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RESEARCH ARTICLE

Assessing the 2D Land Administration in Oyo State: Technical and Institutional Challenges

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Abstract

The continued dominance of two-dimensional (2D) parcel-based cadastral systems in Nigeria constrains the management of increasingly complex land rights, particularly in rapidly urbanizing states such as Oyo. This study assesses the technical and institutional challenges affecting the effectiveness of the current 2D land administration system in Oyo State. Using a mixed-methods design and purposive sampling, data were collected from senior officials in seven technical units of the Oyo State Ministry of Lands, Housing and Urban Development, as well as from private-sector stakeholders, including Estate Surveyors and Valuers, Registered Surveyors, Urban Planners, and Developers. Of the 135 questionnaires administered, 123 were valid, representing a response rate of 91.1%. Quantitative data were analyzed using frequencies, percentages, weighted mean scores, and the relative importance index, while qualitative responses were used to contextualize stakeholder perceptions. The findings reveal major technical limitations, including poor data accuracy and reliability (1.00), inability to represent overlapping or vertically stratified rights (0.97), weak integration with modern geospatial technologies (0.96), and difficulty in updating cadastral information (0.95). Institutional barriers were also prominent, particularly limited funding (0.80), inadequate political will (0.80), bureaucratic inefficiencies (0.78), resistance to technological change (0.74), fragmented responsibilities (0.73), and shortages of skilled personnel (0.70). The study concludes that the hybrid paper-digital 2D system currently in use is inadequate for addressing contemporary multidimensional land governance challenges. It recommends robust policy reforms, technological upgrades, and capacity-building initiatives to support the transition toward modern, spatially enabled, and potentially 3D-ready land administration frameworks.

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1. INTRODUCTION

Land remains a critical resource for socio-economic development because it underpins governance, taxation, infrastructure provision, environmental regulation, and security of tenure (Adedeji, 2025). Effective land administration systems (LAS) provide the institutional and technical basis for recording and managing rights, restrictions, and responsibilities (RRRs), thereby supporting transparency, investment, dispute reduction, and orderly spatial development (UN-GGIM, 2019). Contemporary global frameworks also recognise the centrality of land governance to sustainable development, as secure and accessible land rights influence multiple Sustainable Development Goals. The achievement of these goals depends substantially on the availability of effective and well-organised land administration systems (Musinguzi & Enemark, 2019).

Traditionally, land administration has relied on two-dimensional representations of parcels. While such systems were adequate for simpler land relations, they are increasingly strained by the spatial complexity of contemporary urban environments characterized by high-rise developments, underground infrastructure, mixed-use developments, and layered property interests. In many parts of Nigeria, cadastral practice remains predominantly conventional, fragmented, and dependent on analogue processes complemented by limited 2D digital mapping. This misalignment between traditional cadastral approaches and present-day land use realities contributes to inaccuracies, data inconsistencies, procedural delays, and weak decision support.

Recent studies have shown that conventional 2D land administration systems are limited in their ability to manage spatially complex land relations. For example, Maryam, Abbas, Mohsen, and Behnam (2021) argue that the true configuration of spatial objects is inherently three-dimensional, whereas 2D representations impose analytical restrictions, especially where elevation, depth, and spatial overlap matter. In the Nigerian context, Babalola et al. (2023) observed that parcel registration processes remain vulnerable to missing records, procedural rigidity, and delays in land acquisition and documentation. These weaknesses reduce the efficiency and reliability of land administration in rapidly changing urban environments.

A further limitation of conventional 2D cadastral systems is their inability to represent vertical and overlapping property interests. Saeidian *et al.* (2021) and Taiwo (2024) note that because 2D systems depict land parcels as planar units, they cannot adequately model stacked developments, subterranean structures, or layered RRRs occurring above and below the land surface. This flattening of spatial reality creates ambiguity, weakens legal interpretation, and limits the ability of land managers to visualise and analyse complex urban property situations. As cities become denser and more vertically organised, the inadequacy of strictly planar cadastral representations becomes increasingly apparent.

These limitations also extend to subsurface environments. Underground infrastructure, such as tunnels, utility corridors, basements, and metro lines, is often documented in separate datasets that are not fully integrated with the surface cadastre. As a result, the exact three-dimensional extent of ownership, use rights, and spatial interaction remains difficult to determine. Without an integrated framework, planning, development control, valuation, and conflict resolution are weakened, particularly where multiple interests converge within the same geographic footprint.

Beyond technical constraints, land administration challenges in Nigeria are deeply institutional. The governance framework is shaped by the Land Use Act, overlapping agency mandates, legacy administrative procedures, and weak inter-agency coordination. Emerging policies and professional discussions continue to show that, although technological shortcomings receive increasing attention, institutional weaknesses remain among the most persistent barriers to reform. These include outdated legal frameworks, bureaucratic inefficiencies, limited funding, weak political commitment, and insufficient technical and human capacity.

Oyo State illustrates these challenges clearly. Although ongoing reforms have introduced some digital processes, land administration in the state still operates largely within a hybrid paper-based and 2D digital environment. Recent official updates indicate efforts toward digitization of title processing, building plan approval, property search, and digital archiving, yet these reforms remain within a broader system still characterised by fragmented workflows, legacy records, and limited multidimensional capability.

The persistence of complex tenure arrangements, significant volumes of unregistered interests, and inconsistent record-keeping practices further complicates land governance in the state. These conditions affect title security, land valuation, urban planning, infrastructure coordination, and the ability of institutions to respond effectively to the increasing spatial complexity of development.

Against this background, this study assesses the extent to which the current 2D LAS in Oyo State responds to contemporary land administration needs. Specifically, it evaluates the technical and institutional limitations of the existing system and identifies reform priorities for a more integrated, spatially enabled, and future-ready land administration framework.

1.1 Literature review

International organisations such as the United Nations, FAO, and the World Bank continue to emphasise the importance of effective land governance for inclusive development, poverty reduction, and sustainable urbanization (Uşak, Çağdaş, & Kara, 2024). Within this discourse, the Fit-For-Purpose Land Administration (FFPLA) framework has emerged as an influential approach, particularly for developing contexts where formal land administration coverage remains limited. FFPLA advocates flexible, inclusive, affordable, and scalable systems capable of recognising and recording diverse tenure forms while responding to local institutional realities. LAS frameworks are supported by robust institutions and comprehensive legal arrangements that ensure secure access to land and the protection of land rights (Enemark, McLaren, & Lemmen, 2021). The Framework for Effective Land Administration (FELA) similarly links land administration to sustainable development and highlights the need for systems that are interoperable, sustainable, and responsive to land tenure, land value, land use, and land development dimensions. However, despite the centrality of land rights to development, approximately 70% of the world's population still lacks access to a formal LAS capable of safeguarding their tenure and supporting equitable land governance (UN-HABITAT, 2016).

A consistent finding in the literature is that 2D cadastral systems are technically inadequate for contemporary urban land management. Their limitations are most visible in the representation of vertical and subsurface rights, where overlapping property interests are compressed into a single plane. This creates ambiguity, weakens spatial accuracy, and restricts the analytical usefulness of cadastral data for planning, valuation, infrastructure coordination, and dispute management. Scholars have also noted the related problems of fragmented datasets, weak interoperability, and limited integration with modern geospatial technologies.

Taiwo (2024) and Saeidian *et al.* (2021) emphasise that conventional cadastral structures were not originally designed to model stacked developments, underground facilities, or complex layers of RRRs. Consequently, urban realities such as multi-storey property ownership, utility corridors, basements, and transport infrastructure remain only partially represented. This technical gap becomes more consequential as urban land use intensifies, and land-related decisions increasingly require integrated and multidimensional information.

However, the literature also makes clear that technological inadequacy alone does not explain poor land administration outcomes. Progress is frequently constrained by institutional weaknesses, including legal rigidity, inconsistent policy implementation, inadequate funding, bureaucratic delay, fragmented mandates, and limited technical capacity. Without addressing these structural barriers, efforts to transition toward more advanced models such as 3D or multipurpose cadastres are unlikely to achieve sustainable results.

In Nigeria, the Land Use Act remains the foundational legal framework for land administration, but its implementation has generated significant institutional complications. Studies have linked these complications to the concentration of authority, administrative bottlenecks, uneven governance practices across states, and insufficient alignment between legal procedures and modern cadastral requirements. The resulting institutional environment often limits efficiency in allocation, titling, registration, and data integration.

Abiodun and Odumosu (2024) argue that Nigeria's institutional landscape is fragmented across federal agencies, state ministries, Surveyor General's offices, land registries, physical planning authorities, and customary institutions, many of which operate with overlapping or weakly coordinated mandates. This fragmentation contributes to duplication of functions, inconsistent administrative procedures, weak data sharing, and slow uptake of integrated land information practices.

Related studies further note that the current legal and institutional framework has not been fully harmonised with contemporary paradigms such as the Land Administration Domain Model (LADM), federated cadastral architecture, or fit-for-purpose principles. This misalignment sustains a gap between formal legal processes and the functional requirements of modern, spatially enabled land administration systems.

Okeke, Moka, and Bennett (2025) therefore propose federated cadastral approaches as a way to improve standards-based land information management across institutions. Their argument is particularly relevant to Nigeria, where disconnected workflows, inconsistent data practices, and weak interoperability continue to reinforce the dominance of siloed 2D systems. These observations suggest that meaningful reform

requires not only better technology, but also institutional redesign, shared standards, and organizational learning.

Recent reform efforts in Oyo State point to a growing policy interest in digitization, including online title services, property search, digital archiving, and digital building plan approval. These developments suggest a move toward improved service delivery and transparency; however, they do not in themselves resolve the deeper technical and institutional constraints identified in the literature. This creates an important empirical question regarding how far the present 2D system can realistically support current and future land governance demands in the state.

Land administration extends beyond the mere capture of parcel information. It also includes data storage, retrieval, updating, display, and the modelling of relationships among land objects, rights, and external factors relevant to decision-making. Where underlying data models were not designed for multidimensional representation, the transition from 2D systems to more advanced 3D-enabled environments becomes more difficult. Such transitions are further complicated by infrastructural limitations, software constraints, and the technical complexity of spatial data capture and management.

In summary, the literature indicates that the weaknesses of land administration in Nigeria are both technical and institutional. While many studies discuss these dimensions separately, fewer provide state-level empirical evidence showing how they interact within an existing operational system. This study contributes to that gap by examining these issues in Oyo State through the perceptions of both public-sector and private-sector stakeholders.

2. MATERIALS AND METHODS

2.1 The Study Area

Oyo State is one of the 36 states in the Federal Republic of Nigeria. It is in south-western Nigeria between latitudes 6.5°–9°N and longitudes 3°–5°E and covers approximately 28,454 km². The State is bounded by Ogun State to the south, Kwara State to the north, the Republic of Benin to the west, and Osun State to the east. Oyo State is among the economically active states in the South-West geopolitical zone, with Ibadan as its capital and principal urban centre. The State's geology is dominated by Precambrian basement complex rocks, which commonly form undulating terrain with isolated inselbergs and dome-shaped hills. Elevation generally increases from the southern lowlands towards the northern parts of the State, producing variations in relief that influence drainage patterns and land use.

Oyo State experiences a tropical climate characterised by distinct wet and dry seasons. The dry season typically occurs from about November to March, while the wet season is generally from about April to October. The State is drained by several river systems that flow predominantly from the higher northern areas towards the south. Vegetation ranges from rainforest in the south to the Guinea savannah in the north, reflecting the north–south gradient in moisture conditions. The climate and vegetation support both arable and tree-crop farming across the State, alongside trading and services concentrated in major towns. In Ibadan, economic activities include commerce, small- and medium-scale manufacturing, services, transportation, and informal-sector enterprises, which together influence land values, land-use change, and demand for improved land information for taxation and planning. Oyo State's strategic location and connectivity, especially along the Lagos–Ibadan transport corridor, support investment and continued urban expansion. Major transportation infrastructure includes the Lagos–Ibadan expressway, rail connections, and intra-state road networks that facilitate the movement of people and goods. Ongoing and proposed infrastructure developments within and around Ibadan (such as ring-road and logistics-related projects) are also associated with land-use change, rising development density, and increasing complexity in property rights and land values.

Ibadan is the administrative headquarters of Oyo State and a major metropolitan centre whose spatial growth has produced a mix of traditional neighbourhoods, planned estates, and rapidly redeveloping corridors. It benefits from strategic transportation links, including the Lagos-Ibadan expressway, a national railway line, and various waterways. Ongoing infrastructure projects such as the Ibadan Circular Road and Inland Dry Port continue to drive urban expansion and increase land-use complexity.

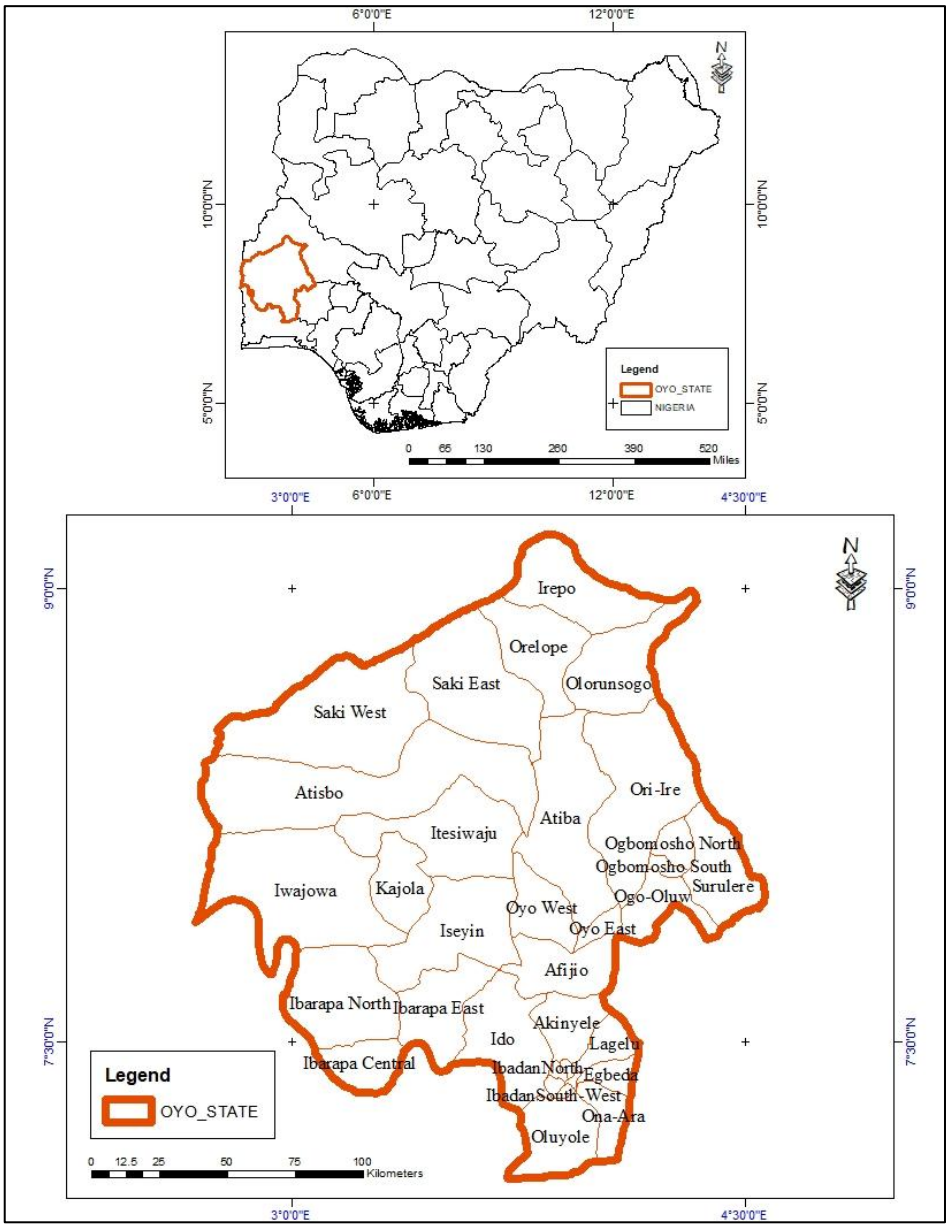

Figure 1. The Study Area (Oyo State, Nigeria)

2.2 Research design

This study adopted a mixed-methods research design to assess the technical and institutional challenges of 2D land administration in Oyo State. The use of both quantitative and qualitative approaches was intended to provide a more comprehensive understanding of the functioning of the existing LAS. The quantitative component enabled the study to identify patterns in stakeholder responses and to rank key challenges, while the qualitative component provided interpretive insight into stakeholder experiences and perceptions regarding the performance of the system.

2.3 Data Collection

Data was collected primarily through a structured questionnaire designed to address the study objectives. The instrument was organised into four sections covering respondent background, the type of land administration system in use, the legal capacity of existing frameworks, and the technical and institutional challenges affecting land administration in the state. Questions were designed for clarity and relevance to

improve response quality. In addition to the questionnaire survey, the study reviewed academic literature, policy materials, and official documents relating to land governance in Oyo State, including materials obtained from the State Secretariat, Agodi, Ibadan. These sources provided contextual support for the interpretation of the empirical findings.

2.4 Sampling and respondents

Purposive sampling was used to select respondents from stakeholder groups considered most directly involved in land administration practice and decision-making in Oyo State. The sample comprised senior officials from seven technical units within the Ministry of Lands, Housing and Urban Development, as well as Registered Estate Surveyors and Valuers, Registered Land Surveyors, Registered Urban Planners, and Developers operating in the state. The focus on senior officers within the ministry was intended to obtain informed institutional perspectives and to minimize duplication of responses within the same unit. A total of 135 questionnaires were distributed, of which 123 were validly completed and returned, representing a response rate of 91.1%. The questionnaire captured perceptions of the effectiveness of the 2D system, its technical limitations, institutional barriers, and its implications for land governance

2.5 Data Analysis

Descriptive statistics, including frequencies, percentages, weighted mean scores, and the relative importance index, were used to analyse quantitative responses. The relative importance index formula is given by: $RII = \frac{\sum W}{A*N}$

where A = highest weight, N = total number of respondents, and W = weighted responses.

Qualitative insights from open-ended responses and reviewed documents were used to enrich the interpretation of the quantitative findings by highlighting recurring stakeholder concerns, explanatory context, and reform priorities

3. RESULTS AND DISCUSSION

3.1 Type of Land Administration System in Use

The findings indicate that 2D digital systems dominate land administration practice in Oyo State, although paper-based procedures remain widespread. This confirms that the State operates a hybrid environment that is still overwhelmingly rooted in 2D administration. The continued coexistence of manual and digital processes suggests that digitization has improved some workflows without fundamentally transforming the representational logic of the system. This is shown in Table 1 and Figure 1.

Table 1: Type of land administration system currently used in Oyo State

Type of Land Administration System	Frequency	Percentage (%)
Paper based	42	34.1
2D digital System	65	52.8
3D digital system	-	0.0
Paper-based System/2D digital System	16	13.0
2D digital System /3D digital System	-	0.0
Total	123	100

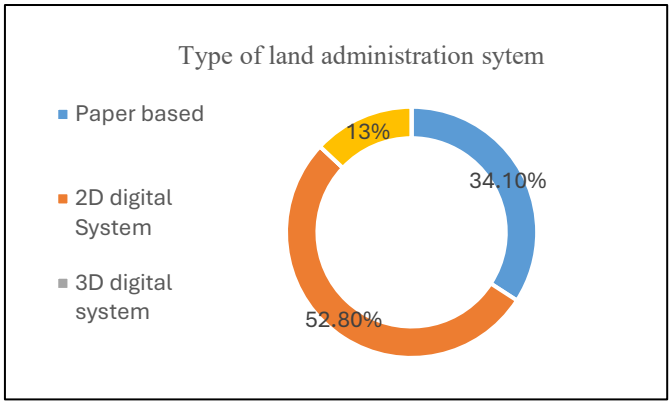

Figure 1: Pie chart showing the type of land administration system used in Oyo State.

3.2 Adequacy of 2D Systems in Capturing Complex Land Rights

A clear majority of respondents considered the 2D system inadequate for representing the complexity of land ownership rights, especially where overlapping claims, customary interests, or unregistered titles are involved. This strong negative assessment suggests that the operational limits of the system are widely recognized by stakeholders and are not merely theoretical concerns raised in the literature. It also indicates that legal and administrative uncertainty may be compounded by the representational weakness of the current cadastral structure. This is shown in Table 2 and Figure 2.

Table 2. Adequacy of the 2D land administration system in capturing the complexity of land ownership rights

2D Adequacy for the complexity of land ownership rights	Frequency	Percentage (%)
Strongly Disagree	41	33.3
Disagree	64	52.0
Neutral	9	7.3
Agree	8	6.5
Strongly agree	1	0.8
Total	123	100

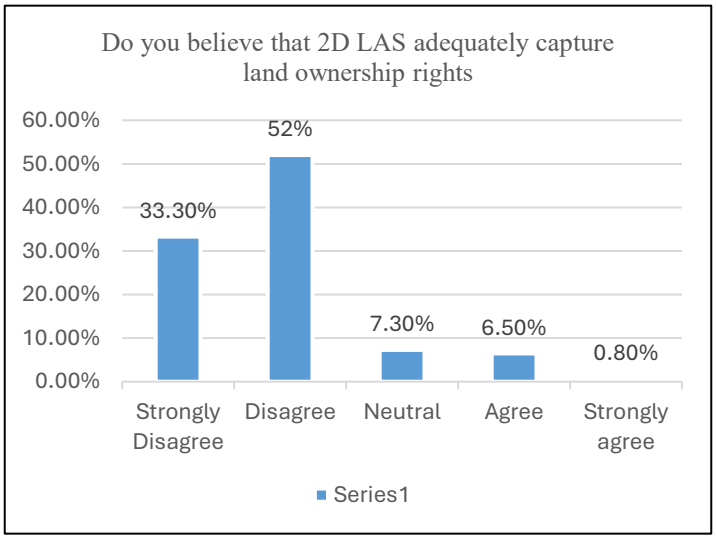

Figure 2. Bar chart showing whether the 2D LAS adequately captures land ownership rights.

3.3 Legal Capacity of Existing Frameworks

More than 73% of respondents indicated that current land administration laws are not sufficient to handle multidimensional land issues such as underground structures, multi-level developments, and vertically layered rights. This finding is significant because it suggests that the technical limitations of the 2D system are reinforced by legal inadequacy. In other words, even if technical reforms were introduced, the existing legal framework would still constrain the effective management of complex land interests. This is shown in Table 3 and Figure 3.

Table 3. Sufficiency of current land administration laws to handle multidimensional land issues

Current law and multidimensional land issues	Frequency	Percentage (%)
Yes	33	26.8
No	90	73.2
Total	123	100

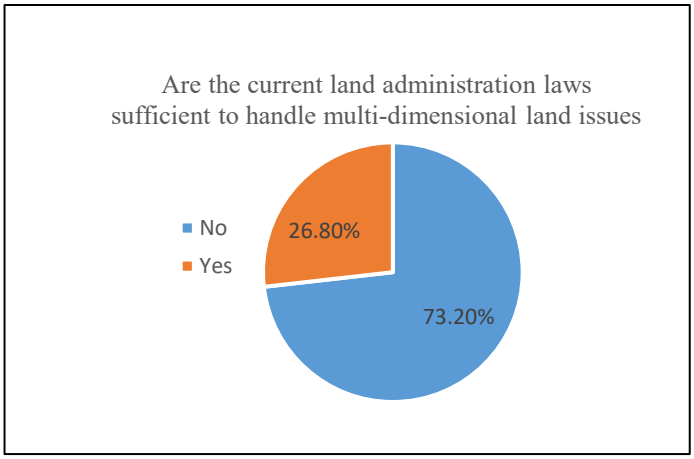

Figure 3: Pie chart showing whether current LAS laws are sufficient to handle multidimensional land issues.

3.4 Frequency of Land Boundary Discrepancies

Respondents reported frequent or occasional discrepancies in land boundaries and ownership, often linked to data inaccuracy, outdated records, and the inherent limitations of the 2D system. This pattern suggests that cadastral weaknesses translate directly into practical governance problems, including disputes, administrative delays, and reduced confidence in official records. The finding also reinforces the importance of data quality and update mechanisms within any land reform effort. This is shown in Table 4 and Figure 4.

Table 4. Frequency of discrepancies in land boundaries or ownership

Frequency of Land Boundary Discrepancies	Frequency	Percentage
Very Often	20	16.3
Often	39	31.7
Occasionally	55	44.7
Rarely	6	4.9
Never	3	2.4
Total	123	100

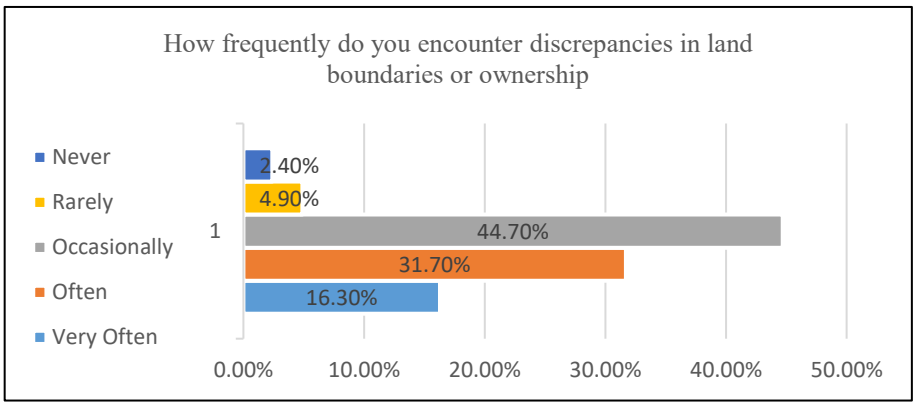

Figure 4. The bar chart shows the frequency of land boundaries or ownership discrepancies.

3.5 Support for Urban Development and Planning

More than 70% of respondents indicated that the current 2D LAS does not effectively support urban planning and land-use management. This finding highlights the consequences of limited spatial integration, weak data quality, and inadequate representation of complex land relations for broader development governance. It suggests that the shortcomings of the existing LAS extend beyond registration and titling to affect planning efficiency, development control, and coordinated urban growth. This is shown in Table 5 and Figure 5.

Table 5. The extent to which 2D systems support urban development and land-use planning

How well do 2D systems support? Urban development and land use planning	Frequency	Percentage (%)
Strongly agree	0	0.0
Agree	15	12.2
Neutral	10	8.1
Disagree	88	71.5
Strongly disagree	10	8.2
Total	123	100

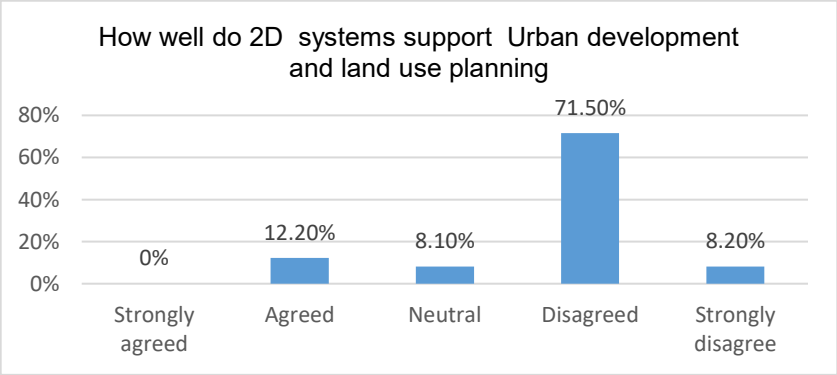

Figure 5. Bar chart showing whether the current 2D LAS supports urban development and land-use planning.

3.6 Technical Limitations

Table 6 shows that respondents identified a set of interrelated technical limitations within the current 2D system. These include poor data accuracy and reliability, inability to represent overlapping or stratified rights, weak integration with modern geospatial technologies, and difficulty in updating cadastral information. The ranking of poor data accuracy and reliability as the most significant challenge is particularly

important because it affects every other function of the system, including title security, planning, dispute resolution, and public confidence. Similarly, the high ranking of limited capacity to represent overlapping rights confirms that the system is poorly suited to increasingly complex urban land configurations.

Table 6. Respondents' assessment of the technical limitations of 2D systems

2D Performance	SA	A	N	D	SD	Average	Mean Score	Rank
Poor data accuracy and reliability	22	66	23	11	2	124	1.00	1st
Cannot represent overlapping/strata rights (e.g., underground or above-ground infrastructure)	28	60	28	7	0	123	0.97	2nd
Lack of integration with modern technologies (e.g., GIS, 3D modeling)	22	66	23	11	2	124	0.96	3rd
Difficulties in updating cadastral information	14	63	26	18		121	0.95	4th

3.7 Institutional Challenges

Table 7 highlights the institutional conditions that sustain the weaknesses of the 2D system. Limited funding and inadequate politics will rank highest, followed closely by bureaucratic processes, resistance to technology adoption, fragmented responsibilities across agencies, and shortages of skilled personnel. These findings indicate that the persistence of the current system is not simply a technological problem; it is embedded in governance, organizational structure, and resource allocation. The close ranking of these factors also suggests that reform will require a coordinated institutional strategy rather than isolated technical upgrades.

Table 7. Key institutional challenges affecting 2D land administration systems

2D Performance	SA	A	N	D	SD	Net Weight	RII	Rank
Limited funding or resources	37	65	20	01	-	507	0.80	1st
Political Will	41	61	19	02	-	510	0.80	2nd
Bureaucratic process	31	67	22	03	-	485	0.78	3rd
Resistance to technology adoption	19	74	23	06	1	473	0.74	4th
Fragmented responsibilities across agencies	13	76	28	05	1	464	0.73	5th
Lack of skilled personnel	17	63	24	18	1	446	0.70	6th

4. DISCUSSION

The findings confirm that the weaknesses of 2D land administration in Oyo State are simultaneously technical and institutional. On the technical side, the study shows that poor data reliability, limited capacity to represent overlapping and vertically stratified rights, weak integration with modern geospatial tools, and difficulties in updating cadastral records undermine the functional effectiveness of the existing system. These are not merely design limitations; they translate directly into practical governance problems, including uncertainty in ownership representation, recurring boundary discrepancies, reduced confidence in official records, and weak support for valuation, planning, and development control. The evidence therefore supports the wider literature that 2D cadastral systems are increasingly inadequate for complex urban land environments.

The institutional findings are equally important because they explain why technical weaknesses persist. Respondents identified limited funding, inadequate political commitment, bureaucratic delay, fragmented agency roles, resistance to technological change, and shortages of skilled personnel as major barriers to

reform. This indicates that incremental digitization alone will not produce a modern LAS if the legal and organizational environment remains unchanged. In practical terms, the state's current reform trajectory may improve service delivery at the margins, but its long-term effectiveness will depend on legal modernization, stronger standards, sustained capacity building, and more coherent inter-agency coordination.

Taken together, the results suggest that the inadequacy of the 2D system in Oyo State is best understood as a systemic problem rather than a purely technological one. The study, therefore, contributes state-level empirical evidence showing that readiness for more advanced cadastral reform depends on the alignment of spatial, legal, institutional, and governance conditions. This aligns with international perspectives such as fit-for-purpose land administration and the Framework for Effective Land Administration, both of which emphasise that sustainable reform must integrate technical innovation with institutional preparedness. The implication is clear: successful transition toward a more spatially enabled and potentially 3D-ready system in Oyo State will require coordinated reform rather than isolated digital upgrades.

5. CONCLUSION

This study concludes that the current 2D land administration system in Oyo State is no longer adequate for contemporary land governance. Although some digital reforms are underway, the system remains constrained by poor data reliability, weak multidimensional representation, limited technological integration, legal inadequacy, and persistent institutional bottlenecks. The central implication is that reform must move beyond partial digitization toward a coordinated programme of legal modernization, institutional restructuring, improved inter-agency collaboration, investment in geospatial technology, and sustained human-capacity development. Only such an integrated approach can support secure tenure, more efficient land markets, improved urban planning, and a realistic pathway toward a spatially enabled and potentially 3D-ready cadastral framework in Oyo State.

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