Effect of Geographic Information System on Urban Land Administration in Enugu, Nigeria

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Abstract: Numerous indications suggest that the goals of land administration are bedeviled by inefficiencies such as title document duplicity, delayed processes and ineffective land use monitoring. To address these land administration ineptitudes, policy makers, practitioners and academics have attenuated the adoption of information and communication technology facets such as geographic information systems (GIS). In response, the study investigated the effect of this technology on urban land administration in Enugu, Nigeria using GIS as proxy. Descriptive research design was employed over a population of 411 employees of the Enugu State Ministry of Lands, Survey and Town Planning. Given the manageable nature of the population, a census study was conducted. Data was collected from primary sources using structured questionnaire, and analysis employed Spearman Rank Order Correlation as a result of the nonparametric nature of the data collected. Findings show significant positive correlations between ArcGIS data management and duplicity attenuation (r=.928; p<.01), data efficiency and customer responsiveness (r=.937; p<.01), and remote sensing data capture and land use monitoring for sustainability in the study area (r=.790; p<.01). The study concluded that effect of GIS on urban land administration in Enugu was significantly positive. It was therefore recommended that recruitment and training of requisite ArcGIS, Geomedia and remote sensing competencies be made by the Ministry to alleviate duplicity of title documents, enhance customer responsiveness and environmental impacts of land use in Enugu, Nigeria.

Keywords: **ArcGIS, Geographic Information System, Land title data efficiency, Remote sensing, Sustainable development**

I. PRIMER

Land administration is the application and operationalization of land tenure systems in the management, use and alienation of land title (Dale & McLaughlin, 2000; Williamson et al., 2010). In Nigeria, this responsibility is saddled with the Ministry of Lands, Survey and Town Planning with the mandate of controlling land and its resources for the use and benefit of all citizens in a sustainable manner (Magaji & Umar, 2020). The motive of this responsibility becomes quite necessary in light of the criticality of land to ecological wellbeing and survival which implies that with any paucity of control, chaos such as disputes and conflict may ensue (Asaaga, 2021; Ewurum, 2016; Umeh, 1973). With the developmental scourge that usually follow such chaos, it becomes imperative that land administration responsibilities such as title issuance and security management, land registry management, land policy consultancy, general conveyance, development control and physical planning be discharged effectively and efficiently.

From the Nigerian perspective, however, reports of inefficiency appear to have trailed the discharge of these responsibilities by the Ministries. The system is riddled with issues as low customer responsiveness as a result of delays in processing orders such as Certificate of Occupancy (C of O), stringent land policy, alteration of layout plans and deed documents, poor record keeping, obsolete cadastral mapping systems, mismanagement of land expropriation, lack of uniformity, ineffective stakeholder management, and so on (Abolade et al., 2018; Adeniyi et al., 2018; Ewurum et al., 2020; Fateye et al., 2020; Madumere, 2019; Obi-Aso, 2020; Otubu, 2018). In a conscious effort to stem the scourge of these inefficiencies, scholars and practitioners alike have broached the pertinence and efficacy of information and communications technology (ICT) systems such as Geographic Information System (GIS) (Abolade et al., 2018; Akey & Mshelia, 2016; Atazadeh et al., 2017; Kalogianni et al., 2020; Moreri et al., 2018; Nissi et al., 2021).

Their argument is premised upon the logic that GIS familiarizes urban land administration with speed, accuracy, security, innovation, database management and efficiency attributes that offer strategic improvement on the already bedeviled current *modus operandi*. This elucidation underlines GIS as a computer software application that collects, stores, analyzes and visualizes geographic data for the purpose of evidence-driven decision making (Chrisman, 1999; Malczewski, 2000). When GIS fundamentals are presented, what is usually implied is a compendium of desktop, online and specialized applications for the management of spatial data.

When one reflects on the cruciality of spatial data management to land administration through data capture, storage, analysis, presentation and transfer, then the criticality of GIS in addressing the bane of land administration in developing countries like Nigeria cannot be overemphasized. To manage geographic data, GIS employs remote sensing for data capture and cadastral mapping, ArcGIS for data storage, security and analysis, and Hexagon Geomedia for fast analysis, visualization and efficiency of geographic data. In spite of these GIS potentials, there appears a conspicuous gap in empirical literature as regards its effect on urban land administration in the country generally, and Enugu particularly. We approach the

investigation from the standpoint of the Ministry of Lands, Survey and Town Planning in the State with a view to ascertaining the correlations between GIS methodologies and urban land administration systems in Enugu.

1.1 Purpose of the Study

The aim of the study is to ascertain the effect of GIS on urban land administration in Enugu, Nigeria with a view to eliciting strategies addressing maladministration and enhancing investor confidence in the sector. The specific objectives of the study are as follows:

1. To determine the correlation between ArcGIS data management and duplicity attenuation in Enugu land registries.
2. To ascertain the effect of data efficiency on customer responsiveness of the Ministry of Lands in Enugu, Nigeria.
3. To determine the effect of remote sensing data capture on land use monitoring for sustainability in the study area.

II. RELATED WORKS

The review of related works was structured to present the conceptual framework, empirical review, and the study's critique of extant related research. These are presented as follows:

2.1 Conceptual Framework

Geographic Information Systems (GIS) are powerful automated or computer-based tools that enhances the collection, analysis, visualization, simulation, and utilization of geographical data for the purpose of making decisions (Elwood, 2006; Franch-Pardo et al., 2021; Wang, 2020). By this process, it makes spatial data available and useful for decision making. It does this by integrating a number of distinct databases such as geomdeia, remote sensing, satellite and aerial imagery, spreadsheets and several others, for the purpose of mapping, communication, planning and environmental footprint mitigation (Fabbri et al., 2012; Hussain et al., 2020; Jha & Tukkaraja, 2020; Satria & Castro, 2016). With these integrations, the goal is aggregated towards improving processes and eliminating defects.

In that case, applications of GIS technology in land administration have usually targeted the inefficiencies of the system, especially from the perspective of forgery or duplicity, delays in processing customer/client requests, and land use monitoring. With respect to duplicity and forgery attenuation, Joos (2022) opines that GIS uses applications such as Esri's proprietary ArcGIS token-based authentication mechanism to administer access to data. By implication, only the authorized has access to data and should any falsification occur, the person will be held liable. For speeding up processing of customer requests, the GIS technology uses geomedia such as Hexagon to give customers quick and convenient access to necessary information within seconds as against the delayed process of sourcing files and documents manually (Kahn et al., 2015). It

is pertinent to note that such access may not imply access to altering the data.

From the perspective of land use monitoring, Ewurum et al. (2018) argue that GIS utilizes remote sensing technology such as geospatial imagery to capture data on how land use impacts the environment for the purpose of generating past, current and forecasted data to be employed in decision making. When the criticality of land to all aspects of economic and national development is considered, then it becomes crucial that these inefficiencies are eliminated. For this reason, the goal of sustainable development is therefore enhanced because when such monitoring is adhered to, environmental footprints can be significantly mitigated and reduced. In light of the foregoing, we present the conceptual framework of GIS in land administration in Figure 1.
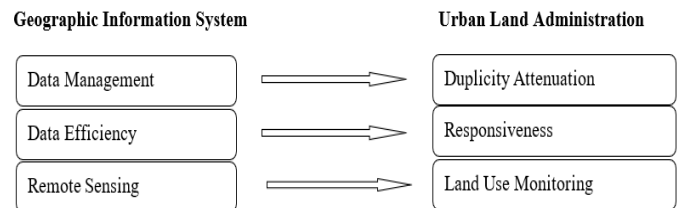

Figure 1: Conceptual Framework of the Study

Source: Generated, 2022

Figure 1 indicates the conceptual framework that guided the investigation of the research problem. Since the framework was aligned with the objectives of the study, the empirical review examines prior works addressing the scope of the objectives of the study. The essence is to position our findings in empirical literature with respect to a confirmation or repudiation of related works.

2.2 Empirical Review

From the perspective of land use monitoring, Aboelnour & Engel (2018) examined historical change to measure the urban sprawl of GCR, and its effect on land surface temperature (LST). The examination focused on generating land use/land cover (LULC) maps derived from Landsat 5 TM for 1990 and 2003 and Landsat 8 OLI for 2016, using several classification techniques. A spectral radiance model and a web-based atmospheric correction model were used to successfully evaluate LST from thermal bands of Landsat data. Overall accuracy of Landsat derived land use data were 90.3%, 96.5% and 94.9% for years 1990, 2003 and 2016, respectively. The LULC change analysis revealed vegetation loss to urban land by an amount of 7.73% and from barren lands to urban uses by 8.70% within a 26-year timespan (1990-2016) leading to decrease in vegetation areas, and consequently increasing the LST and modifying the urban microclimate.

Fengyun et al. (2014) employed a series of indexes to evaluate degree of dynamic land use change, degree of exploitation, degree of land depletion, comprehensive index of land use extent. The Markov process had been applied to analyze and predict the variation tendency of land use in 2018 and 2032.

The results showed that in the past 14 years, the structure of land use had a great change, especially the arable land and construction land, reduced 208.38 km2, 141.89 km2 respectively. Also, index of arable land pressure was introduced to analyze the effect of arable land reduction on food security. The analysis results predicted that food security of Shangqiu city was increasingly serious.

Regarding duplicity attenuation and responsiveness to demand, Shekarau & Aliyu (2019 examined the effectiveness of GIS on land administration in Kaduna, Nigeria. The study hypothesized that the adoption of Geographical information system (GIS) technology in land administration will facilitate timely title registration, provide tenure security, ease land application processes and information sharing, facilitate land transactions, reduce corruption associated with land dealings, create efficient land markets and serve as a decision support system to government at all levels in formulating policies relating to land. The paper therefore advocated for the immediate computerization of all land records using Geographical information system (GIS) technology as imperative for efficient and effective urban land administration.

Critique of Literature

Having reviewed the minimal volume of empirical works devoted to the discourse, an important fact that has emerged indicates that prior research on GIS pretermitted the investigation of the phenomenon from the perspective of its effect on urban land administration in the study area. Following this lacuna, the study examined the effect of GIS on land administration in Enugu, using the State Ministry of Lands, Survey and Town Planning as case study.

III. METHODOLOGY

The study is quantitative in nature and therefore employed survey research method. Population of the study was 411 core staff of the Enugu State Ministry of Lands, Survey and Town Planning. Due to the manageable nature of the population, the study employed holistic sampling. Data were collected from primary sources using a structured questionnaire. The study area is Enugu Urban and the geospatial representation is shown in Figure 2:
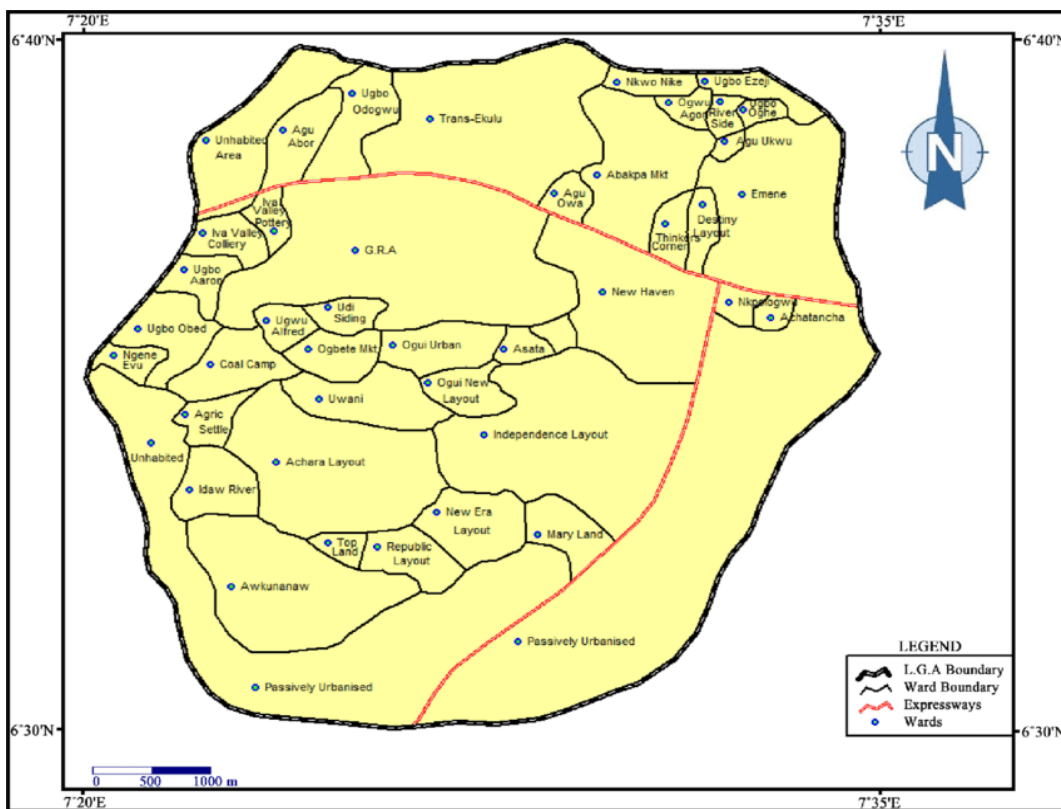

Figure 2: Geospatial Map of Enugu, Enugu State, Nigeria.

Source: Ezenwaji et al. (2016).

Figure 2 shows the geospatial illustration of Enugu Urban displaying its major layouts such as Independence Layout, Government Reserved Area, Trans Ekulu, Achara Layout, New Haven, Ogui New Layout, Abakpa and others. The studied examined the effect of GIS on administering land title and uses in these layouts of the city. The Ministry is located at the GRA axis of Enugu Urban. Test of Robustness on the research instrument involved the dyad of validity and reliability tests. For validity, face validity was used to ascertain the goodness of fit between the instrument and the research problem using 6

experts from surveying and geoinformatics, land registries and Estate Management. The final instrument emanated from their modifications and recommendations and thus fine-tuned for convenient understanding by respondents.

For reliability, the study employed test re-test method on a random sample of 15 respondents over a period of two weeks. After analysis using Cronbach Alpha, a coefficient of .892 was obtained as shown in Table 1. Since the coefficient showed high consistency, the instrument was deemed reliable.

Table 1: Reliability Statistics Reliability Statistics	
Cronbach's Alpha	N of Items
.892	18

Data were presented with line graphs while analysis of data employed Spearman Rank Order Correlation Coefficient. The logic behind the use of this test statistic is explained by the nonparametric nature of our data. The decision rule is to reject the null hypothesis where observed *p-value* <.01, thus, implying that the result is significant. Out of the 411 copies of the questionnaire distributed at the Ministry, 296 passed the test of validity for analysis.

IV. ANALYSIS

Data presentation and analysis followed the consistency of the objectives of the study. These are presented as follows:

4.1 Objective 1

This objective examined the correlation between ArcGIS data management and duplicity attenuation in Enugu land registries. Accordingly, we test the null hypothesis that correlation between ArcGIS data management and duplicity attenuation is not significant in Enugu land registries. The analysis is presented as follows:

Table 2: Spearman Rank Order Correlation Analysis of ArcGIS and Duplicity Attenuation

Correlations			ArcGIS	Duplicity Attenuation
Spearman's rho	ArcGIS	Correlation Coefficient	1.000	.928**
		Sig. (2-tailed)	.	.000
		N	296	296
	Duplicity Attenuation	Correlation Coefficient	.928**	1.000
		Sig. (2-tailed)	.000	.
		N	296	296
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: Generated, 2022

Table 2 shows the correlation between ArcGIS and duplicity attenuation in Enugu land registries as confirmed by the Spearman *rho*. At a significance *p<.01,* the result is significant and the null hypothesis rejected. Thus, correlation between

ArcGIS data management and duplicity attenuation in Enugu land registries is significantly positive (r=.928; *p<.01*).

4.2 Objective 2

This objective examined the effect of data efficiency on customer responsiveness of the Ministry of Lands in Enugu, Nigeria. Accordingly, we test the null hypothesis that effect of data efficiency on customer responsiveness of the Ministry of Lands in Enugu, Nigeria is not significant. The analysis is presented as follows:

Table 3: Spearman Rank Order Correlation Analysis of Data Efficiency and Customer Responsiveness

Correlations			Data Efficiency	Customer Responsiveness
Spearman's rho	Data Efficiency	Correlation Coefficient	1.000	.937**
		Sig. (2-tailed)	.	.000
		N	296	296
	Customer Responsiveness	Correlation Coefficient	.937**	1.000
		Sig. (2-tailed)	.000	.
		N	296	296
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: Generated, 2022

Table 3 illustrates the effect of data efficiency on customer responsiveness of the Ministry of Lands in Enugu, Nigeria as indicated by the Spearman *rho*. At a significance *p<.01,* the result is significant and the null hypothesis rejected. Thus, effect of data efficiency on customer responsiveness of the Ministry of Lands in Enugu, Nigeria is significantly positive (r=.937; *p<.01*).

4.3 Objective 3

This objective ascertained the effect of remote sensing data capture on land use monitoring for sustainability in the study area. Accordingly, we test the null hypothesis that the effect of remote sensing data capture on land use monitoring for sustainability in the study area is not significant. The analysis is presented as follows:

Table 4: Spearman Rank Order Correlation Analysis of Remote Sensing Data Capture and Land Use Monitoring

Correlations			Remote Sensing Data	Land Use Monitoring
Spearman's rho	Remote Sensing Data	Correlation Coefficient	1.000	.790**
		Sig. (2-tailed)	.	.000
		N	296	296
	Land Use Monitoring	Correlation Coefficient	.790**	1.000
		Sig. (2-tailed)	.000	.
		N	296	296
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: Generated, 2022

Table 4 shows the effect of remote sensing data capture on land use monitoring for sustainability in the study area. At a significance *p<.01,* the result is significant and the null hypothesis rejected. Consequently, effect of remote sensing data capture on land use monitoring for sustainability in the study area is significantly positive (r=.790; *p<.01*).

V. FINDINGS

The study examined the application of GIS in land administration in Enugu urban from the perspective of the Ministry of Lands, Survey and Town Planning. The essence is to ascertain the symmetric movement of the dependent variable as a result of the introduction of the independent variable. Succinctly, we answer the question – at what rate, and in what direction would land administration systems react to any application of GIS to the system? From the analysis as indicated by the applicable Spearman *rho* the study found that:

1. Correlation between ArcGIS data management and duplicity attenuation in Enugu land registries was significantly positive (r=.928; *p<.01*).
2. Effect of data efficiency on customer responsiveness of the Ministry of Lands in Enugu, Nigeria was significantly positive (r=.937; *p<.01*).
3. Effect of remote sensing data capture on land use monitoring for sustainability in the study area was significantly positive (r=.790; *p<.01*).

5.1 Conclusion

The findings reveal that significant positive correlations exist amongst the proxies of GIS and urban land administration as shown the Spearman *rho* for ArcGIS & duplicity attenuation, data efficiency & customer responsiveness, and remote sensing data capture & land use monitoring for sustainable land use in the study area. As result, the study concluded that effect of GIS on urban land administration in Enugu was significantly positive. The position of the study aligns with previous works in other areas such as Aboelnour & Engel (2018), Fengyun et al. (2014) and Shekarau & Aliyu (2019).

5.2 Recommendations

It was therefore recommended that:

1. Investment should be made into the recruitment of requisite ArcGIS competencies and training of existing staff so as to attenuate the duplicity of title documents in Enugu land registries.
2. To alleviate customer and client concerns arising from delays in processing C of Os and other requests, it was suggested that GIS software such as Hexagon Geomedia be acquired with apposite human capital development for its utilization so as to ensure data efficiency through the storage, analysis, visualization and timely retrieval of data in the Ministry.
3. In light of the anthropogenic footprints leading to climate change and global warming, the study recommended the increased integration and adoption of remote sensing technology as a means of assessing environmental impacts in Enugu urban through land use monitoring.

5.3 Practical Implications

From the findings and conclusion of the study, the study makes practical contributions to extant literature with the empirical evidence offering pathways through which geographic information system could alleviate land administration inefficiencies such as land title document duplicity, delay in responding to customer orders, and environmental pollution arising from land use. The study followed extant literature and observed empirical data to disaggregate these pathways into adoptions of ArcGIS, Geomedia and remote sensing technology.

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