https://doi.org/?????????
ISSN: 2805-3346

RESEARCH ARTICLE

Challenges and Prospects of Spatial Data Infrastructure for Physical Development Planning in Lagos State, Nigeria

Timileyin John Odunayo[1*], Muyiwa Elijah Agunbiade[2], Abdullateef Iyanda Bako[3], and Bukola Baheedoh Moshood[3]

[1]Centre for Housing and Sustainable Development, University of Lagos, Lagos, Nigeria

[2]Department of Urban & Regional Planning, University of Lagos, Lagos, Nigeria

[3]Department of Urban & Regional Planning, University of Abuja, Abuja, Nigeria

Received: 13 February 2026

Revised: 19 March 2026

Accepted: 12 May 2026

Published: 28 July 2026

Cite article as: Odunayo, T. J., Agunbiade, M. E., Bako, A. I., & Moshood, B. B.(2026). Challenges and prospects of spatial data infrastructure for physical development planning in Lagos state, Nigeria. *African Journal of Housing and Sustainable Development, 8*(1), 71-88. https://doi.org/??????????????????????

*Corresponding author:
todimutimi@gmail.com

ABSTRACT

Spatial Data Infrastructure (SDI) plays a pivotal role in land-use planning, infrastructure provision and sustainable urban development. In Lagos State, SDI adoption remains low despite the growing complexity and need of urban data-oriented decision-making. This paper examines the challenges impeding the implementation of SDI and its potential to support physical development planning. The paper adopted a mixed-method design that incorporates qualitative data obtained by use of structured interviews and field observations alongside spatial analysis of eleven development plans, consisting of Master Plans and Model City Plans. Data format, data compatibility, and spatial integrity were assessed using Geographic Information Systems (GIS) tools. The results indicate the existence of a few technical and institutional limitations: ongoing use of AutoCAD instead of GIS-based formats, inconsistent use of coordinate systems, disaggregated spatial data, inadequate GIS capabilities of employees, and ineffective inter-agency collaboration. These issues have compromised effective planning, sharing of information and coordination of different development plans. In spite of these shortcomings, the research reveals an emerging scenario: growing political support for adoption of digital planning tools, expansion of technical capacity within governmental institutions and willingness of planning professionals to utilise spatial technologies. The paper suggests feasible measures such as the creation of centralised cloud-based geospatial database, data format standardisation, use of GIS platforms, institutional framework coordination and improvement of capacity building. The study concludes that Lagos State can enhance its spatial data systems by managing these challenges through institutional reforms and technological investments to facilitate more efficient, inclusive and resilient urban planning. The results are relevant to the wider discussion of sustainable land management and infrastructure governance in African cities.

Keywords: Spatial data infrastructure, GIS, Urban planning, Land management, Lagos State

1.0 Introduction

Spatial Data Infrastructure (SDI) is a holistic approach in urban planning and sustainable development that integrates policy, technology and institutional frameworks to enhance accessibility and use of geospatial data. SDI plays a critical role in supporting decision-making across sectors such as land management, environmental governance and climate-change adaptation by facilitating the integration and interoperability of geospatial data. Established frameworks such as the INSPIRE Directive in Europe and the National Spatial Data Infrastructure (NSDI) in the United States

demonstrate structured approaches to geospatial data coordination and accessibility (European Commission, 2007; Federal Geographic Data Committee, 2013; UNECA, 2017). Since 2003 the United Nations Economic Commission for Africa has been focusing on SDI (African Action Plan on Global Geospatial Information Management 2016-2030), and this highlights its role in the realisation of the Sustainable Development Goals (UNECA, 2017). More recent technologies such as cloud-based systems and open-source GIS software have only increased the potential of SDI, although implementation remains uneven across developing areas (Maphale & Smit, 2020).

While SDI initiatives in Nigeria have been improving since the 2000s, issues of financial constraints, lack of technical capacity and data standard inconsistency actually persist (Mwange et al., 2018). Lagos State, a megacity with a population of over 20 million people (and estimated to grow to 32.6 million by 2050), illustrates these problems in the face of rapid urbanisation (UN-Habitat, 2022). The challenges that have limited the effectiveness of the National Geospatial Data Infrastructure (NGDI) in Nigeria include reliance on dated data, poor institutional coordination and disjointed data-management systems — problems which limit effective urban planning and decision-making (United Nations Economic Commission for Africa, 2017; World Bank, 2020).

According to Mwange et al. (2018), limited political support and stakeholder cooperation undermine SDI initiatives in Africa, with Nigeria being no exception and Lagos particularly manifesting these coordination and governance failures. Empirical research in Nigeria has continuously shown that the use of Geographic Information System (GIS) in planning practice has not been fully adopted, with many agencies still using traditional tools like AutoCAD, thus limiting higher levels of spatial analysis and integration of data. The implementation of GIS in Lagos State in particular is not evenly distributed and has not yet been incorporated into planning and land administration (Alagbe & Ojo, 2021; Akinola et al., 2018). Institutional, technical and policy constraints, e.g., insufficient infrastructure, lack of technical capacity and ineffective data governance, further complicate these limitations and are some of the factors limiting the shift to a proactive urban planning system in Nigeria (Effiong & Ilechukwu, 2016; Akinola et al., 2018).

The aim of this study is to determine the challenges and opportunities of SDI with regard to physical development planning in Lagos State, Nigeria, with a view to designing an effective GIS platform for managing land use sustainably. The specific objectives are: (i) to determine and evaluate current land use and development plans; (2) to outline SDI-related issues; (3) to propose a single data format to compute land use; and (4) to develop a platform that would store, analyse and manage land-use data. By filling these gaps, this study will be providing a strategic course of action in order to improve SDI and aid informed decision-making and sustainable urban development in Lagos State.

1.1 Study Area

Lagos State is situated in southwest Nigeria. It is the most economically important and urbanised state of the country. It has the highest population density as it covers a total area of around 3,577 square kilometres, although it is the smallest state in terms of land area (UN-Habitat, 2022). Lagos is the commercial and industrial centre of Nigeria, bounded to the north and east by Ogun State, the south by the Atlantic Ocean and the west by the Republic of Benin, with the state contributing more than two-thirds of all Nigerian economic activities (National Bureau of Statistics, 2021). As the business capital of Nigeria, Lagos State offers a strong example of exploring the Spatial Data Infrastructure (SDI) in physical development planning since it is the largest urban centre in Nigeria, with its population and spatial expansion rapidly rising (UN-Habitat, 2022; National Bureau of Statistics, 2021).

This paper examined eleven development plans in Lagos State, which are classified into Master Plans (e.g., Badagry, Epe, Ikorodu, Lekki) and Model City Plans (e.g., Agege Ifako/Ijaiye, Alimosho, Apapa, Ikeja, Ikoyi-VI, Mainland Central, and Oshodi/Isolo). As illustrated in Figure 2, these plans cover model city areas and sub-regions, which are meant to lead sustainable land use and urban development (MPP&UD, 2021; Dar Al-Handasah, 2020). Potential avenues of enhancing SDI can also

be found in continuous efforts such as the Lagos State Land Information Systems that is aided by the World Bank, as well as the relatively good economic foundation of the state and the changing state of institutional structures to plan urban development.

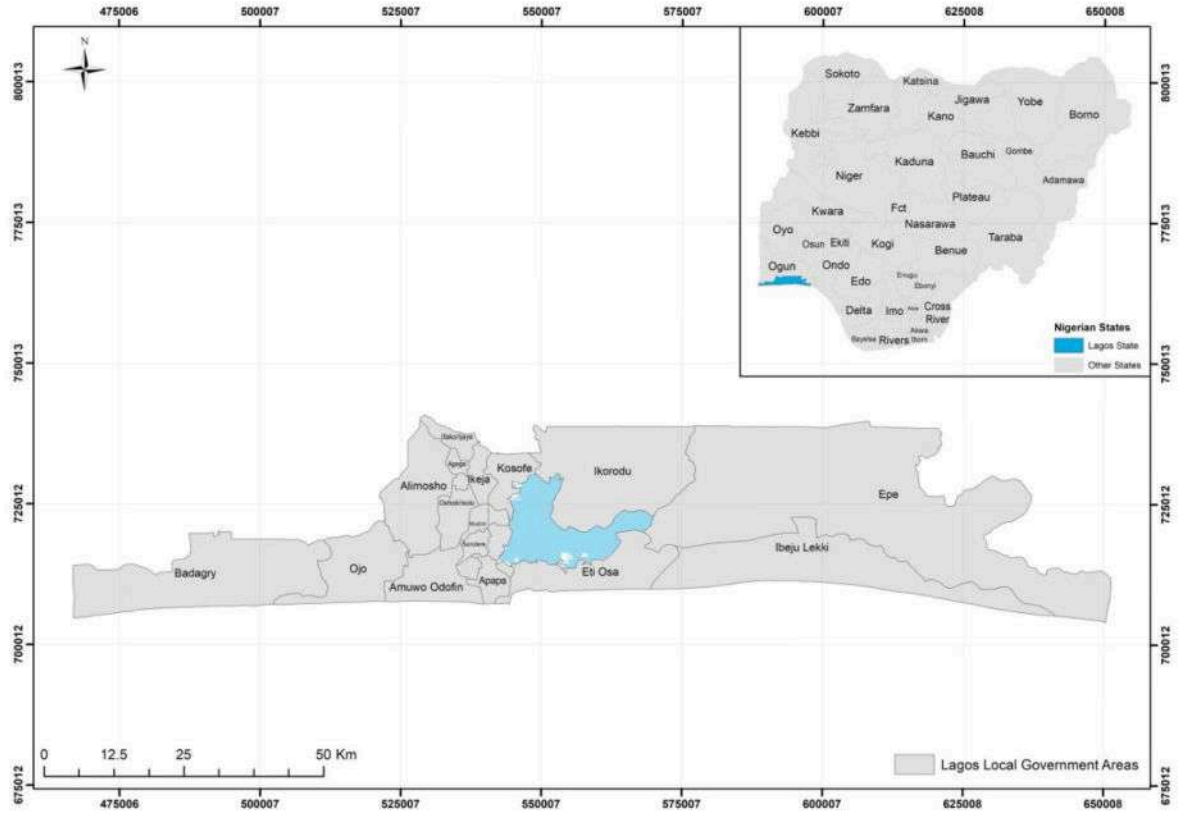


Figure 1: Lagos State within the Context of Nigeria

Source: Authors' Design (2023)

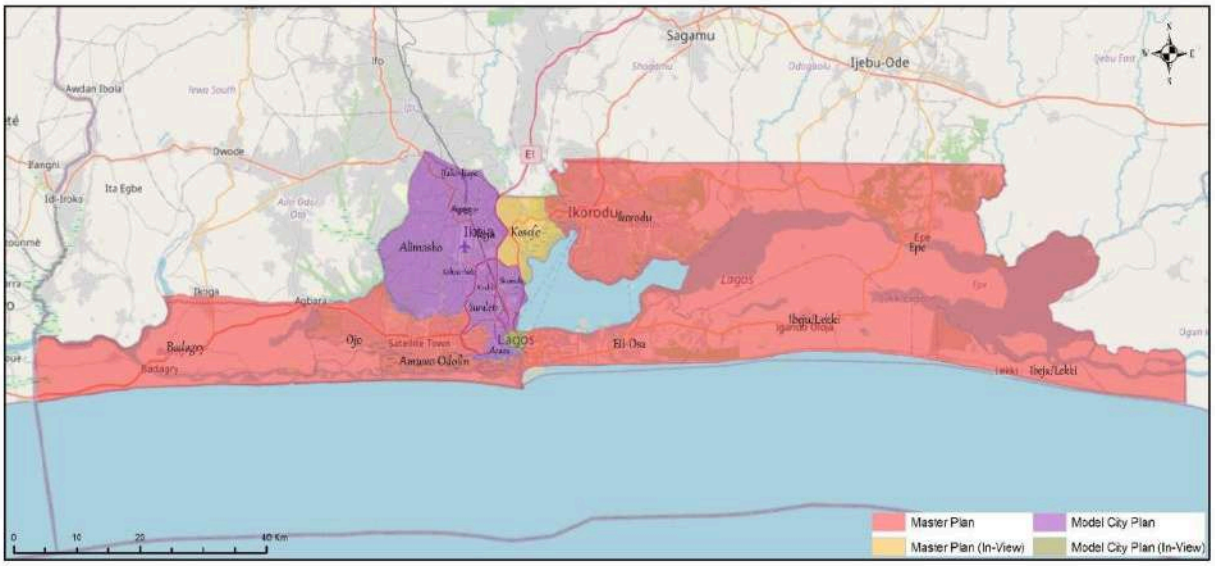


Figure 2: Master Plans and Model City Plans in Lagos State

Source: Authors' Design (2023)

2.0 Theoretical/Conceptual Framework

This study adopts the Spatial Data Infrastructure (SDI) model, which frames SDI as a comprehensive system consisting of spatial data, technologies, institutional organisation, policies and the human resource needed to facilitate successful spatial planning and decision-making. Recent SDI literature highlights the importance of spatial data systems not solely in terms of technological tools but also in terms of governance structures, data standards and institutional coordination (Al-Bakri & Fairbairn, 2023; Li et al., 2024).

The SDI framework refers to such major components as (i) spatial data and metadata, (ii) technological infrastructure, (iii) institutional and organisational arrangements, (iv) policy and legal frameworks, and (v) human capacity. These elements are mutually complementary and the deficiency of one of the elements may have a major impact on the overall performance of the system. Recent research shows that the development of SDI in most countries has been limited owing to challenges with these components, especially when it comes to interoperability, governance and resource constraints (Ali et al., 2025; Al-Bakri & Fairbairn, 2023).

This work is based on the principles of the Integrated Geospatial Information Framework (IGIF), which was established by the United Nations Committee of Experts on Global Geospatial Information Management, the body that offers strategic projections on enhancing national and sub-national geospatial systems. IGIF identifies governance, integration of data, capacity development and infrastructure as key pillars of success in geospatial information management. The latest use of this framework underscores its applicability in informing the process of SDI development, especially in developing areas that continue to have institutional and technical gaps (Letsosa & Muthumini, 2023).

In the current study, the SDI framework is used to analyse the structure and effectiveness of spatial data systems in Lagos State. The challenges to be identified, including use of non-GIS formats, inconsistencies in data, institutional fragmentation, capacity gaps, weak policy frameworks, etc., relate directly to the shortcomings of the main SDI components. In the same vein, the strategies suggested resonate with reinforcing these elements by enhancing the standardisation of data, technological advances, institutional coordination and reforms in governance. Therefore, implementation of the SDI framework facilitates an organised perception of how spatial data issues impact physical development-planning and gives a set format to suggest specific interventions.

3.0 Materials and Methods

This study adopts a mixed-method design, which combines qualitative and quantitative research methods to investigate the opportunities and challenges of Spatial Data Infrastructure (SDI) in the physical development planning of Lagos State in Nigeria. The qualitative part – a major part of the study – consisted of interviews and field observations to extract the institutional practices and stakeholder views. The quantitative part comprised descriptive evaluation of spatial datasets and development plans, backed up by spatial analysis through the Geographic Information System (GIS). The methodology will allow triangulation of the approach and allow a complete picture of the implementation of SDI in the study area.

The study data was gathered from April to August 2023, using primary and secondary sources. Structured oral interviews with officials of the Lagos State Ministry of Physical Planning and Urban Development, especially the Regional and Master Plan Department, were the primary data source. The interviews were conducted on major issues of spatial data formats, data management practices and inter-agency collaboration, technical capacity, and institutional challenges. Field observations were also carried out to evaluate implementation of development plans and current practices of data management in the concerned agencies. The secondary data emanated from development plan reports, i.e., Master Plans (e.g., Badagry, Epe) and Model City Plans (e.g., Ikeja, Agege Ifako/Ijaye), which were accessed in the archives of the Lagos State Government. A total of eleven (11) development plans made up the study population, purposively selected because of their relevance to physical planning and obtained in the course of the research (Creswell, 2014). This type of non-probability sampling allowed for limiting attention to the plans that were prepared with detailed spatial information, including the Lekki

Comprehensive Master Plan and the Alimosho Model City Plan.

The interview tool included open-ended and closed questions aimed at obtaining a qualitative focus and overall trends in the practice of SDI. The analysis was based on documented field notes, researcher observations and summarised responses during the interviews, since it was impossible to retrieve complete archived transcripts. This method is congruent with qualitative research practices, wherein thematic interpretation is undertaken with the aid of detailed note-taking and observational records. Both qualitative and spatial analyses were performed. Thematic analysis was used to analyse qualitative data (interviews and observations) and determine recurring patterns and crucial issues, while grouping them into key themes. The formats, compatibility and spatial integrity of the development plans were evaluated with the help of spatial analysis in ArcMap (version 10.8) and QGIS (version 3.22). Where feasible, AutoCAD datasets were converted into GIS-compatible formats (e.g., shapefiles) so that they could be analysed further. Maps and graphical outputs were used to visualise land-use distributions, data inconsistencies and spatial gaps. Data triangulation was used to generate credible findings by comparing information based on interviews, document analysis and spatial data analysis. Ethical aspects were noted during the research process, such as securing informed participant consent, ensuring anonymisation and limiting the scope of data usage to scholarship.

4.0 Results and Discussions

4.1 Development Plans in Lagos State

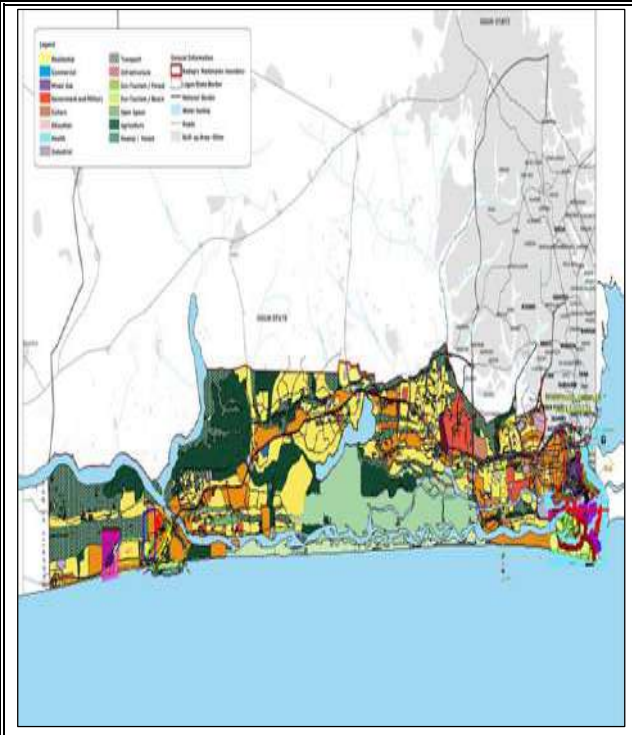
The 11 development plans in Lagos State were evaluated based on their coverage and purpose in urban development. These plans include four Master Plans (Badagry, Epe, Ikorodu, and Lekki) and seven Model City Plans (Agege Ifako/Ijaiye, Alimosho, Apapa, Ikeja, Ikoyi-Victoria Island, Mainland Central and Oshodi/Isolo). As outlined in Table 1, the Master Plans typically encompass larger sub-regional territories and offer long-term strategic guidance for urban growth, infrastructure provision and land use. The Model City Plans are more focused and deal with land-use control and development regulation within specific districts. This dual approach is an effort to scale regional planning goals with local implementation strategies.

Spatial analysis using ArcMap 10.8 reveals that although the plans offer a high degree of spatial coverage of Lagos State, they have been prepared in an ad hoc manner. Differences in preparation time, data formats and institutional roles have created inconsistencies that hinder their integration into a coherent spatial planning system. Moreover, the presence of multiple plans with varying levels of detail and technological advancement indicates a mixed approach to adopting contemporary geospatial technologies in spatial planning. Although some plans are prepared in formats compatible with GIS, most remain limited by conventional drafting techniques, which reduce their analytical potential. Figures 3 to 5 illustrate the spatial structure and distribution of development plans across Lagos State.

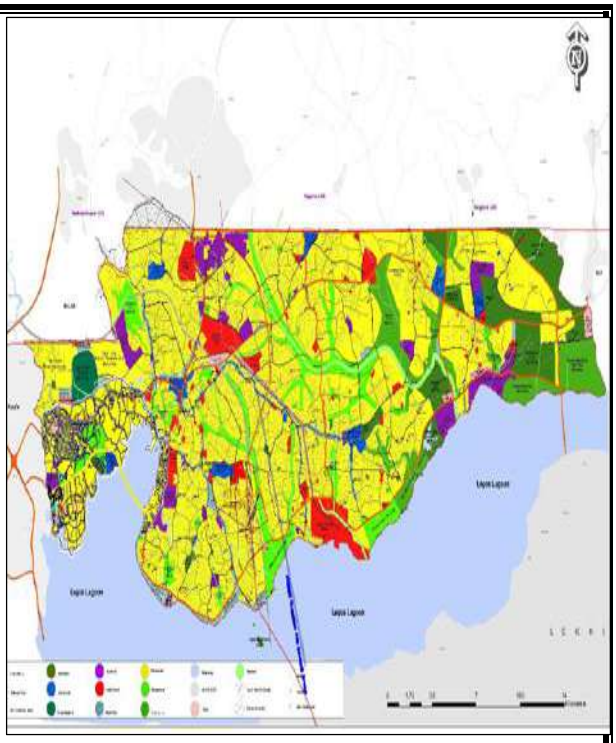
Table 1: Development Plans in Lagos State

S/N	Plan Name	Type	Software Deployed
1.	Agege Ifako/Ijaye	Model City Plan	AutoCAD
2.	Alimosho	Model City Plan	AutoCAD
3.	Apapa	Model City Plan	AutoCAD
4.	Badagry	Master Plan	AutoCAD and ArcMap
5.	Epe	Master Plan	AutoCAD
6.	Ikeja	Model City Plan	AutoCAD
7.	Ikorodu	Master Plan	AutoCAD and ArcMap
8.	Ikoyi vi	Model City Plan	AutoCAD
9.	Lekki	Master Plan	AutoCAD
10.	Mainland central	Model City Plan	AutoCAD
11.	Oshodi/Isolo	Model City Plan	AutoCAD

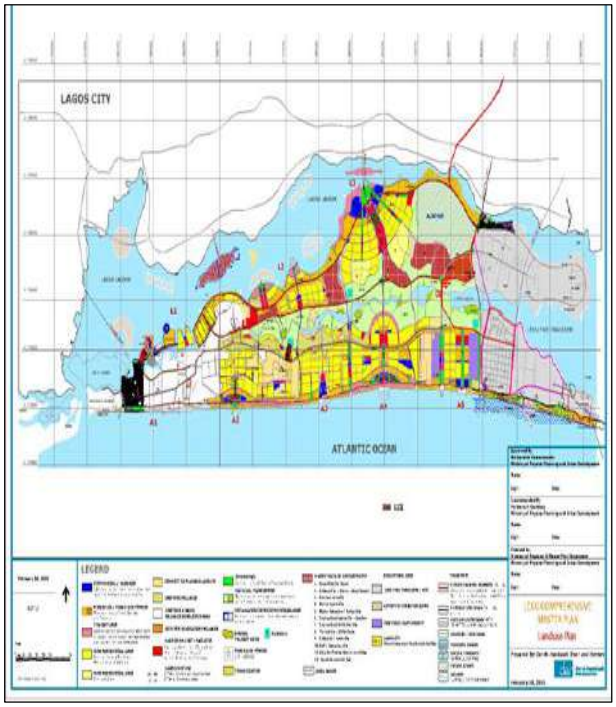
***Source**:* Authors' Compilation (2023)



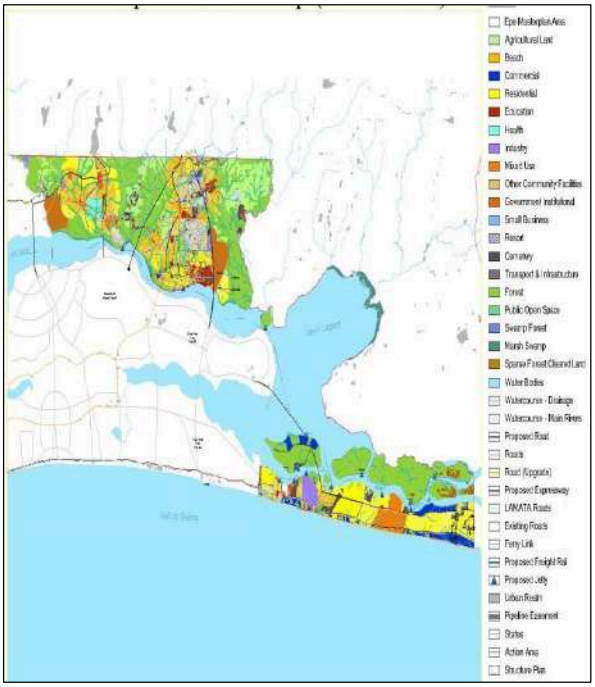
Badagry Land Use Plan (2012-2032)



Ikorodu Master Plan



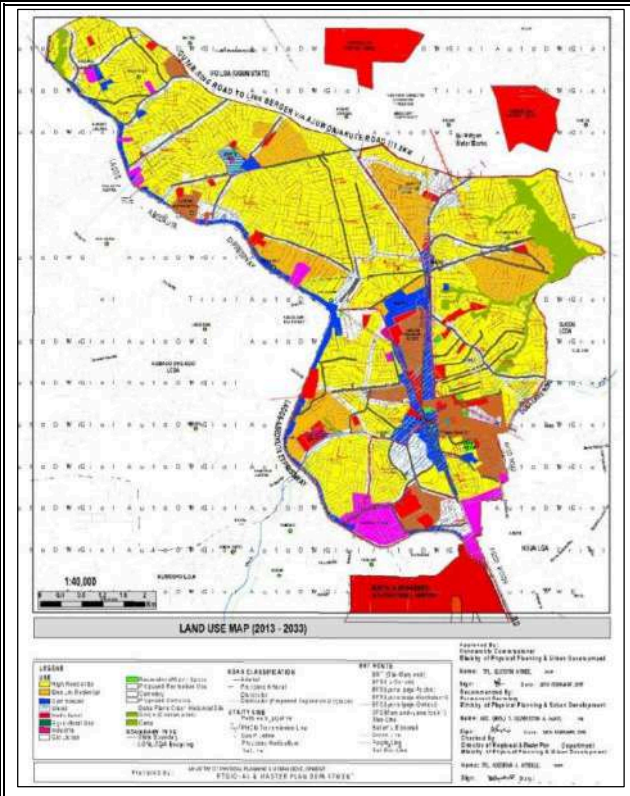
Land Use Map of Lekki Comprehensive Master Plan



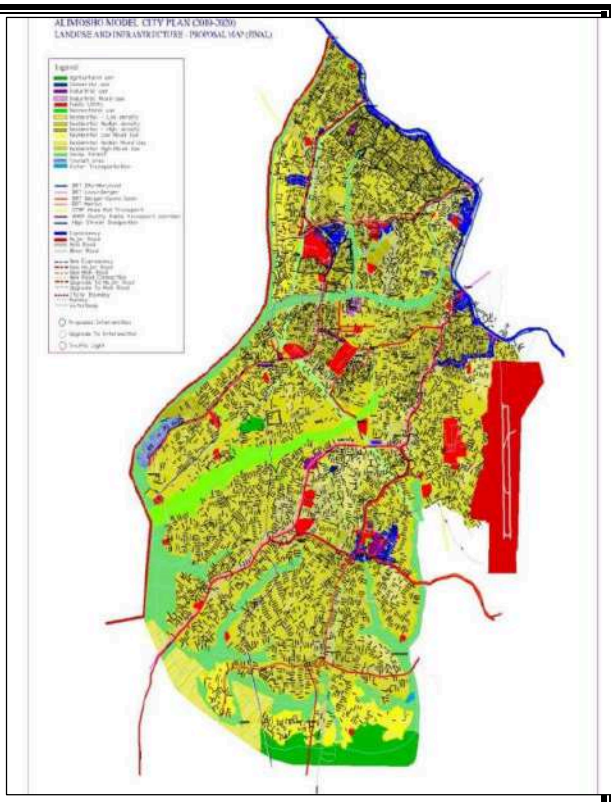
Land Use Map of Epe Master Plan

Figure 3: Master Plans in Lagos State

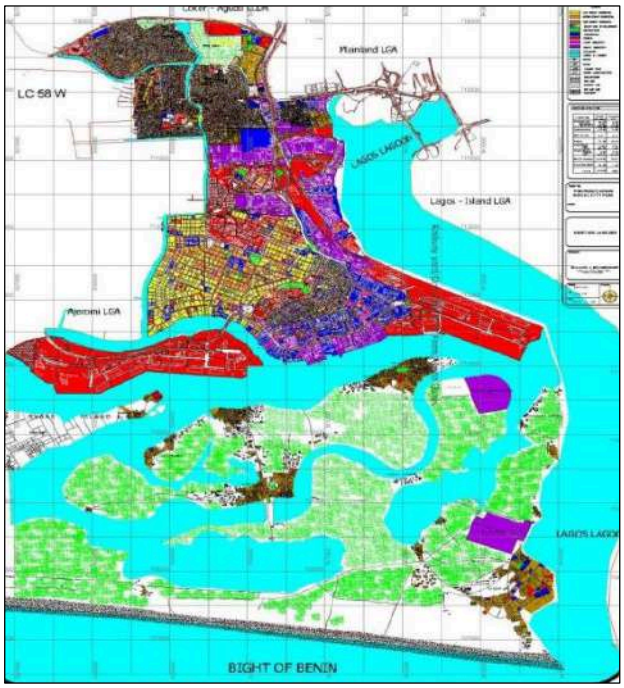
Source: Dar Al-handasah (2007, 2013, 2017); Cityscape Planning Service (2020)



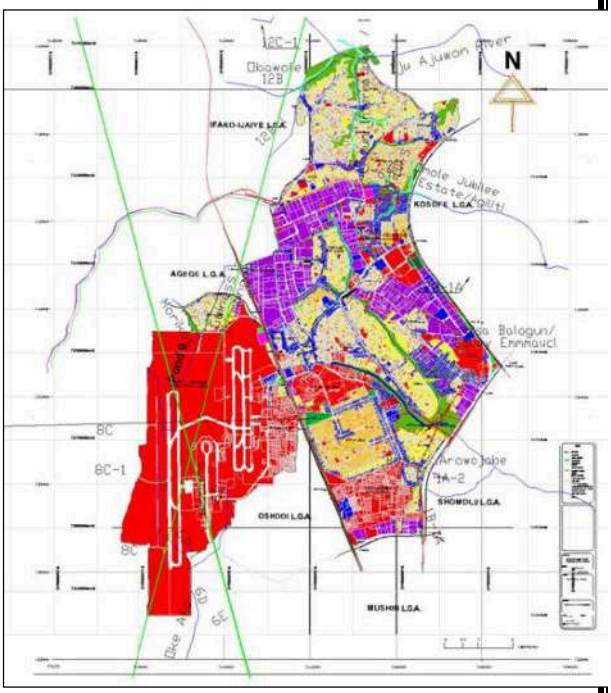
Agege Ifako-Ijaiye Land Use Map



Alimosho Land Use Map (2010-2020)



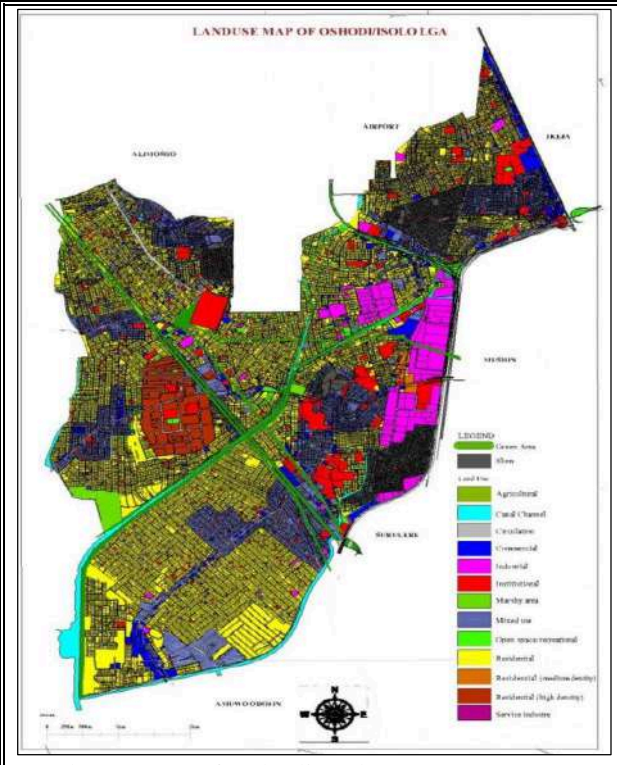
Land Use Map of Apapa Model City Plan



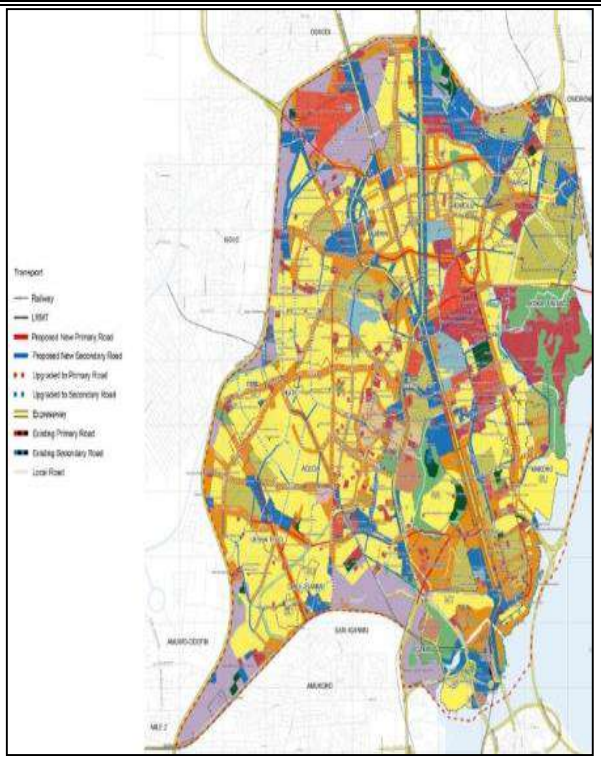
Land Use Map of Ikeja Model City Plan

Figure 4: Model City Plans in Lagos State (Part A)

Source: MPP & UD (2012, 2013, 2016); Firstplus Planning Nigeria (2011)



Land Use Map of Oshodi/Isolo



Land Use Map of Mainland Central Model City Plan

Land Use Map of Ikoyi-Victoria Island Model City Plan (2013-2033)

Figure 5: Model City Plans in Lagos State (Part B)

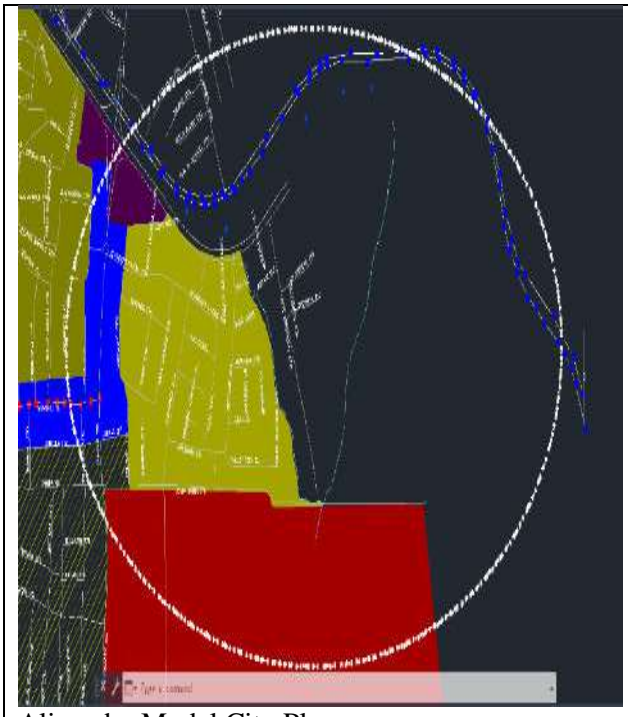
Source: MPP & UD (2013)

4.2 Format of Capture and Presentation of the Development Plans

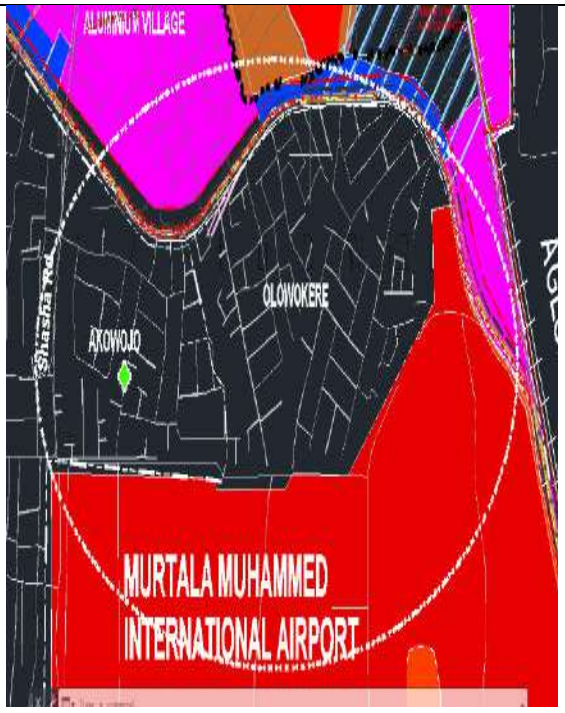
Critical evaluation of the software used in the presentation of the eleven development plans by Lagos State reflects a high level of dependency on AutoCAD, as the software is used in all the eleven development plans. Nine of the plans, i.e., Agege Ifako/Ijaye, Alimosho, Apapa, Epe, Ikeja, Ikoyi-VI, Lekki, Mainland, and Oshodi/Isolo, were only drawn in AutoCAD (.dwg format), whereas Badagry and Ikorodu were prepared in both AutoCAD and ArcMap (Shapefile-compatible) (Table 1). This lack of compatibility hinders compatibility of data and the ability to analyse it, since AutoCAD does not have attribute tables and thus limits the representational properties to spatial delineations (e.g., colour-coded land-use categories) and omits the asymptotic data, such as demographic or infrastructural measures. On the other hand, Shapefiles, which are used in Badagry and Ikorodu, maintain these characteristics, thus improving interactivity through GIS applications like ArcMap and QGIS. This ensuing format difference, in turn, reduces the usefulness of the vector datasets which are fundamental in enforcing and overseeing the development plans.

Moreover, the data used to develop the development plans in Lagos State is represented in heterogeneous vectors with non-consistent coordinate reference systems (e.g., projected versus geographic coordinates), which prevents the merging of such data into a single spatial framework and the creation of a complete land administration system. In comparison to Shapefiles, which retain essential data but are structurally different, AutoCAD — a widely used format throughout plans, with no attribute tables and using a generic coordinate system (e.g. WCS) — is the opposite of the latter. The conversion of these formats is associated with a high level of risk: possible loss of data (e.g., 4050% of attributes lost), long processing time and the occurrence of errors due to the incompatibility of coordinate systems and complicated structural schemes. Besides, plans like Apapa and Alimosho have spatial overlaps and gaps that complicate integration even more and thus require that a standard projection system should be adopted (See Table 2 and Table 3).

Table 2: Sample of Missing Data along Boundaries of Model City Plans



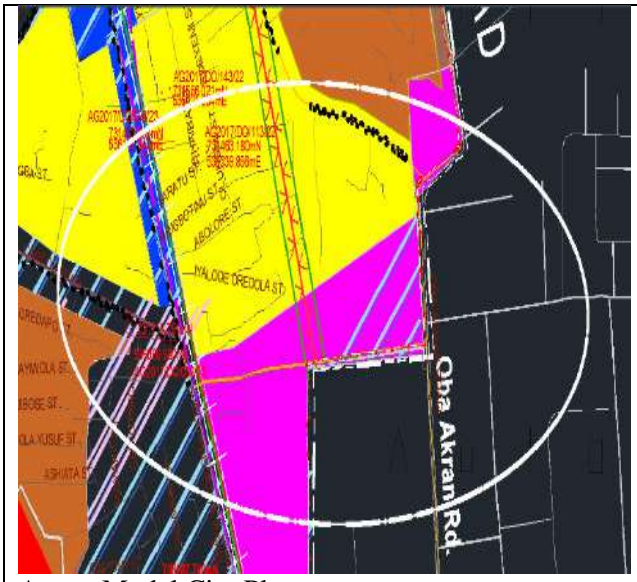
Alimosho Model City Plan



Apapa Model City Plan

Source: Authors' Compilation (2023)

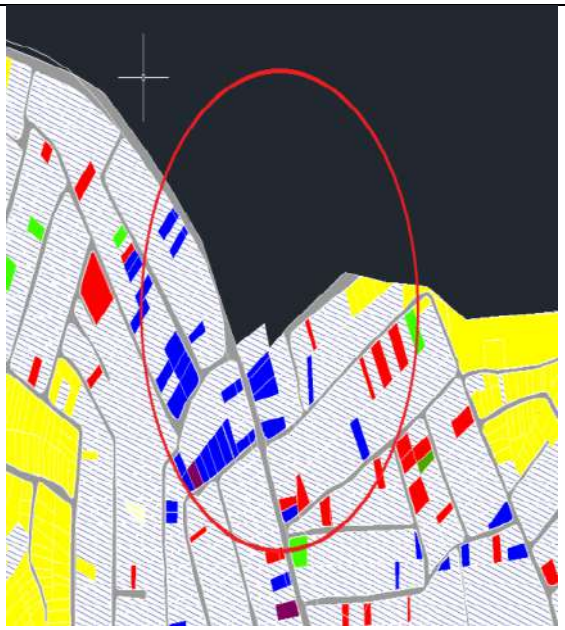
Table 3: Sample of Data Mismatch along Boundaries of Model City Plans



Apapa Model City Plan

Ikeja Model City Plan

Oshodi/Isolo Model City Plan



Alimosho Model City Plan

Source: Authors' Compilation (2023)

4.3 Thematic Analysis of Spatial Data Infrastructure of Lagos State Challenges

Data from the interviews with officials of the Lagos State Ministry of Physical Planning and Urban Development, as well as field observations, were examined based on themes to find the recurring patterns and major constraints influencing the implementation of SDI in Lagos State. The discussion highlights seven key themes indicating technical, institutional, infrastructural and policy-based issues.

4.3.1 Technical Constraints of Spatial Data Systems

One of the prevailing themes of the interviews is that there is still a dependence on AutoCAD to

prepare and store spatial data. According to the respondents, majority of the development plans were generated in AutoCAD (.dwg format), which allows only graphical representation but not the attribute data format needed to carry out sophisticated spatial analysis.

This dependency restricts the usability of spatial data since AutoCAD-based outputs cannot be used with relational databases, attribute queries or geospatial modelling. Conversely, GIS-based formats, e.g., shapefiles, allow one to incorporate both spatial and non-spatial data, thus increasing analytical capability. Continued use of AutoCAD indicates dependency on an old system that limits the shift to a complete, functional SDI framework.

4.3.2 Data Quality and Standardisation Problems

Problems of data quality and standardisation were continually raised. Spatial analysis and interview responses indicated that most datasets utilised in planning are old, incomplete or undocumented. Specifically, the lack of metadata and inconsistent documentation methodology decrease the usefulness and credibility of spatial data.

The next significant problem is the lack of standard coordinate reference systems between datasets. The presence of multiple coordinate systems (e.g., projected and geographic systems) poses a challenge in incorporating datasets into one spatial framework. This issue causes spatial incompatibility, overlapping of efforts and inefficiency in planning processes. The results indicate that the heterogeneity of data is still a significant inhibitor of interoperability in the SDI setting.

4.3.3 Fragmentation of Institutions and Incomplete Sharing of Data

Institutional fragmentation became a major limitation to SDI implementation. Respondents noted that spatial data management is considerably decentralized, with various agencies holding their own datasets and having no common platform on which they can coordinate.

Evidently, the absence of a centralised spatial data repository limits data accessibility and prevents efficient data sharing among stakeholders. This leads to a duplication of information gathering processes and inconsistencies in planning outputs. Moreover, the absence of formal data-sharing procedures or institutional structures also limits cooperation between government agencies, thus undermining the effectiveness of the entire system of spatial planning.

4.3.4 Deficit in Capacity and Skills

One of the common themes in the interviews is the lack of technical capacity by the personnel in spatial data management. According to many respondents, the members of staff do not receive the necessary training in GIS application, a situation which limits their capability to analyse, interpret and manage spatial data. Despite the growing knowledge of geospatial technologies, it is concerning that limited capacity-building opportunities exist. This explains the continued reliance on traditional methods of mapping, even as it limits the possibility of utilising cutting-edge SDI tools. The results indicate the significance of life-long professional development and institutional investment in human capital building.

4.3.5 Infrastructural Constraints

Poor technological infrastructure is another limitation to the effectiveness of SDI implementation. It was observed that most of the agencies relied on outdated computer systems, have limited data storage capacity and poor Internet connectivity. The processing, as well as accessibility, of spatial data was also affected by frequent power interruptions. Such infrastructural shortcomings decrease the effectiveness of the data-processing work and restrict the possibility of real-time data access and sharing. The results imply that strong digital infrastructure is the key to the successful operationalisation of SDI systems.

4.3.6 Policy and Governance Weaknesses

Lack of a comprehensive legal and institutional framework on spatial data governance was found to be one of the key challenges. Respondents observed that the state has no well-defined policies on issues of ownership, access, privacy and data sharing.

Such regulatory unpredictability puts agencies in a state of uncertainty and restricts accountability in data-management practices. Moreover, the lack of effective policy enforcement mechanisms adds to the lack of consistency in the use of spatial data and hampers planning. The results show that successful implementation of SDI will depend on a clear governance framework with enforceable policies.

4.3.7 Inadequate Financing and Lack of Political Commitment

Lack of financial resources and intermittent political goodwill were also cited as key impediments. According to the respondents, funding for spatial data projects is usually insufficient and erratic, with negative implications for long-term planning and the sustainability of SDI projects.

Budgetary allocations were reported as being affected by political priorities, which frequently led to discontinuation of SDI programmes. This instability restricts the capacity of agencies to invest in modern technologies, infrastructure and capacity building. Thus, financial investment and strong political will are needed to propel SDI development in Lagos State.

4.3.8 Interrelationship of Challenges

The analysis also indicates that these issues are not isolated but interlinked. As an example, inadequate financing limits investment in infrastructure and capacity building, while ineffective institutional frameworks contribute to data fragmentation and inadequate standardisation. Similarly, technical constraints are further complicated by ineffective training and absence of policy guidelines. This interdependence highlights the need for a comprehensive approach to the development of SDI, with technical, institutional and policy interventions being undertaken concurrently to produce significant changes in spatial-planning systems.

4.3.9 Relative Prominence of the Challenges Identified

For more analytical depth, the identified themes were evaluated based on their relative salience in the interview responses and field observations. In spite of the lack of specific quantitative frequencies, the frequency of recurrence and focus of the issues among the participants was used to divide the challenges into levels of importance: ‘high’, ‘moderate’ and ‘emerging’.

Table 4: Relative Prominence of SDI Challenges in Lagos State

S/N	Theme	Level of Prominence	Interpretation
i.	Technical limitations (AutoCAD reliance)	High	Widely emphasised as a core constraint affecting spatial analysis and integration
ii.	Data quality and lack of standardisation	High	Frequently reported issue affecting interoperability and data reliability
iii.	Institutional fragmentation and poor data sharing	High	Strong consensus on lack of coordination across agencies
iv.	Capacity and skills deficit	High	Consistently identified as limiting effective use of GIS technologies
v.	Infrastructural constraints	Moderate	Commonly mentioned but often linked to funding limitations
vi.	Policy and governance gaps	Moderate	Noted as an underlying issue affecting coordination and accountability
vii.	Funding constraints and political commitment	High	Highlighted as a cross-cutting issue influencing all other challenges

Source: Authors’ Computation (2026)

The analysis indicates that technical, institutional and capacity-related challenges constitute the most critical barriers to SDI implementation in Lagos State. In particular, the widespread reliance on AutoCAD, combined with inadequate technical skills and fragmented institutional arrangements,

significantly constrains the effectiveness of spatial-data systems. Funding constraints were also identified as a cross-cutting issue, influencing the availability of infrastructure, training opportunities and technological upgrades. By contrast, policy and infrastructural challenges, while important, were less consistently highlighted and often manifested as secondary effects of broader systemic limitations.

4.4 Strategies Proposed to Improve the Spatial Data Infrastructure to Support Physical Development Planning in Lagos State

The strategies proposed here are based on the challenges that were identified during the thematic analysis. Therefore, the recommendations reflect a problem-focused approach, offering systematic directions towards enhancing Spatial Data Infrastructure (SDI) in Lagos State by aligning every intervention with specific constraints.

Overcoming Technical constraints of Spatial Data Systems

The existing challenges associated with the ongoing use of AutoCAD demands a shift to GIS-based systems such as ArcGIS and QGIS. These systems are conducive to high-quality spatial analysis, attribute management and interoperability, which are crucial elements of a viable SDI. The conversion of the old datasets stored in AutoCAD to GIS-compatible formats should be given top priority, while proper data validation processes are initiated to reduce information loss in the conversion process. Figure 6 is an extract of the Ikorodu Master Plan in ArcGIS, which is an attribute table.

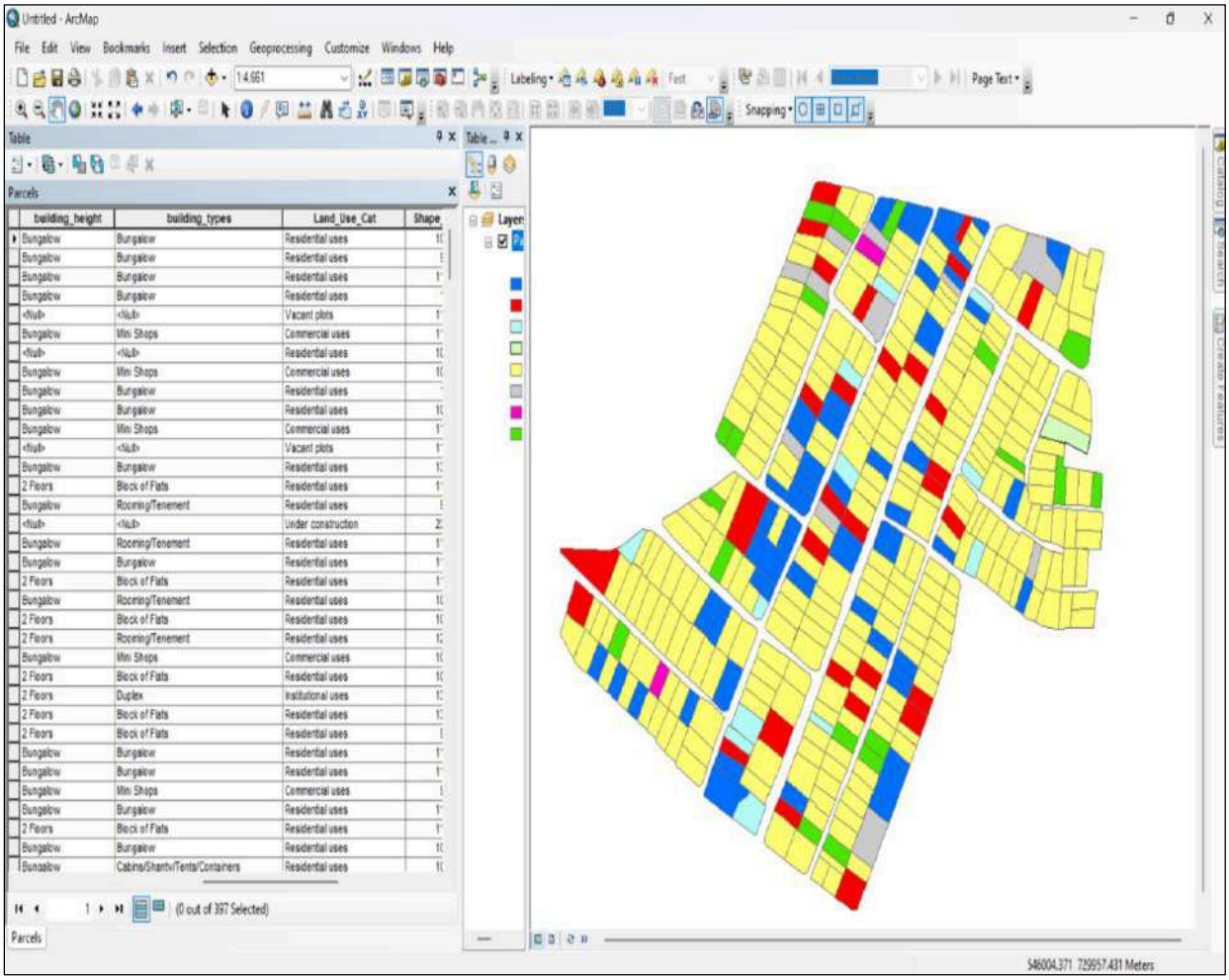


Figure 6: Attribute Table in ArcMap

Source: Authors' computation (2023)

Enhancing the Data Quality and Standardization

Standardisation of spatial data is essential for guaranteeing interoperability among agencies. It is advisable to adopt a single coordinate reference system, e.g., the WGS 1984 UTM Zone 31N, to help in eradicating spatial anomalies. Moreover, development of metadata standards and data documentation protocols will increase the reliability of data, as well as its accessibility and usability, over time in the SDL framework. Figure 7 shows an example of a coordinate system.

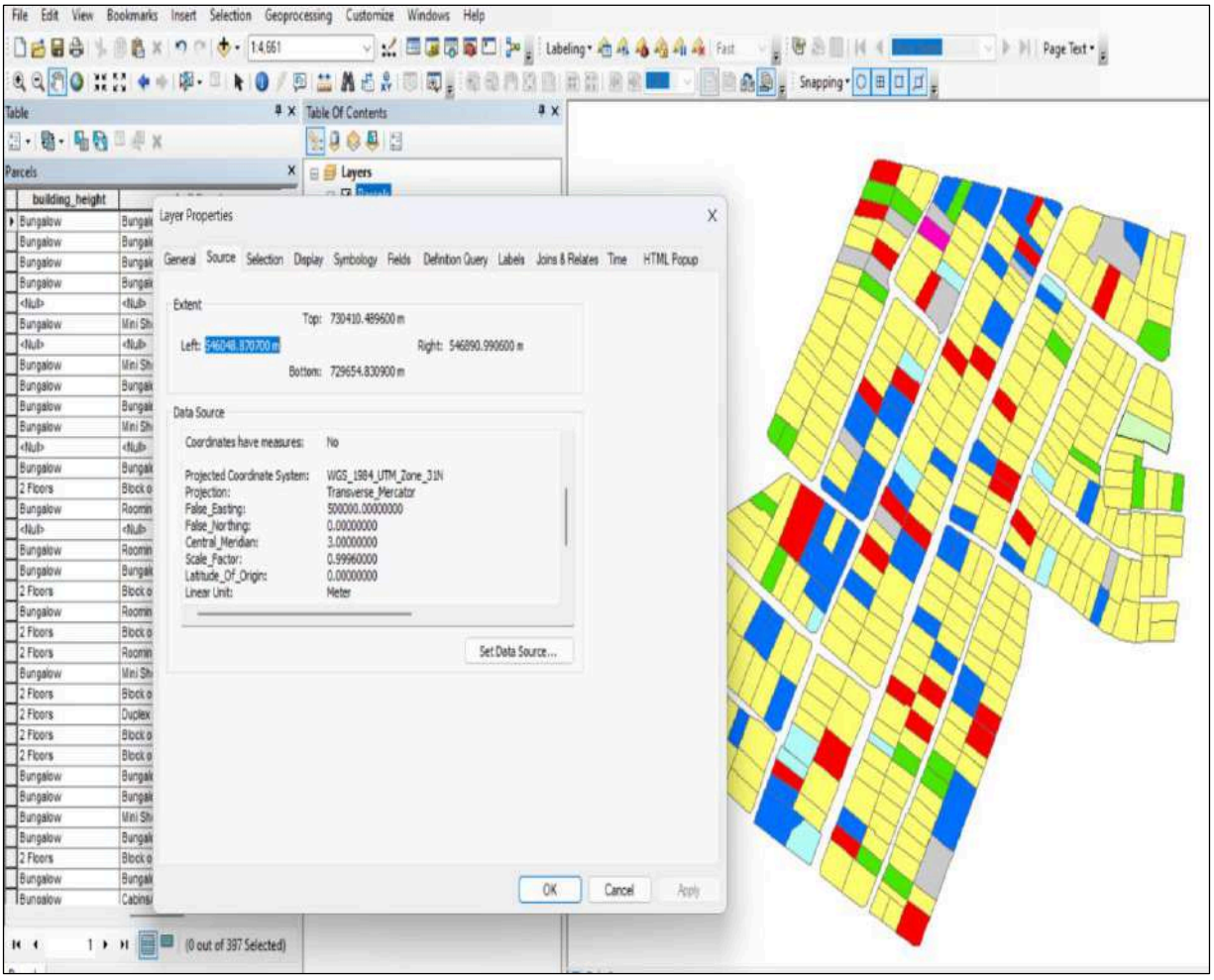


Figure 7: Sample of coordinate system

Source: Authors' computation (2023)

Developing a Centralized Spatial Data Infrastructure

To enhance coordination and data sharing among government agencies, it is important to create a centralised and cloud-based geospatial database, which must be able to support a variety of data formats such as vectors, raster and tabular data, in addition to being under stakeholder control. Data consistency and reduction of duplication of efforts will be achieved by having a centralised system that will enhance collaborative planning processes. Additionally, Lagos State needs to implement web-based GIS systems that can host spatial data and offer interactive mapping applications to facilitate the accessibility and transparency of data. Google Earth, OpenStreetMap and agency-specific portals can boost levels of city engagement and monitoring, while promoting stakeholder inclusion in the decision-making process (see Figure 8 and Figure 9).

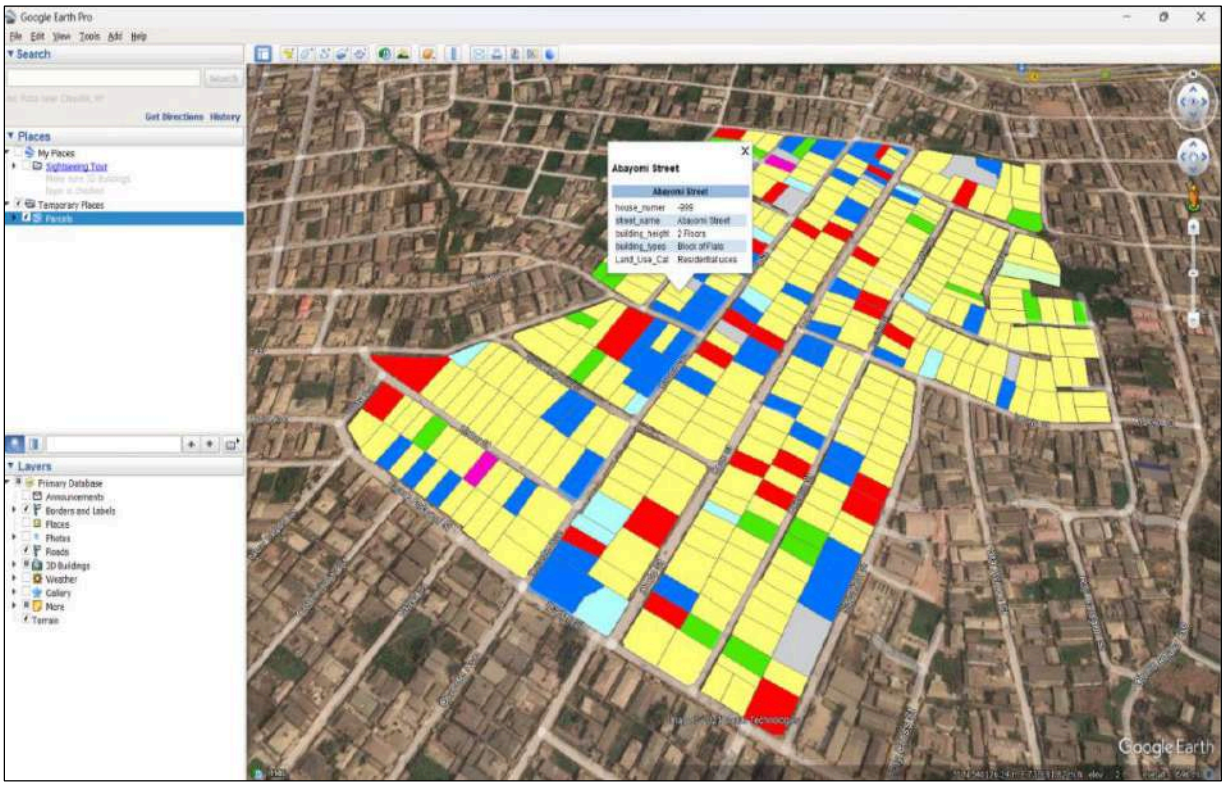


Figure 8: Extract of Ikorodu Master Plan Overlayed on Google Earth
Source: Authors' Computation (2023)

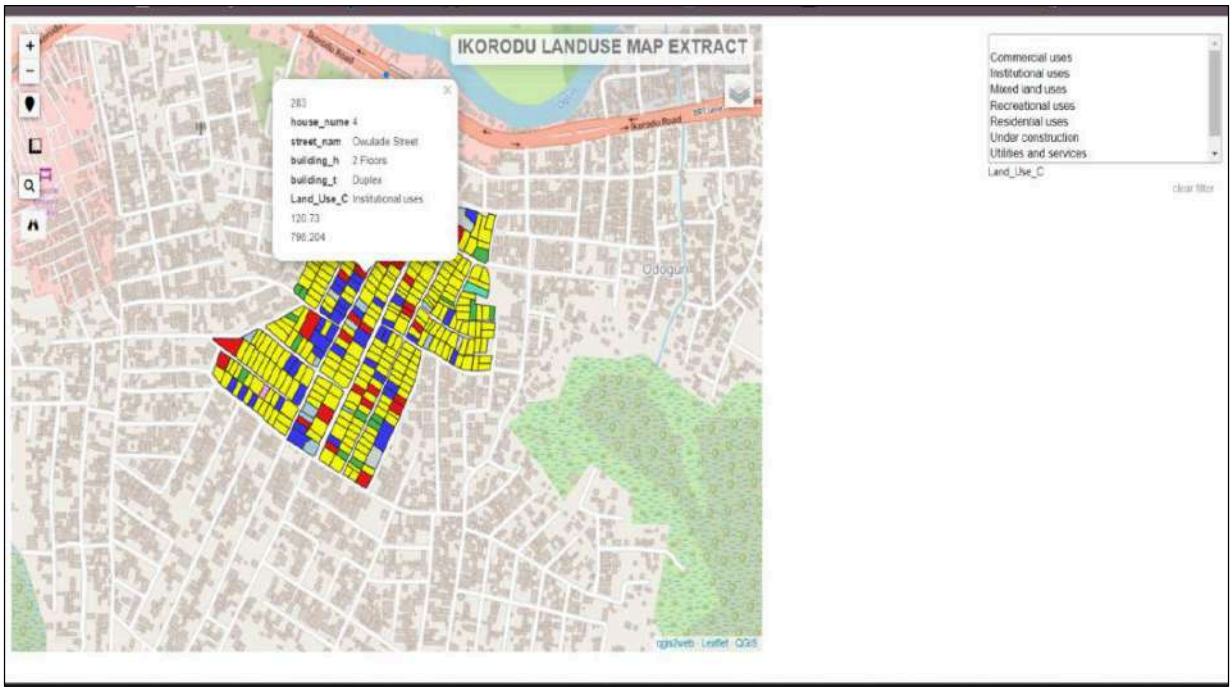


Figure 9: Extract of Ikorodu Master Plan Converted to Web Map
Source: Authors' Computation (2023)

Strengthening Technical Capacity and Human Capital

As this study shows, it is necessary to build capacity in order to maximise the use of geospatial technologies. Planning personnel should engage in regular training programmes in GIS applications, spatial data analysis and SDI management. Collaboration with educational establishments and professional organisations will also promote knowledge sharing and skills improvement.

Enhancing Technological Infrastructure

There should be investment in modern technological infrastructure to facilitate the implementation of SDI. The requisite facilities include high-performance computer systems, secure data storage systems, consistent internet systems and backup power supply systems. Real-time data collection and monitoring can also be enhanced by using GIS-enabled field devices.

The Formation of Policy and Institutional Frameworks

It would equally be necessary to establish an effective legal and institutional framework for the regulation of spatial data management. Such a framework would address issues of data ownership, access privileges, privacy requirements and data-sharing policies. At the state level, establishing and SDI coordinating body would further promote governance, adherence and institutional cooperation.

Sustainable Funding and Political Support

In the long term, the success of SDI initiatives would depend on sustainable funding systems and political commitment. Government should ensure adequate budgetary allocation to geospatial data development as well as infrastructure and capacity building. Moreover, collaboration with international organisations, development agencies and the private sector may be explored in the bid to secure funding and technical support for SDI implementation.

Cohesive and Holistic Implementation Strategy

Given that the identified challenges are interlinked, SDI development must be approached comprehensively. Institutional reforms, capacity building and policy development must complement all technical improvements. If a coordinated approach is adopted, the various sectors can benefit from one another's gains.

5.0 Discussion of Findings

This paper has highlighted the opportunities and challenges of Spatial Data Infrastructure (SDI) with regard to physical development planning in Lagos State. The results show that, despite the existence of various development plans, successful spatial planning has been hampered by technical, institutional and policy-based constraints. These results are consistent with recent research stating that the implementation of SDI in developing areas has been hampered by the difficulties associated with the current governance framework, limited data interoperability and resource constraints (Al-Bakri & Fairbairn, 2023; Letsosa & Muthumini, 2023).

As noted earlier, the continued use of AutoCAD for preparing spatial data is an impediment to analytical capability and interoperability. Recent SDI studies have highlighted the significance of coherent geospatial structures that facilitate the smooth interchange of data and sophisticated spatial analysis. The fact that non-GIS formats are still being used in Lagos State suggests a transition phase in the development of SDI, as old systems dominate despite the existence of more powerful geospatial solutions (Letsosa & Muthumini, 2023).

Other identified challenges relate to data quality and standardisation, which manifest as inconsistent coordinate reference systems and missing metadata. This aligns with the results of Li et al. (2024), who argue that successful SDI systems require properly structured environments that allow data to circulate efficiently and in an interoperable manner. Similarly, Al-Bakri and Fairbairn (2023) report that insufficient standardisation is a key impediment to the implementation of spatial datasets in most developing nations.

Also noted as key limitations were institutional fragmentation and lack of data sharing. This observation is consistent with recent empirical data showing that poor institutional coordination and the

lack of centralised data control are major obstacles to SDI performance (Ali et al., 2025). The absence of a spatial data repository in Lagos State implies the presence of bigger governance issues. Without a central archive, cooperation will be limited and there will be an overlapping of agency functions.

Moreover, the available personnel lacks the requisite technical capacity in GIS applications. For example, Ali et al. (2025) report that in low- and middle-income countries the efficient use of geospatial technologies has been severely hampered by the lack of technical expertise in these countries.

There were also infrastructural constraints such as poor computing infrastructure, unreliable Internet connectivity and poor power supply, which were identified as limiting the implementation of SDI. This is in line with recent research stating that SDI effectiveness relies not only on data and software but also on facilitating infrastructure, including digital systems, storage capacity and network reliability (Li et al., 2024).

These problems are further worsened by policy and governance gaps. To be sure, the lack of clear legal provisions to cover data ownership, access and sharing leads to uncertainty and prevents accountability among agencies. Recent international assessments suggest that effective governance structures and policy integration are critical to sustainable SDI growth, especially in areas with weak institutional coordination (Adeleye et al., 2025).

In general, the results support the argument that SDI development is a multidimensional process that involves technology, institutional coordination, human capacity and policy frameworks. As the report of empirical research at the state level (Lagos State), this study contributes to the literature on SDI implementation, especially by directly connecting SDI constraints to the organisation and execution of development plans, while examining their implications for effective physical planning.

6.0 Conclusion

The study investigated issues and opportunities of Spatial Data Infrastructure (SDI) as compared to physical development planning in Lagos State, Nigeria. The results suggest that, despite the potential of SDI to support effective land-use planning, the development of infrastructure and environmental management, its successful implementation continues to be hampered by technical, institutional and policy-related barriers. The excessive use of AutoCAD in processing spatial data, the lack of integration with GIS and the lack of standardised coordinate systems and poor data-management behaviours have all played a role in the inefficiency of urban planning. Furthermore, poor institutional cooperation, insufficient funding and poor legal frameworks also hinder SDI implementation in the state.

However, the research also outlines possibilities for enhancing SDI implementation. Given Lagos State's significant economic capacity, as well as the growing interest in GIS use and the continuous transformation programmes that have been initiated, the state is in a strong position to improve in the sphere of spatial data management. Indeed, the suggested solutions — implementing a centralised, cloud-based geospatial database, switching to GIS-based data management, adopting a homogeneous coordinate system and strengthening stakeholder cooperation — represent a feasible path to overcoming current obstacles.

Therefore, by solving these problems using technological investments, capacity building and policy reforms, Lagos State can strategically deploy SDI in its drive towards sustainable urban development. A comprehensive SDI framework will enable data-driven decision-making processes, improve collaboration between the planning agencies and increase resilience to urbanisation pressures. Finally, the effective implementation of SDI will make Lagos State an example of spatially empowered governance and effective land administration in Nigeria and elsewhere.

Acknowledgement

The authors acknowledge the use of Artificial Intelligence-based tools (ChatGPT and Open AI) for language editing and clarity enhancement during the process of manuscript preparation. No AI tools were used for data collection, analysis, interpretation of results or generation of the original research content. All the intellectual contributions and conclusions remain the sole responsibility of the authors.

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