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Evaluation of the Use of GIS in Land Administration in Anambra State Ministry of Lands Awka, Anambra State, South East Nigeria

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Abstract

Land administration plays a major role in economic growth, urban development, and public trust. In Nigeria, manual and paper-based land records have historically led to delays, disputes, and inefficiencies. Despite the introduction of Geographic Information System (GIS) technology in several states, there is limited empirical evidence showing its measurable impact on land registration performance in Anambra State. This study was justified by the need to move beyond assumptions and provide data-driven evaluation of GIS outcomes in public land administration. The objectives of the study were to examine trends in land document registrations before and after GIS implementation, assess growth and productivity changes, and determine whether GIS significantly influenced land administration performance at the Awka substation. Secondary data were obtained from official records of the Anambra State Ministry of Lands, covering 2020–2024. Data were analyzed using trend analysis, growth rates, efficiency ratios, Spearman correlation, and Interrupted Time Series Analysis (ITSA) with R Console version 4.4.3. Results show that total land registrations increased from 1,424 in 2023 to 3,442 in 2024, representing a 141.7% year-over-year growth. Certificates of Occupancy rose from 488 in 2020 to 1,850 in 2024, while Deeds of Assignment increased by 6.75 times within the period. Spearman correlation for C of O was perfect and significant ($\rho = 1.00$, $p < 0.0001$). These findings indicate substantial efficiency gains after GIS implementation. The study concludes that GIS significantly improved land administration throughput and service delivery. It recommends sustained funding, staff training, workflow simplification, and public reporting of performance indicators to strengthen transparency and public confidence.

Keywords: C of O, Economic Growth, GIS, Land Administration, Urban Development

1. Introduction

Land is one of the most valuable resources in any society. It supports housing, business, agriculture, and public infrastructure. In Nigeria, however, managing land has not always been easy. For many years, land records were kept manually on paper, which made them difficult to trace, easy to damage, and sometimes vulnerable to manipulation (Saleh & Lay, 2026). These challenges often resulted in delays, double allocations, land disputes, and lack of public trust in the system. As cities continue to grow and demand for land increases, the pressure on land administration offices becomes even greater. In response to these challenges, many states in Nigeria have begun adopting Geographic Information System (GIS) technology to modernize their land management processes. GIS allows land records to be stored digitally, mapped accurately, and retrieved quickly. In Anambra State, the Ministry of Lands introduced GIS to improve efficiency, transparency, and service delivery, particularly in the issuance of Certificates of Occupancy and other land documents. While digital systems promise better

performance, it is important to move beyond assumptions and examine actual evidence of improvement.

This study therefore evaluates the use of GIS in land administration at the Awka substation of the Anambra State Ministry of Lands. It seeks to understand whether the introduction of GIS has truly improved registration output, efficiency, and overall service delivery (Wagh & Auti, 2025). By analyzing official records before and after GIS implementation, the study provides practical insight into how technology can strengthen land governance in a growing urban environment.

The review of relevant literatures brings together evidence on how digital land systems are reshaping administration in Nigeria, highlighting practical gains, persistent challenges, and the need for measurable reforms. Abubakar et al. (2020) opined because the growing population population of Nguru and its old paper-based records which are considered messy and hard to find, the town faces serious land management problems. The study introduced a new way of working by creating a digital Geographic Information System (GIS) database combined with a Land Information System (LIS) to replace the outdated manual maps. The research findings showed that the digital system makes it much faster to edit and find land details, which helps the local government collect taxes more accurately and reduces the number of court fights over who owns which plot. However, a major limitation identified is that the town needs a lot of money to buy computer equipment and the staff require extensive training to use it properly. Ultimately, the study argues that towns must adopt these digital tools immediately to ensure land deals are honest and fair. Nigeria has traditionally struggled with a poor land record system, where less than 10% of the land is properly mapped or registered (Saleh & Lay, 2026). Hence, the study by Saleh & Lay (2026) explored the Abuja Geographic Information System (AGIS) to see how digital tools can make city management more professional and efficient. The results found that while the digital system is more up-to-date and reliable than traditional records, many citizens still find the registration process confusing and expensive. A significant limitation is that corruption still persists within the system, and many people are "undecided" because they do not understand how the technology works. Conclusion: The authors conclude that the government must simplify its rules and lower fees so that everyone, including women and young people, can access land safely. According to Ekwunife et al., (2022), in Enugu, the land office was often slowed down by duplicate documents, lost files, and a slow process for issuing ownership certificates. Therefore the motivation of this research to look at the impact of using Geographic Information System (GIS) software to manage city land more effectively. Findings showed a strong positive association between using digital tools and reducing the number of fake land documents. Also, the approach was found to improve how fast staff can help customers. The study's main limitation is that the office lacks enough trained workers who are experts in these specific advanced computer programs. Hence, switching to digital records was found to be a massive success for Enugu, making land administration much more reliable for the public if the right people are hired to run the systems.

The work by Bello et al., (2025) noted that Nigeria deals with many environmental threats like floods, the spread of deserts in the north, and oil spills in the south. Hence, the need to appraise the use of Geographic Information Systems (GIS) and Remote Sensing (RS), which uses satellite images, to monitor these changes nationwide. The results demonstrated that satellite data can accurately predict flood risks and show exactly where forests are being lost to new buildings. Moreover, a persistent limitation identified was that different government offices do not share their data with each other, and they often lack the funding to keep these systems running long-term. Hence, the need for Nigeria to build a shared national data network so that leaders can make better decisions to protect the environment and respond to disasters. According to Wagh & Auti (2025), city planners often find it hard to explain complex maps and data to the people living in local neighborhoods. Therefore the motivation to examine the

role of Geographic Information Systems (GIS) and Public Participation Geographic Information Systems (PPGIS) in making city planning more understandable. Findings showed that these tools help create greener cities and allow for more fruitful discussions about future neighborhood changes. However, a major limitation was that many planners in countries like the United States are not yet using these tools to involve the public as much as they should. The study concludes that digital mapping is revolutionizing city design by making it more efficient and helping cities adapt to the challenges of climate change. The land registry in Abia State previously found to rely on slow paper records that led to long delays and frequent arguments over ownership (Okorafor, 2025). The study by Okorafor (2025) investigated the impact of the Abia Geographic Information System (ABIA-GIS) on how land is managed in the region. Results indicated that most real estate experts felt the digital system reduced land disputes and made the registration process more professional. A key limitation is that while the system is better, it has led to higher registration fees, and some staff struggle to keep up with software updates. In conclusion, the research found that digital tools are far better than the old paper way, providing hope for more sustainable natural resource management in Nigeria.

Daniel & Mbon (2024) opined that public administration involves making tough choices about where to spend government money on services like health, waste collection, and schools. Their research explored how Geographic Information Systems (GIS) and Global Positioning Systems (GPS) can help government leaders make these decisions. The findings showed that using GPS data allows offices to identify high-crime areas, track trash collection, and monitor how well staff are working. Moreover, a major limitation was the high cost of software and a general lack of trained people to handle the technology. The authors concludes that if government leaders understand these simple mapping tools, they can provide much fairer and faster services to the general public. According to Navratil (2020), land remain a limited resource that must be managed carefully through both legal and technical records. The author was motivated to look at how Geographic Information Science (GIScience) is helping to modernize records for crowded cities. This includes a shift toward "3D Cadastres," which are three-dimensional land records for buildings stacked over tunnels. It was found that the 3D models help solve complex legal issues in urban areas that traditional flat maps cannot handle. The study identifies a major limitation: setting up a new land record system from scratch is extremely slow and can take many decades to finish. The review concludes that science must keep adapting land records to meet the changing needs of growing societies and crowded urban spaces.

The work of Jiang et al., (2023) explained that when city planners choose between different buildings designs, their choices are often influenced by their own personal feelings or preferences. Consequently, the authors then proposed using Geographic Information Systems (GIS) with the Analytic Network Process (ANP) to score planning options objectively. The model proposed showed that protecting nature should be the top priority (over 40%) when planning new housing in North Carolina. A limitation identified in the study was that the study only compared three specific options, which might not show the full picture of a city's complex needs. Hence, the study concludes that using this data-driven method helps planners avoid personal bias and ensures that new developments respect the local environment. Zhai et al, (2025) expressed that managers need a clear way to know which land is best for growing crops and which land should be protected from development. Then the study considered that integration of the Land Evaluation and Site Assessment (LESA) method into a Geographic Information System (GIS) to map out farmland potential in China. The study identified that 17% of the area was "best land" for farming, while poor land was better used for trees or grazing7679. A limitation of this method was that it assumes land stays the same and does not account for dynamic changes like cities growing over farms. Therefore the study concludes that combining soil data with location data helps leaders save high-quality farmland and supports sustainable farming practices. Alagbe & Ojo (2021) noted that Lagos is a massive city where extreme population growth puts intense pressure on very tiny areas of land. Hence, the

authors were moved to investigate the level of Geographic Information System (GIS) use within the Lagos State Lands Bureau. The outcome of the study showed that while staff are using digital tools, each office works on its own and their systems are not linked together. Moreover, a serious limitation identified was that a lack of steady funding and enough trained experts stops the city from having one large, shared system. Hence, the study concludes that Lagos must move toward a fully joined-up system to manage its massive land needs effectively and fairly for all citizens.

Across the studies reviewed, it was found that moving from paper records to digital systems like GIS improves land administration, but the journey is not always smooth. In Nguru and Enugu, digital tools reduced disputes and made work faster (Abubakar et al., 2020; Ekwunife et al., 2022). In Abuja and Abia, systems became more reliable, though citizens still complained about high costs and confusion (Saleh & Lay, 2026; Okorafor, 2025). Other works showed that lack of funding, poor coordination, and weak staff capacity can slow progress (Alagbe & Ojo, 2021; Daniel & Mbon, 2024). While these studies prove that GIS can transform land management, none of them provided clear, recent performance-based evidence on how GIS has changed actual registration outputs in Anambra State, especially using measurable trends and productivity indicators. Hence, the gap this study seeks to addresses. Specifically, the study aims to: (i) examine trends in land document registrations before and after GIS implementation in Awka, (ii) measure growth, efficiency, and productivity changes linked to GIS adoption, and (iii) assess whether the introduction of GIS significantly influenced land administration performance in the state.

2. Methods

2.1 Research Design

The research design adopted for this study is the quantitative research design. Quantitative research is a systematic investigation of phenomena by gathering quantifiable data and performing statistical, mathematical, or computational techniques.

2.2 Research Location

The research location is Awka, a city in the southeast of Nigeria and the capital of Anambra State. Upon the creation of Anambra state in 1991, Awka was announced as the capital city of Anambra State, Nigeria. The city was declared capital on 21 August 1991, on the creation of a new Anambra state and Enugu state by bifurcation of the old Anambra State. The city of Enugu remained the capital of Enugu State while Awka, became the capital of the new Anambra State. Awka was divided into twenty one local governments areas namely; Aniocha, Awka south, Awka North, Idemili north, Idemili south, Ekwusigo, Oyi, Aguata, Orumba north, Orumba south, Nnewi south, Nnewi north, Ogbaru, Dunukofia, Onitsha north, Onitsha south, Anyemelum, Anambra East, Anambra West, Njikoka, Ihiala. Awka south is the main city centre and the heart beat of Anambra State, south-east Nigeria. Awka is in the tropical rainforest zone of Nigeria and experiences two distinct seasons brought about by the two predominant winds that rule the area: the southwestern monsoon winds from the Atlantic Ocean and the northeastern dry winds from across the Sahara desert. The monsoon winds from the Atlantic creates six months of heavy tropical rains, which occur between April and July, followed by a short dry period in August lasting two to three weeks with the rain resuming in September and October. This is followed by five months of dryness (November–March) marked by a Harmattan wind, also known as Ugulu in Igbo, which is a particularly dry and dusty wind which enters Nigeria in late December or in the early part of January and is characterized by a grey haze limiting visibility and blocking the sun's rays before dissipating and leading to extreme dry heat in the latter months of February and March. The temperature in Awka is generally 27–30 °C between June and December but rises to 32–34 °C between January and April, with the last few months of the dry season marked by intense heat.

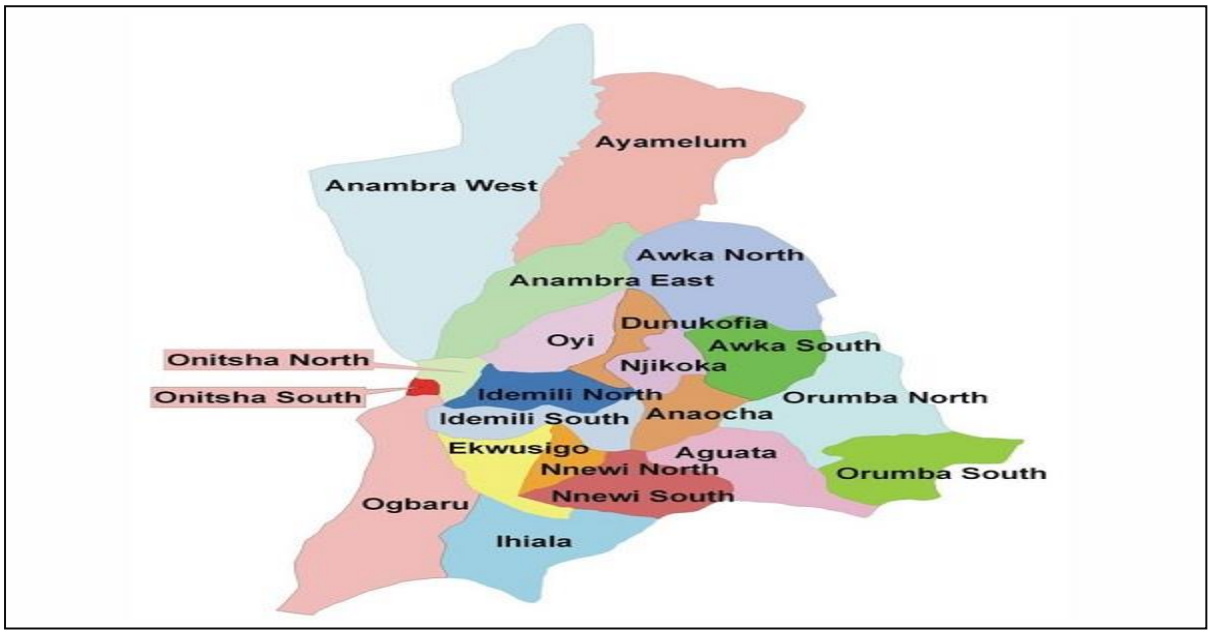

Figure 2: Map of Nigeria showing Anambra state showing local government areas. [Commons.wikimedia, 2023).

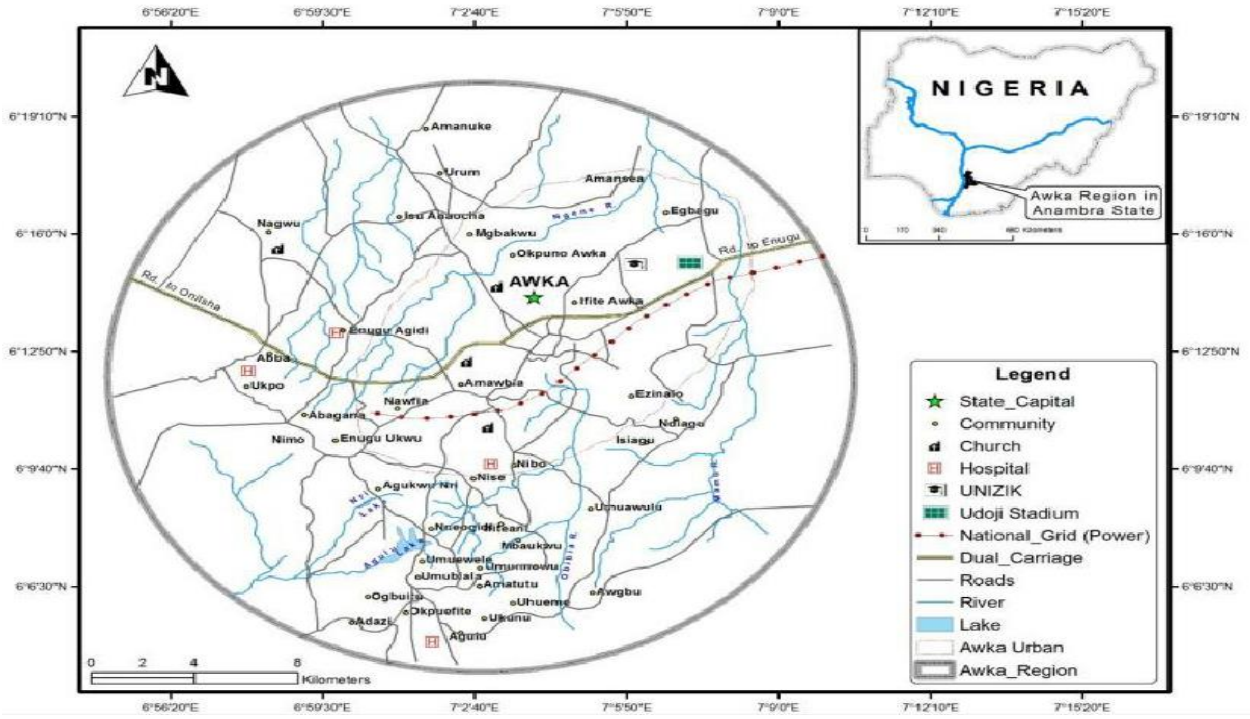

Figure 3. Location Map of the Awka Region (Anambra State) with Major Facilities (Source: Ezenwaji et al., 2013)

2.2 Sources of Data

The data used for this study were obtained from official administrative records of the Anambra State Ministry of Lands, Awka, covering the period 2020 to 2024. These records consist of documented information on land-related transactions processed at the Awka substation, including Certificates of Occupancy (C of O), Powers of Attorney, Deeds of Assignment, Mortgages, Subleases, Surrenders, Court Judgments, and Recertifications. The dataset captures yearly registration volumes before and after the implementation of the Geographic Information

System (GIS), thereby providing a reliable basis for assessing changes in land administration performance. As an official government source, the data reflect actual operational outputs of the Ministry and are considered appropriate for evaluating trends in efficiency, productivity, and service delivery within the state's land management system.

2.3 Method of Data Analysis

The data collected for this study was arranged year by year and document type by document type to make comparison clear as well as meaningful. We first summarized the total number of land documents registered each year and calculated growth rates to see how performance changed before and after the introduction of GIS. Simple trend analysis was used to observe patterns over time, while percentage changes helped us measure how strong the increase was. We also applied correlation analysis to examine how document types moved with time and used basic efficiency ratios to compare productivity between 2020 and 2024. An Interrupted Time Series approach was further used to assess whether the introduction of GIS made a noticeable difference in registration levels and trends. All computations and visualizations were carried out using R Console version 4.4.3, which provided a reliable platform for organizing, analyzing, and presenting the results clearly.

3. Result and Discussions

3.1 Results

This section presents the key findings on how land document registrations changed over time, especially before and after the introduction of GIS at the Awka substation.

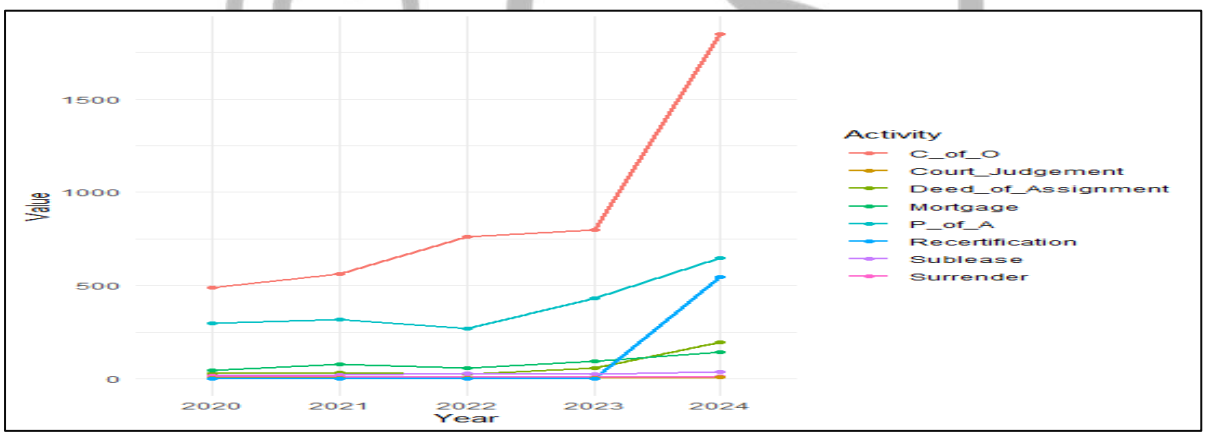

Figure 3. Annual Trends in Land Document Registrations before and After GIS Implementation in Awka Substation (2020–2024)

The line chart in Figure 3 illustrates the yearly trend in land document registrations from 2020 to 2024 across eight document types at the Awka substation. The data indicates a substantial increase in registrations following the full implementation of GIS in 2022. The most notable surge was in Certificates of Occupancy (C of O), which increased from 488 in 2020 to 798 in 2023, and then multiplied to 1,850 in 2024. Recertification remained at zero until 2023 but rose to 545 in 2024, underscoring the role of GIS in enabling previously infeasible services. Deed of Assignment and Mortgage registrations also saw sharp increases, with Deed of Assignment jumping from 57 in 2023 to 196 in 2024. Hence, the total number of registered documents rose from 1,424 in 2023 to 3,442 in 2024, reflecting a 141.7% year-over-year growth, the most substantial increase across the period. This trend strongly suggests that GIS has enhanced the

efficiency, accessibility, and capacity of land administration systems, validating its role as a transformative tool in spatial land management and governance.

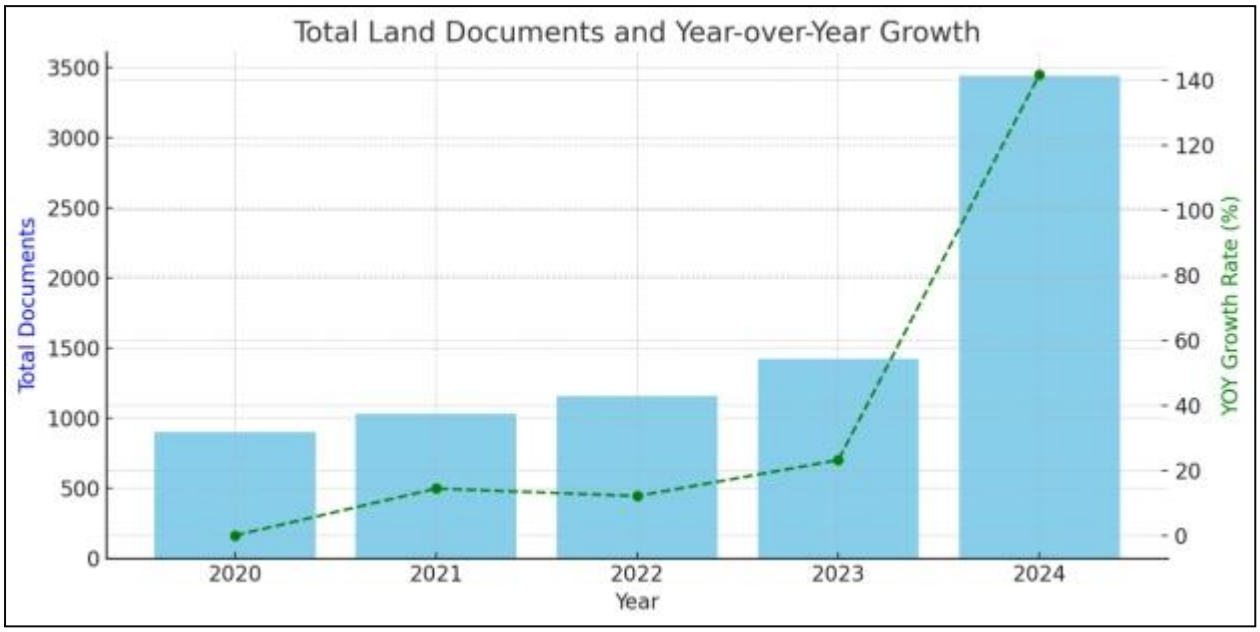

Figure 4. Total Land Document Processing and Annual Growth in Awka Substation (2020–2024)

The bar and line plot in Figure 4 illustrates the total number of land documents processed annually and the corresponding year-over-year (YOY) growth rates from 2020 to 2024. There was steady but modest growth from 901 documents in 2020 to 1,424 in 2023, with YOY increases ranging from 12.1% to 23.2% during this period. However, in 2024, a rise occurred, with total documents skyrocketing to 3,442, representing a 141.7% YOY growth the highest across the 5-year span. This unprecedented increase coincides with the full-scale implementation of GIS at the Awka substation, strongly indicating that GIS has significantly improved land administration capacity, operational efficiency, and service delivery. The pattern reflects how technological intervention can radically transform bureaucratic processes, reduce delays, and enhance public access to land registration services.

Table 1. Summary Result of the Interrupted Time Series Analysis (ITSA)

Source of variation	Coefficient	*P*-Value	CI Lower	CI Upper
Const	771	0.713745	-19527.5	21069.47
Time	130	0.918536	-12707.9	12967.88
Intervention	-1309.67	0.498711	-17883.3	15263.96
Time_After_Intervention	1013	0.534616	-13340.2	15366.18

The ITSA model in Table 1 evaluated the effect of GIS implementation in 2022 on the total number of land documents registered. Here are the key findings from the model. The coefficient for time was obtained as 130.00, indicating a small positive trend in total document registrations over time prior to GIS, though this was not statistically significant (p = 0.9185). However, the immediate level change due to GIS implementation in 2022 was captured by the coefficient −1309.67. Although this suggests an initial dip, it is not statistically significant (p = 0.4987), and the confidence interval was considered to be wide. The post-GIS trend change was +1013.00, indicating a sharp rise in total documents per year after 2022, but again, this estimate was not statistically significant (p = 0.5346). Although the model detects a substantial positive trend after GIS implementation, statistical significance is not established. The sharp increase observed in 2024 (as seen earlier in visualizations) suggests that GIS likely had a meaningful impact, but a more granular dataset (e.g., monthly or quarterly records) would offer greater power to detect significance.

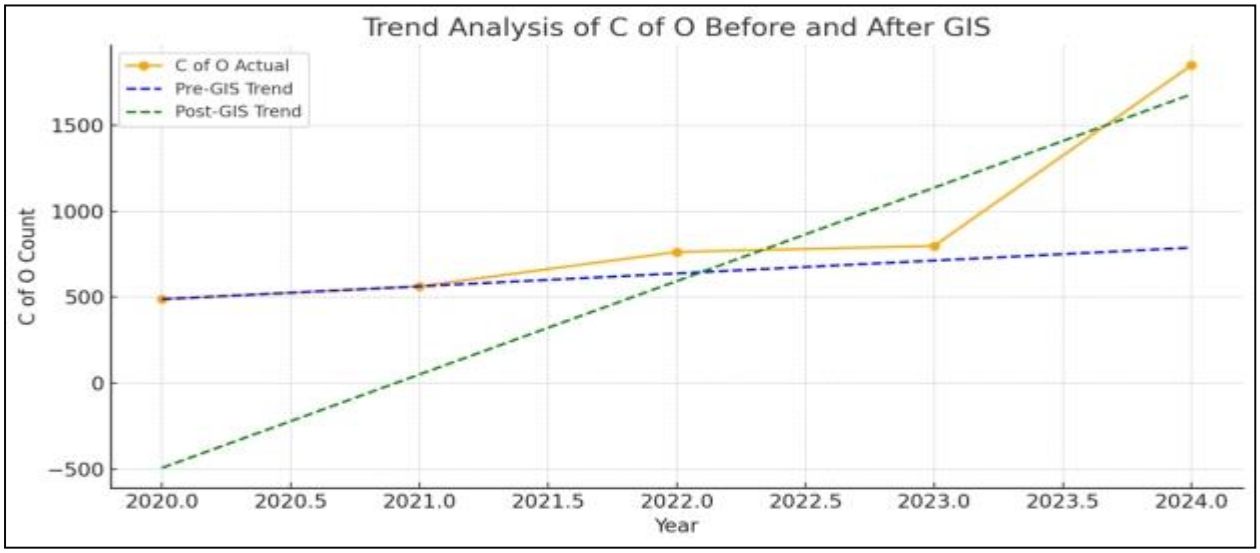

Figure 5. Trend Analysis of C of O before and After GIS

The plot presented in Figure 5 revealed that the fitted linear trend shows a modest upward slope for Pre-GIS Trend (2020–2021) while there was a much steeper slope indicates a strong acceleration in C of O issuance after GIS was introduced, suggesting improved capacity and efficiency for Post-GIS Trend (2022–2024).

Table 2. Result of Spearman correlation between Years

	Spearman rho	*p*-Value
C_of_O	1.00	1.40E-24
P_of_A	0.70	0.1881
Deed_of_Assignment	0.70	0.1881
Mortgage	0.90	0.0373
Sublease	0.90	0.0373
Surrender	-0.30	0.6238
Court_Judgment	0.30	0.6238

Recertification	0.89	0.0405

The Spearman correlation in Table 2 between Year and land document types shows strong positive associations, indicating that as time progressed (and GIS was introduced), registrations generally increased: C of O: $\rho = 1.00$, $p < 0.0001$ which indicates perfect positive correlation and highly significant. Mortgage: $\rho = 0.90$, $p = 0.037$ which indicates strong, statistically significant correlation. Sublease: $\rho = 0.9$, $p = 0.037$, this result indicates strong, statistically significant. P of A & Deed of Assignment: $\rho = 0.7$ each, but $p = 0.188$ showed moderate correlation and not statistically significant. These results reinforce the view that GIS implementation has had a positive impact on the volume and consistency of land title registrations, particularly for C of O, Mortgage, and Sublease documents.

Table 3. Summary result of Efficiency and Productivity Performance

registered titles	2024/2020 Ratio	Annual Productivity Index (%)
C_of_O	3.790	69.77
P_of_A	2.16	29.19
Deed_of_Assignment	6.75	143.96
Mortgage	3.15	53.80
Sublease	2.25	31.25
Surrender	0.76	-5.88
Court_Judgment	1.57	14.28
Recertification	0.00	0.00
Total	3.82	70.50

The result obtained in Table 3 quantifies the administrative efficiency gains and productivity improvements in land document processing between 2020 (pre-GIS) and 2024 (full GIS deployment) at the Awka substation:

The Efficiency Ratios (2024 / 2020) result showed: C of O issuance increased by 3.79 times (from 488 to 1,850). Deed of Assignment rose 6.76 times, the highest growth ratio. Mortgage and P of A increased by 3.15 and 2.17 times respectively. Also, Annual Productivity Index (% Growth per Year): Deed of Assignment: Grew at an average rate of 143.97% per year.C of O: Averaged 69.77% annual growth. Mortgage and Sublease grew by 53.80% and 31.25% per year respectively. These outcome provide strong quantitative evidence that GIS implementation significantly enhanced land administration throughput, especially in high-demand services like C of O and Deed of Assignment. The high productivity index confirms that GIS helped streamline bottlenecks, cut processing delays, and scale capacity.

3.2 Discussion of Results

The results of this study show that the introduction of GIS at the Awka substation changed the story of land registration in a practical way. Registrations was found to increase sharply after full deployment, especially for Certificates of Occupancy, Deed of Assignment, and Mortgage documents, confirming that digital systems can increase speed and output. This aligns with the experience in Nguru, where moving from paper records to a GIS and Land Information System made land information easier to find and reduced disputes (Abubakar et al., 2020). It also agrees with findings from Enugu and Abia, where digital tools reduced fake documents and improved professionalism in land offices (Ekwunife et al., 2022; Okorafor, 2025). However, just like other studies have shown, technology alone is not enough. High costs, staff training gaps, and

weak coordination can limit the full benefit of GIS (Saleh & Lay, 2026; Alagbe & Ojo, 2021). The implies that while GIS has improved efficiency and productivity, government must continue to invest in staff capacity, simplify procedures, and ensure that fees remain affordable so that the benefits are not only visible in numbers but also felt by ordinary citizens.

4. **Conclusion**

This study examines whether the introduction of Geographic Information System (GIS) truly changed land administration performance in Awka. Evaluating the evidence, it was found that after full GIS implementation, land registrations increased, especially for high-demand documents like Certificates of Occupancy, Deeds of Assignment, and Mortgages. Total registrations rose from 1,424 in 2023 to 3,442 in 2024, representing a 141.7% increase within one year. Certificates of Occupancy was found to grow from 488 in 2020 to 1,850 in 2024, nearly four times the earlier figure. These changes show that digital systems can significantly improve speed, output, and overall capacity in public land offices. The results also show that productivity improved across most document types, with strong positive associations between time and registration levels after GIS deployment. Although the statistical model did not show strong significance due to limited time points, the practical impact seen in the trend analysis and efficiency ratios is difficult to ignore. Therefore, GIS has reduced bottlenecks and expanded service delivery.

Based on these findings, two major policy recommendations emerged; first, the government should institutionalize and expand GIS infrastructure across all land offices in the state, ensuring stable funding, continuous software upgrades, and proper maintenance. Second, there must be sustained investment in staff training and workflow simplification so that the benefits of digital systems are not slowed down by human capacity gaps. In addition, transparent performance indicators such as processing time and service costs should be publicly reported to strengthen accountability and public trust.

Conflict of interest statement

The authors hereby declare that they have no conflict of interest regarding the publication of this research.

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