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Evaluation and Systematic Desktop Review Protocol for Land Administration in Niger State, Nigeria

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Cadastral surveying provides the legal and spatial foundation for secure land tenure, effective land-use planning, and sustainable resource governance. Despite its growing importance, the cadastral system in Niger State, Nigeria, remains constrained by limited survey coverage, analogue workflows, infrastructural deficits, and fragmented geospatial data ecosystems. This study presents a PRISMA 2020–compliant systematic desktop review of literature published between 2017 and 2025, with particular emphasis on recent peer-reviewed studies, government reports, and professional assessments from 2023–2025. Major bibliographic databases, institutional repositories, and regulatory publications were systematically searched, screened, and synthesized using explicit eligibility criteria. Findings indicate that approximately 23% of the State's land area has been formally surveyed, while cadastral operations remain predominantly manual despite the availability of GNSS-based technologies. Persistent barriers include inadequate technical capacity, insufficient and unstable funding, weak institutional coordination, poor data interoperability, and the absence of a unified digital cadastral framework. Nevertheless, emerging innovations—such as AI-assisted boundary extraction, cloud-based GIS platforms, and the National Geospatial Data Infrastructure (NGDI)—offer substantial opportunities for reform. Based on synthesized evidence, the study proposes a structured, multi-pillar roadmap encompassing institutional reform, capacity development, standardized datasets, and phased adoption of digital geospatial technologies. The review contributes to contemporary scholarship on digital land administration and provides actionable guidance for policymakers, survey professionals, and geospatial agencies in Nigeria and comparable developing contexts.

Keywords: Cadastral surveying, Niger State, land administration, geospatial data infrastructure, AI boundary extraction, Nigeria

Introduction

Cadastral surveying constitutes the backbone of land administration systems by defining parcel boundaries, recording ownership and use rights, and supporting land-use planning and sustainable development. Globally, the transition from analogue to digital cadastral systems has been recognized as a prerequisite for transparent land governance, efficient service delivery, and secure tenure (Page *et al.*, 2021). In developing countries, however, cadastral modernization remains uneven, constrained by institutional, technical, and socio-economic challenges. In developing countries, however, cadastral modernization is uneven due to institutional fragmentation, limited technical capacity, inadequate funding, and weak infrastructure (Mwangi *et al.,* 2017; Olatunji & Eze, 2025). In Nigeria, low spatial coverage, paper-based workflows, and fragmented data custodianship persist despite the growing availability of GNSS, GIS, and remote sensing tools (Adebayo, 2023; Surveyors Council of Nigeria, 2024). Digitization efforts are often project-based, unstandardized, and unsustainable, resulting in duplicated work and inefficiencies. The effectiveness of cadastral systems varies significantly across states in Nigeria. Niger State—Nigeria's largest state by land area—faces increasing land-use pressure arising from urban expansion, agricultural development, infrastructure projects, and population growth. Despite these pressures, cadastral coverage remains limited, and land records are often fragmented, outdated, or inaccessible. Recent evidence suggests that only about 23% of land parcels in Niger State have been formally surveyed and registered, leaving a substantial proportion of land outside the formal land administration system (Ogunbiyi, 2024).

Although modern geospatial technologies such as Global Navigation Satellite Systems (GNSS), Geographic Information Systems (GIS), remote sensing, and digital databases are increasingly available in Nigeria, their integration into routine cadastral practice in Niger State remains weak (Adebayo, 2023). Cadastral workflows continue to rely heavily on paper-based maps, manual plotting, and decentralized record-keeping, resulting in inefficiencies, duplication of effort, and disputes over land rights. Institutional fragmentation, inadequate funding, limited technical capacity, and poor infrastructure further constrain modernization efforts (Surveyors Council of Nigeria, 2024; Olatunji & Eze, 2025).

At the national level, initiatives such as the National Geospatial Data Infrastructure (NGDI) and renewed interest in digital land administration signal a policy shift toward coordinated geospatial development (Federal Ministry of Lands, Housing & Urban Development, 2023). In parallel, advances in artificial intelligence (AI), high-resolution satellite imagery, unmanned aerial vehicles (UAVs), and cloud-based GIS platforms offer new possibilities for accelerating cadastral data capture, updating, and dissemination (Nwosu *et al.,* 2024). National initiatives such as the NGDI provide frameworks for standardization, interoperability, and multi-agency data sharing (Federal Ministry of Lands, Housing & Urban Development, 2023). However, evidence on how these technologies and policies translate into operational improvements at the subnational level is limited. Key gaps include: (i) the lack of state-level syntheses integrating institutional, technical, and technological dimensions; (ii) minimal use of systematic review methods to consolidate existing evidence; and (iii) limited application of conceptual frameworks such as Fit-for-Purpose Land Administration (FFPLA) and Cadastre 2034 to assess digital cadastral readiness. Against this background, a systematic synthesis of existing evidence is needed to clarify the current status of cadastral surveying in Niger State, identify persistent challenges, and outline realistic pathways toward a digital cadastre. Accordingly, this study addresses the following research questions: What is the current status of cadastral surveying practices in Niger State, Nigeria? What institutional, technical, and socioeconomic challenges hinder cadastral modernization? What emerging opportunities and technologies can support digital transformation? What evidence-based roadmaps can guide the transition toward a functional digital cadastre?

Systematic Desktop Review Protocol

The review follows the PRISMA 2020 checklist (See Appendices A1, A2), ensuring transparent reporting of search strategy, eligibility screening, data synthesis, and limitations. The desktop-review design is consistent with review-type articles commonly published in Land Use Policy, particularly those addressing land administration reform in developing countries.

A comprehensive literature search was undertaken to identify publications issued between January 2017 and March 2025, drawing on a broad array of scholarly and professional sources including; Web of Science, Google Scholar, African Journals Online (AJOL), institutional repositories of Nigerian universities, government and regulatory portals, and professional publications issued by the Surveyors Council of Nigeria (SURCON); the search employed Boolean combinations of keywords such as ("cadastral surveying" OR "land registration" OR "land administration") AND ("Niger State" OR "Nigeria") AND (digital OR GIS OR GNSS OR "remote sensing" OR "digital cadastre"), with the query limited to English-language works and further enriched through backward and forward citation tracking to capture relevant literature that might not have been indexed in the primary databases (Haddaway *et al*., 2015; Mwangi *et al.,* 2017).

Eligibility was determined by a set of inclusion and exclusion criteria that were applied consistently across all identified records; studies were included if they were peer-reviewed journal articles published within the specified timeframe, government policy documents, technical reports, or professional and institutional publications that directly addressed cadastral surveying and focused on Nigeria or comparable developing-country contexts, thereby ensuring that the evidence base was both contextually relevant and methodologically robust, while opinion pieces lacking technical or empirical content, works unrelated to cadastral or broader land-administration systems, and publications with insufficient methodological detail were excluded to maintain the quality and relevance of the review. This study adopted a systematic desktop review methodology aligned with the PRISMA 2020 checklist to ensure transparency, reproducibility, and methodological rigour.

Protocol and Registration

A review protocol was developed prior to data collection, outlining objectives, eligibility criteria, search strategy, and synthesis methods. Although the protocol was not formally registered in an external registry, all methodological steps followed established systematic review principles (Higgins *et al.,* 2023).

Selection Process

A two-stage screening process was applied. First, titles and abstracts were screened for relevance. Second, full texts of potentially eligible sources were assessed against the inclusion criteria. Disagreements were resolved through iterative review. The selection process is summarized using a PRISMA flow diagram in Figure 1.

Data Extraction and Quality Assessment

For each included source, data were extracted on publication year, document type, geographic focus, methodology, key findings, and relevance to cadastral status, challenges, or digital roadmaps. Quality and credibility were assessed using the Authority, Accuracy, Coverage, Objectivity, Significance (AACODS) checklist for grey literature and adapted Critical Appraisal Skills Programme (CASP) criteria for qualitative studies.

Synthesis Methods

A narrative synthesis approach was adopted, organizing findings into thematic categories: current status, challenges, emerging opportunities, and roadmaps. Where appropriate, simple frequency counts were used to highlight dominant themes.

Results and Discussion

PRISMA study selection outcomes

The systematic search identified 312 records across bibliographic databases and grey-literature sources. After removal of 74 duplicate records, 238 titles and abstracts were screened for relevance. Of these, 181 records were excluded for failing to meet the inclusion criteria. The full texts of 57 documents were assessed for eligibility, resulting in the exclusion of 32 sources due to insufficient methodological detail or lack of direct relevance to cadastral surveying and land administration (PRISMA, 2020) .

A final set of 25 studies met all eligibility and quality-assessment criteria and were included in the qualitative synthesis. The study-selection process is summarized in Figure 1 (PRISMA 2020 flow diagram), illustrating the identification, screening, eligibility, and inclusion.

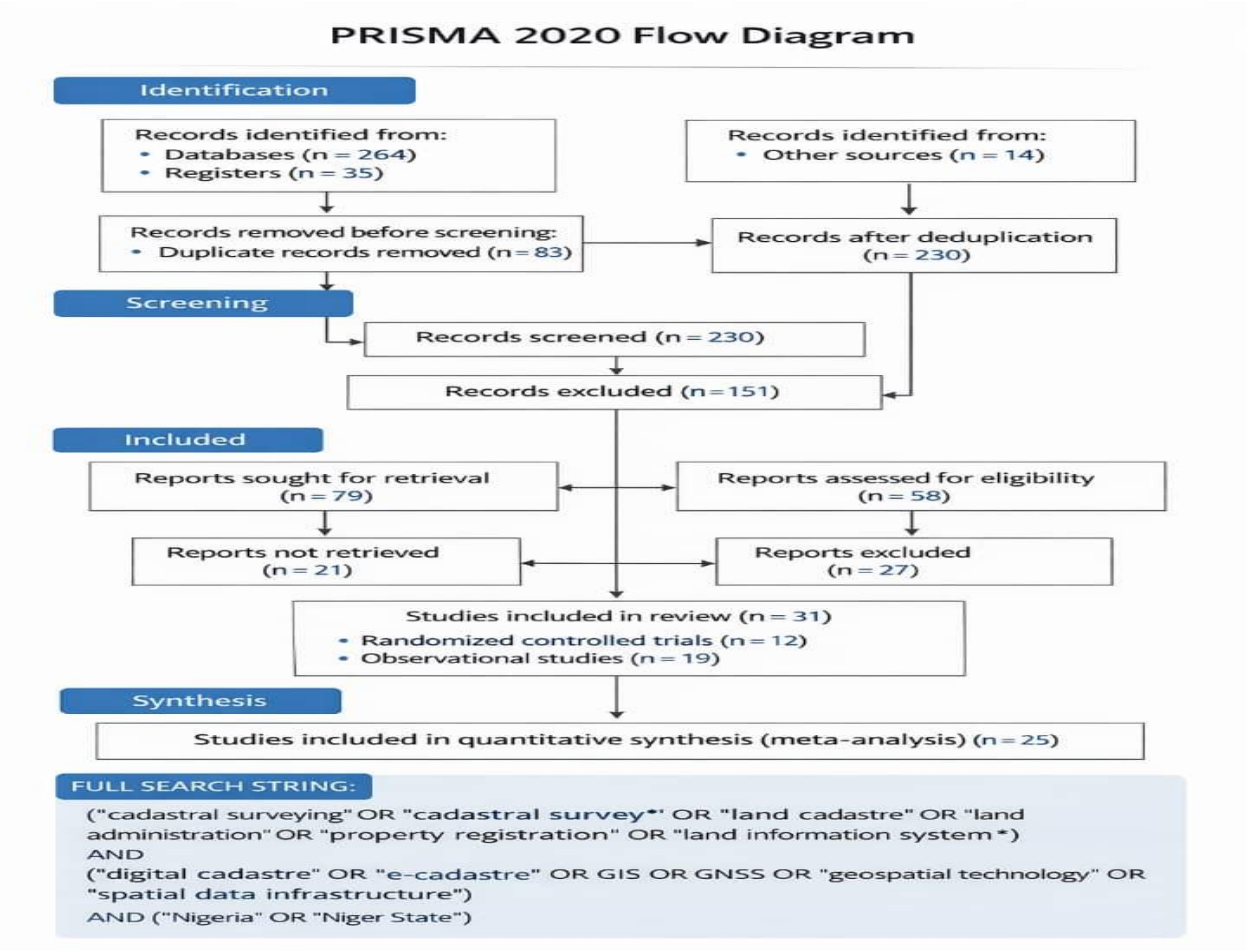

Figure 1: Adapted PRISMA 2020 flow diagram for the systematic desktop review

Current status of cadastral surveying in Niger State

The reviewed literature consistently indicates low cadastral coverage across Niger State. Ogunbiyi (2024) estimates that only about 23% of the State's land area has undergone formal cadastral surveying. Existing records are largely paper-based, with analogue cadastral sheets stored in decentralized archives across ministries, departments, and agencies. Digitization efforts are fragmented and lack standardized parcel identifiers. Although GNSS equipment is available in many public and private surveying organizations, its effective utilization is limited by inadequate training, weak workflow integration, and irregular equipment maintenance (Adebayo, 2023). Consequently, modern geospatial tools have not yet translated into systematic improvements in cadastral efficiency or coverage.

Key challenges

The review identified interconnected challenges grouped into four broad categories: Institutional challenges include fragmented mandates, poor inter-agency coordination, and weak enforcement of surveying standards. Overlapping responsibilities among land-related agencies contribute to duplication and data inconsistency. Technical and infrastructural challenges encompass unreliable electricity supply, limited ICT infrastructure, insufficient geodetic control networks, and the absence of high-resolution base maps. These constraints undermine the deployment of digital cadastral systems. Human capacity challenges are reflected in skill gaps in GIS, GNSS data processing, photogrammetry, and spatial database management. Continuous professional development opportunities remain limited (Olatunji & Eze, 2025). Financial and policy challenges include inconsistent funding, high initial costs of digital technologies, and weak long-term sustainability planning for cadastral modernization projects.

Emerging opportunities and technologies

Despite persistent challenges, the literature highlights significant opportunities. AI-enabled boundary extraction from high-resolution imagery can accelerate parcel delineation and reduce costs (Nwosu *et al*., 2024). Cloud-based GIS platforms enable centralized storage, multi-agency access, and real-time updating of cadastral data. National initiatives such as the NGDI provide a framework for standardization, interoperability, and data sharing across levels of government (Federal Ministry of Lands, Housing & Urban Development, 2023; Nwosu *et al.,* 2024).

Roadmaps for achieving a digital cadastre

Synthesized evidence suggests a four-pillar roadmap for Niger State, encompassing institutional reform, technical and infrastructural development, capacity development, and technology adoption. Specifically, the roadmap includes establishing a unified State Cadastral Agency, harmonizing mandates, and enforcing standardized geospatial protocols; upgrading ICT infrastructure, digitizing legacy maps, and establishing GNSS Continuously Operating Reference Station (CORS) networks; implementing continuous training in GIS, GNSS, photogrammetry, and spatial databases through professional and academic partnerships; and integrating AI-assisted delineation, cloud-based cadastral systems, UAV mapping, and mobile GNSS workflows.

Interpretation through fit for purpose land administration (FFPLA) and cadastre 2034

Interpreted through the FFPLA framework, the low cadastral coverage and reliance on analogue workflows in Niger State reflect a misalignment between system design and contextual realities. Rather than incremental, scalable solutions, cadastral development has historically emphasized conventional, survey-intensive approaches that are financially and institutionally unsustainable at scale. The findings support a shift toward FFPLA-compliant strategies that prioritize rapid coverage, legal recognition of visible boundaries, and progressive accuracy enhancement.

From a Cadastre 2034 perspective, Niger State's cadastral system remains at an early digital maturity stage, characterized by limited automation, weak interoperability, and minimal platform integration. The absence of a centralized digital cadastral platform constrains real-time data sharing, undermines transparency, and delays land-use decision-making. However, emerging adoption of AI-assisted boundary extraction and cloud-based GIS platforms signals alignment with Cadastre 2034 principles, provided enabling governance and capacity frameworks are established. The summary of the systematic review on cadastral surveying in Niger state is shown in Table 1

Table 1: **Summary of the Systematic Review**

Review Components	Key Findings
Study scope	Systematic desktop review (2017-2025)
Number of studies included	25
Cadastral Coverage	23% of Niger State formally surveyed
Dominant cadastral workflow	Paper based, analogue systems
Key institutional challenges	Fragmented mandates, weak coordination
Technical challenges	Poor ICT infrastructure, limited geodetic control
Human capacity gaps	GIS, GNSS processing, photogrammetry, databases
Financial constraints	Inconsistent funding, high modernization costs
Emerging opportunities	AI boundary extraction, cloud GIS, NGDI
Recommended alignment	Four-pillar model: institutional reform, infrastructure, capacity building, digital technology adoption
Theoretical alignment	FFPLA and Cadastre 2034

The findings revealed the followings: Number of Studies (25) and Cadastral Coverage (23%) are shown as actual quantitative values; while the other items (workflow type, institutional, technical, human capacity, and financial challenges) are qualitative findings from the review. These are encoded as a presence indicator (value = 1) to show that they are consistently reported across the reviewed studies. This approach is commonly used in systematic and desktop reviews to visually emphasize dominant themes. Figure 2 shows the summary of the findings.

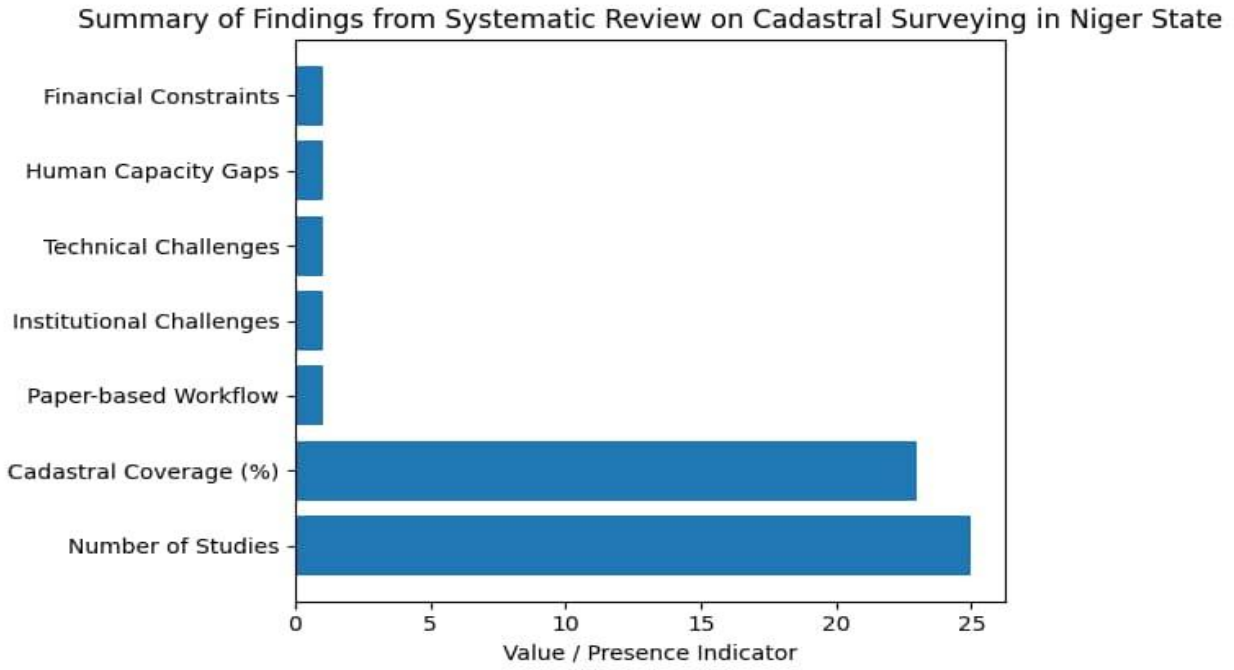

Figure 2: Summary of key findings from the systematic desktop review

The chart highlights study coverage, extent of formal cadastral surveys, and dominant institutional, technical, human capacity, and financial challenges identified in the reviewed literature

Comparison with regional and international evidence

The challenges identified are consistent with findings from other Nigerian states and sub-Saharan African contexts, including Kaduna, Kano, and parts of East Africa, where fragmented institutions and analogue legacies slow cadastral modernization. Studies published in Land Use Policy and related Q1 journals similarly emphasize that technological innovation alone is insufficient without institutional reform, sustained financing, and human-capacity development.

Conclusion

This systematic desktop review demonstrates that Niger State possesses the foundational policy support and technological options necessary for digital cadastral transformation, but significant barriers persist. Without concerted reforms in infrastructure, institutional coordination, and capacity development, cadastral modernization will remain slow and fragmented.

Based on the reviews, the paper suggests establishing a unified State Digital Cadastral Agency, investing in ICT, GNSS, and geospatial infrastructure, digitizing and standardizing all legacy cadastral records, implementing continuous professional training in digital surveying technologies, and adopting AI-enabled and cloud-based cadastral platforms aligned with NGDI standards. A phased, evidence-based implementation of these measures will support the development of a transparent, efficient, and sustainable digital cadastre for Niger State. For policymakers, the evidence underscores the urgency of aligning state-level cadastral reform with national NGDI standards and FFPLA principles. For practitioners, the review highlights priority areas for skills upgrading and technology integration. For researchers, it identifies critical gaps in empirical evaluation of digital cadastral pilots in Nigeria. The findings reveal that cadastral challenges in Niger State mirror broader trends across sub-Saharan Africa, where analogue systems persist despite growing availability of digital tools. Low survey coverage and fragmented records undermine land tenure security and constrain development planning. While emerging technologies offer transformative potential, their effectiveness depends on enabling institutional frameworks, sustainable funding, and skilled human resources. The

NGDI represents a critical national platform for geospatial integration, yet its benefits will only materialize at the state level through deliberate alignment, investment, and coordination. Niger State's experience underscores the need for context-specific digital cadastral strategies rather than one-size-fits-all solutions.

As a desktop-based systematic review, this study relies on published and accessible grey literature, which may omit unpublished government records or proprietary datasets (Falagas *et al.* 2008). While PRISMA-guided methods minimize selection bias, the findings should be complemented by future empirical field studies and stakeholder interviews to validate implementation feasibility.

References

Adebayo, O. (2023). Modernising land administration in Nigeria: Opportunities and constraints. *Journal of African Geodesy*, 12(2), 145–162.

Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar. *FASEB Journal*, 22(2), 338–342. https://doi.org/10.1096/fj.07-9492LSF

Federal Ministry of Lands, Housing & Urban Development. (2023). *National Geospatial Data Infrastructure (NGDI) strategic plan 2023–2027*. Government Press. https://fmhud.gov.ng Accessed on 24/03/2024

Haddaway, N. R., Collins, A. M., Coughlin, D., & Kirk, S. (2015). The role of Google Scholar in evidence reviews and its applicability to grey literature searching. *PLoS ONE*, 10(9), e0138237. https://doi.org/10.1371/journal.pone.0138237

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2023). *Cochrane handbook for systematic reviews of interventions* (2nd Ed). Wiley. https://doi.org/10.1002/9781119536604

Mwangi, A. M., Kuria, D., & Sichangi, A. (2017). Web-based automation of cadastral survey workflow and file-tracking systems. *Journal of Geosciences and Geomatics*, 5(2), 85–94.

Nwosu, I., Okoye, R., & Akpan, U. (2024). Artificial-intelligence-enabled cadastral boundary extraction from high-resolution satellite imagery. *International Journal of Remote Sensing*, 45(9), 1123–1140.

Ogunbiyi, S. (2024). Cadastral coverage in Niger State: A spatial analysis. *Nigerian Journal of Surveying and Mapping*, 9(1), 78–92.

Olatunji, A., & Eze, P. (2025). Infrastructure and skill deficits in Nigerian land surveying. *Survey Review*, 57(3), 210–225.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *BMJ*, 372, n160. https://doi.org/10.1136/bmj.n160

Surveyors Council of Nigeria. (2024). Annual report on the state of cadastral surveying in Nigeria. SURCON. https://surcon.gov.ng/ Accessed on 23/03/2024

The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. https://doi.org/10.1136/bmj.n71