhães *et al.* (2022) on occupational health and safety explored factors influencing safety compliance among workers, which can be valuable for

public health organizations. The study employed an exploratory-descriptive, cross-sectional documentary, quantitative, and retrospective research, in the historical series: 2011 to 2015. One crucial factor identified is the availability and accessibility of medical expertise within the workplace. When employees have access to qualified medical professionals who understand the specific risks and challenges associated with their job, they are more likely to trust and comply with safety protocols and recommendations. Additionally, the study highlighted the importance of employee education and awareness regarding occupational health and safety measures, which can further promote safety compliance among public health workers.

Also, Zhou *et al.* (2023) in a study titled 'Grounded theory-based analysis of occupational health and safety management modes in supply chain by core enterprises-evidence from China' used the grounded theory method to conduct an analysis of occupational health and safety management modes within the supply chain of core enterprises. They adopted semi-structured interview method. The interview involved a total of 16 persons with 210,000 words of interview scripts obtained. The evolution model of occupational health and safety management mode in the supply chain by core enterprises was established after three coding process of the grounded theory was done. The findings from the study indicated that core enterprises currently employ three modes of occupational health and safety management for their suppliers: defensive mode, passive mode, and strategic mode.

Furthermore, Lari (2024) examined a longitudinal study on the impact of occupational health and safety practices on employee productivity. The study was conducted using a mixed method of both qualitative and quantitative data approach. A total of 293 employees before and after the OHS interventions. The results of the study revealed that OHS interventions can enhance work place ambiance and also boost the productivity of the employees. In addition to this, they also reported that there was a direct link between improved OHS practices and heightened productivity.

Methodology

This study adopted a survey research design which involves the use of structured questionnaire for data collection. The study obtained a sample size of 322 participants from a population of 1639 health institution employees from Ekiti State University Teaching Hospital and (EKSUTH) and Oba Adejuyigbe General Hospital (OAGH) in the study area, including both senior and junior staffs, the selection of the participants was based on stratified random sampling technique. The questionnaire was made up of two parts which contain questions relating to demography of the respondents and factors influencing safety management practices among public health workers. The indicators for each of the construct employed a 5-point Likert scale, where 1 =never, 2 = rarely, 3 = sometimes, 4 =

often, 5 = always. The data collected were analysed using descriptive statistics on Statistical Package for Social Sciences (SPSS) software.

Results and Discussion

Response Rate

A total of 322 copies of questionnaire were randomly administered among the respondents. 322 copies were retrieved, dully filled and considered valid for the purpose of this research.

Factors Influencing Safety Management Practices among Public Health Workers

Table 1 shows the results of the factors influencing safety management practices among public health workers. It includes the percentage distribution, mean values, and standard deviations of responses to various safety management factors, along with their rank and corresponding remarks. The first factor, personal adherence to safety protocols provided, recorded the highest mean score of 4.04, indicating that this factor significantly influences safety management practices. A notable 41.3% of respondents reported "Always" adhering to safety protocols, with a combined 70.2% selecting "Often" or "Always." This suggests that personal commitment to following safety protocols is highly valued among respondents. The standard deviation of 0.988 suggests low variability in responses, indicating consistency among participants in this regard.

Organizational support for workers who report safety concerns ranked second, with a mean score of 3.63. Here, 58.1% of respondents indicated that they "Often" or "Always" experience organizational support. This high mean value underscores the importance of a supportive organizational environment in encouraging adherence to safety practices. The standard deviation of 1.109 suggests slightly more variability in responses compared to the first factor. The adequacy of safety equipment provided in the workplace ranked third, with a mean score of 3.58. A substantial 52.5% of respondents felt that safety equipment was "Often" or "Always" adequate, though 16.8% of respondents indicated that it was "Rarely" adequate, pointing to some room for improvement. The standard deviation of 1.091 indicates moderate variability in perceptions regarding the adequacy of safety equipment.

The frequency of safety incident or hazard reporting follows with a mean score of 3.51. A total of 50% of respondents reported that safety incidents are "Often" or "Always" reported, while 22.7% indicated "Rarely" or "Never." The relatively high mean suggests that safety incident reporting is a regular practice, though there are some respondents who may not always engage in this practice. The standard deviation of 1.218 reflects some variation in the consistency of reporting behavior.

Enforcement of safety training protocols in the workplace ranked fifth with a mean of 3.48. About 25.8% of respondents "Always" observe the enforcement of these protocols, while 32.6% noted that enforcement is only "Sometimes" present. This

indicates that enforcement, while generally perceived as adequate, could benefit from more consistency. The standard deviation here is 1.158, suggesting a moderate variation in the responses.

The belief that the workplace environment is safe from physical hazards recorded a mean of 3.44, with 50.6% of respondents feeling that their workplace is "Often" or "Always" safe. However, 10.2% felt that it is "Never" safe, which could indicate that a minority of respondents perceive significant risks in their work environment. The relatively high standard deviation of 1.303 indicates a broader range of perceptions about workplace safety. Effectiveness of safety training sessions in the workplace received a mean score of 3.42, with 44.4% of respondents indicating that safety training is "Often" or "Always" effective. Nonetheless, 15.5% of respondents felt that the training was "Rarely" effective, indicating that the quality or delivery of safety training could be enhanced. The standard deviation of 1.074 suggests relatively lower variability in responses compared to other factors.

Updating organizational safety practices in response to external regulation scored a mean of 3.40, ranking eighth overall. A total of 49.7% of respondents reported that safety practices are updated "Often" or "Always," although 16.5% felt that updates were "Rarely" made. This factor, classified as "Moderately High," suggests that while there is responsiveness to external changes, more frequent updates could be beneficial. The impact of environmental factors on personal adherence to safety practices ranked ninth with a mean of 3.30. While 40.4% of respondents selected "Sometimes" as their response, 39.7% felt that environmental factors "Often" or "Always" impacted adherence. This suggests that the environment plays a significant, though not overwhelming, role in influencing safety practices. The standard deviation of 1.084 indicates moderate variability in responses.

The influence of external regulation on personal safety practices ranked tenth with a mean score of 3.29. While 32% of respondents felt that external regulation "Sometimes" influences their practices, 11.8% indicated "Never," highlighting that external regulations may not always be a determining factor for some individuals. The higher standard deviation of 1.241 indicates greater variability in responses for this factor. Frequency of safety training sessions in the organization recorded a mean of 3.13, suggesting that safety training occurs less frequently than desired. A total of 40.7% of respondents indicated "Sometimes," while only 12.1% reported that training sessions are "Always" frequent. The standard deviation of 1.080 reflects moderate variability in the frequency of these training sessions.

Finally, public perceptions of safety had the lowest mean score of 3.03, with 15.5% of respondents indicating "Never" and 19.3% selecting "Rarely," suggesting that public perception is not a significant factor for a large portion of respondents. The relatively high standard deviation of 1.281 reflects variability in how respondents perceive the influence of public opinion on their daily safety practices. The overall grand mean for the factors is 3.44, which falls within the "High" category, indicating that most factors have a significant influence on safety management practices among public health workers in the study area. However, certain areas,

such as the frequency of training sessions and the influence of public perceptions, might require additional focus to enhance overall safety practices.

Table 1: Factors Influencing Safety Management Practices among Public Health Workers

Factors Influencing Safety Management Practices among Public Health Workers	Never	Rarely	Sometimes	Often	Always	Mean	Std. Deviation
Personal adherence to safety protocols provided.	1.6%	4.7%	23.6%	28.9%	41.3%	4.04	0.988
Organizational support for workers who report safety concern.	4.3%	11.5%	26.1%	32.9%	25.2%	3.63	1.109
Adequacy of safety equipment provided in workplace.	1.6%	16.8%	29.2%	26.7%	25.8%	3.58	1.091
Frequency of safety incidence or hazard reporting.	5.0%	17.7%	27.3%	21.1%	28.9%	3.51	1.218
Enforcement of safety training protocol in workplace.	4.0%	16.5%	32.6%	21.1%	25.8%	3.48	1.158
Belief that workplace environment is safe from physical hazards.	10.2%	14.0%	25.2%	23.0%	27.6%	3.44	1.303
Effectiveness of safety training sessions in workplace.	3.4%	15.5%	36.6%	24.8%	19.6%	3.42	1.074
Updating organizational safety practices in response to changes in external regulation.	5.9%	16.5%	28.0%	31.4%	18.3%	3.40	1.137
Impact of environment factors on personal adherence to safety practices.	6.2%	13.7%	40.4%	23.9%	15.8%	3.30	1.084
Influence of external regulation on personal safety practices.	11.8%	11.5%	32.0%	25.2%	19.6%	3.29	1.241
Frequency of safety training sessions in organization.	7.5%	18.0%	40.7%	21.7%	12.1%	3.13	1.080
Public perceptions of safety.	15.5%	19.3%	26.7%	23.9%	14.6%	3.03	1.281

Source: Researcher's field survey (2024)

Discussion of Findings

The findings indicate that several factors significantly influence safety management practices among public health workers. The results highlight the importance of personal adherence to safety protocols, organizational support, and

adequacy of safety equipment, which align with earlier studies that emphasize the importance of individual commitment and institutional backing in promoting a safety culture (Mearns & Reader, 2008; Neal & Griffin, 2006; Zhang et al., 2020). The high mean scores for personal adherence and organizational support suggest that health workers' safety practices are reinforced when they understand clear protocols and receive adequate institutional encouragement.

The results indicate that factors like the frequency of safety incident reporting and the enforcement of safety training protocols are important to effective safety management practices. These findings are in order with previous literature indicating that regular incident reporting and protocol enforcement contribute to heightened safety awareness and proactive risk management (Loh et al., 2019; Pousette et al., 2017). However, the differences in responses regarding the consistency and deliberate enforcement and safety reporting indicate the need for more systematic and structured approaches.

The results regarding safety workplace, perceptions and the training effectively reveal that while most respondents feel secure, a small number still perceives physical risks. This observation corroborates with Clarke (2010), who observed that while safety training is generally effective, occasionally, there are gaps in the quality or consistency of training that can impact workers' perceptions of their safety. In addition to this, the difference responses on updating safety practices in response to external regulations indicate an area for improvement, reinforcing that regular updates and compliance with external standards are important for maintaining an effective and good safety culture (Vinodkumar & Bhasi, 2011).

The external regulations and environmental factors moderate impact suggests that while external guidelines are important, internal management and context-specific practices mostly have influence in shaping safety behaviors. This is in line with research by DeJoy et al. (2004), who found that external regulatory frameworks are most effective when align with internal safety strategies tailored to the organization's specific context. Overall, the findings from this study underscore the multifaceted nature of safety management practices, which depend on a combination of personal, organizational, and external factors. These results contribute to the body of literature on occupational safety in healthcare settings and show that finding solution to inconsistencies in training frequency and enhancing communication of safety practices could further improve overall safety outcomes among public health workers.

Conclusion and Recommendations

This study explored the factors safety management practices among public health workers in Ado-Ekiti, Ekiti State, Nigeria. The findings from this study established that personal adherence to safety protocols, organizational support for reporting safety concerns, and the provision of adequate safety equipment play crucial roles in shaping effective safety management. Additionally, comprehensive safety training was found to increase workers' awareness, confidence, and preparedness for handling emergencies, ultimately leading to enhanced job performance. Clear communication and consistent enforcement of safety procedures further reinforced workers' trust in their organizations, promoting adherence to safety measures. Hence, this study recommends that managers of healthcare organizations should focus on improving safety training programs by ensuring that training sessions are comprehensive, practical, and relevant to the specific risks encountered by health workers; by designing training modules that address real-world scenarios, encourage active participation, and include regular refreshers to keep workers up-to-date with the latest safety protocols.

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