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Research article

Geographic Information Systems for Sustainable Urban Planning and Development Control in Calabar Metropolis, Nigeria

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ABSTRACT

Objective: This study evaluates the institutional readiness and practical value of Geographic Information Systems for sustainable urban planning, management and development control in Calabar Metropolis, Nigeria. Method: A mixed-method cross-sectional design combined 87 usable questionnaires from staff of seven planning-related ministries, departments and agencies, archival development-permit records for 2013–2018, field observation and construction of a prototype geospatial development-control database in ArcMap 10.0. Results: Although 66.6% of respondents reported good or fair GIS knowledge, 26.4% reported no access to GIS or CAD, and only 4.6% identified development control as an existing GIS application. All respondents regarded GIS deployment as necessary, while approval delays, weak inter-office communication, inadequate staffing, limited political commitment, funding constraints and perceived corruption remained prominent barriers. Recalculation of annual records showed 2,206 applications, of which 1,485 were approved and 721 remained unapproved. Implications: Digital permitting should integrate parcel geometry, setbacks, building lines, document tracking and inspection histories, supported by staff training, governance rules and phased implementation. Contribution: The article converts a technology-readiness survey and prototype into a reproducible institutional pathway for evidence-led development control in a rapidly growing African city for accountable, timely and spatially consistent municipal decision-making in practice.

KEYWORDS

Geographic information systems; Development control; Urban planning; Digital permitting; Institutional readiness; Spatial database; Calabar Metropolis; Nigeria

Introduction

Urban planning depends on information about parcels, buildings, roads, drainage, utilities, environmental constraints and the sequence through which development decisions are made. When these records are maintained as disconnected paper files, the planning authority may know that an application exists without being able to relate it efficiently to the parcel, approved drawing, site inspection, setback requirement or subsequent alteration. Geographic Information Systems (GIS) provide a means of linking mapped location with descriptive records. Their value is therefore not simply cartographic. A GIS can support the full regulatory chain from application intake and plan assessment to site inspection, compliance monitoring and periodic reporting.

Calabar Metropolis has experienced sustained growth in residential, commercial and institutional development. The planning challenge is not only the volume of development, but also the need to coordinate decisions across ministries, departments and agencies responsible for surveying, planning, utilities, environmental management and urban services. The source study observed that many planning and monitoring practices remained analogue, with maps and plans stored in cabinets and with limited capacity to integrate new information. Such arrangements can delay document validation, obscure file movement and weaken the ability of officers to compare an approved proposal with what is subsequently built.

Technology, however, should not be treated as an automatic solution. A digital platform can reproduce existing institutional weaknesses if records are incomplete, responsibilities are unclear or staff do not trust the system. Sustainable GIS adoption requires organisational rules, consistent identifiers, reliable base data, trained personnel, maintenance budgets and authority to act on the information generated. The relevant question is therefore not whether GIS is modern, but whether it can be embedded in a defensible planning workflow that improves traceability, spatial consistency and administrative accountability.

Recent scholarship from Cross River State demonstrates that environmental and built-environment questions are inseparable from service location, livelihoods and local governance. Spatial work on petrol filling stations and eateries shows that facilities concentrate in response to access and market conditions, while studies of tourism support services, entrepreneurship and riverine livelihoods show that infrastructure and environmental management shape economic opportunity (Eneyo & Ekpenyong, 2018; Eneyo et al., 2023; Eneyo & Archibong, 2024; Eneyo, 2026a, 2026b; Eneyo et al., 2026). Eneyo's environmental science and tourism texts further emphasise the need to connect resource use, service systems and sustainability in place-specific analysis (Eneyo, 2025a, 2025b, 2025c). These publications do not substitute for evidence in the present study, but they provide an appropriate regional frame for interpreting planning institutions, environmental change and household adaptation.

This article evaluates institutional readiness for GIS-supported urban planning and reconstructs the prototype development-control application produced by the source study. It asks five questions. What level of GIS knowledge and software access existed among staff? Where was GIS already being used? What administrative constraints affected plan approval and monitoring? What do permit records reveal about workload and decision outcomes? Finally, how can a geospatial development-control database be implemented without overstating the capabilities of the available evidence? The contribution is an empirically grounded pathway from readiness assessment to phased institutional adoption.

Literature review

Geographic Information Systems (GIS) have emerged as powerful tools for sustainable urban planning and development control by providing spatial data management, land-use monitoring, and evidence-based decision-making capabilities. In rapidly urbanizing cities such as Calabar Metropolis, GIS-based approaches are increasingly important for understanding urban growth patterns, managing land resources, and supporting effective planning interventions. Awuh et al. (2018) demonstrated that the integration of remote sensing and GIS techniques is effective for assessing land-use/land-cover dynamics in Calabar, revealing significant urban expansion and changes in spatial patterns that require improved planning strategies. Similarly, Offiong and Eteng (2014) reported that urbanization in Calabar has contributed to the reduction of green spaces, highlighting the need for geospatial monitoring tools to guide sustainable urban development. Challenges associated with land administration and ineffective development control have historically affected urban management in Nigeria, with Nwaka (1980) emphasizing the importance of improved land governance systems for achieving organized urban growth. Furthermore, Mabogunje (1990) identified institutional and administrative limitations within Nigerian urban planning frameworks, demonstrating the need for stronger planning mechanisms supported by modern technologies. Recent studies have shown that GIS can enhance development control practices by enabling spatial databases, monitoring unauthorized developments, and improving enforcement efficiency (Abubakar et al., 2025). In addition, Coker et al. (2013) emphasized that sustainable urban development in Calabar requires integrated planning approaches that balance environmental protection, infrastructure development, and population growth. Collectively, these studies highlight the critical role of GIS as a decision-support system for achieving sustainable urban planning and effective development control in Calabar Metropolis and other rapidly growing Nigerian cities.

GIS integrates hardware, software, spatial data, procedures and people. Early planning applications emphasised overlay analysis, suitability mapping and computer-assisted cartography, while later systems expanded into enterprise databases, web services and decision-support platforms (Berry, 1987; Hopkins, 1977; Tomlin, 1990). In urban planning, the essential advantage is the ability to combine layers that represent parcels, land use, infrastructure, environmental constraints and administrative decisions. The system can reveal relationships that are difficult to identify from separate paper maps, but it remains dependent on the quality and governance of the underlying data. Sustainable urban planning also requires longitudinal monitoring. A plan is not implemented merely because it is approved. Authorities must observe changes, record deviations, update infrastructure information and evaluate whether development remains consistent with policy. Yeh (1999) argued that GIS is especially useful in developing-country planning because it supports data integration and scenario analysis under conditions of rapid change. Hathout (2002) demonstrated its value for monitoring urban growth, while UN-Habitat (2009) connected spatial information to inclusive and sustainable city management. These applications indicate that GIS is most useful when linked to recurring decisions rather than one-off map production.

Development control is a particularly suitable domain because it is spatial by definition. Every permit concerns a site with boundaries, access, neighbouring uses and prescribed dimensions. A GIS-based workflow can store the application reference, applicant details, parcel geometry, proposed use, building footprint, setback lines, approval conditions, inspection dates and enforcement status. Officers can then query pending applications, map areas of repeated non-compliance and compare the approved footprint with field observations. The approach can also reduce dependence on individual officers' memory and provide an auditable history of decisions. The literature nevertheless warns against technological determinism. Institutional fragmentation, incompatible datasets, weak leadership, staff turnover and inadequate maintenance can prevent a system from becoming operational. A sophisticated database without a clear legal and administrative mandate may remain a demonstration project. Conversely, a modest parcel-based database with reliable identifiers and disciplined updating can substantially improve routine work. Organisational readiness therefore includes more than awareness; it involves access, skills, procedures, incentives and responsibility for data stewardship.

Mixed-method evaluation is appropriate for assessing this readiness because the technology has both measurable and experiential dimensions. Survey data can describe knowledge, software access and perceptions, while interviews and observation reveal how files move, how site visits are arranged and why officers may resist or support change. A prototype can then demonstrate feasibility without claiming that it has already transformed institutional performance. Creswell (2011) supports such integration when quantitative and qualitative evidence address different parts of the same problem.

The distinction between digitisation and digital transformation is also important. Scanning a plan creates an image, but it does not make the information spatially queryable. Digital transformation requires the parcel and proposed development to be represented as structured features with attributes, rules and relationships. Building lines, setbacks and developable areas should be encoded as geometry; application status should use standard categories; and each inspection should be time-stamped. This structured design permits reproducibility and future analysis. The research gap in Calabar concerns the connection between institutional readiness, documented approval workload and a practical database model. Previous discussions often advocate GIS in general terms. The source study instead surveyed staff across seven relevant agencies, reviewed six years of development-permit records and constructed a prototype using an existing government mixed-use layout. That combination allows a more defensible assessment of both need and feasible implementation.

A defensible enterprise GIS must also distinguish authoritative records from reference layers. Parcel boundaries, approved layouts and permit decisions require identified custodians, controlled editing and documented update dates. A road layer downloaded for visual orientation may be useful without being legally authoritative, whereas a cadastral boundary used to determine encroachment must have traceable provenance. Mixing these categories without metadata can create false precision. For development control, every operational layer should therefore record its source institution, coordinate system, scale, date, permitted use and responsible officer. Metadata is not an administrative extra; it is part of the evidence chain through which a spatial decision can later be explained or reviewed. Interoperability is equally important because urban development decisions rarely belong to one office. Survey, planning, environment, works, fire service and utility agencies may each hold part of the record needed for a permit. A centralised database is one option, but it is not the only defensible architecture. A federated arrangement can allow agencies to retain custodianship while exchanging agreed fields through common identifiers and services. The decisive requirement is that the same parcel and application can be recognised across systems. Without a stable parcel identifier and application number, officers may create parallel records that cannot be reconciled, weakening both efficiency and accountability.

Digital permitting also changes the temporal structure of oversight. Paper systems often reveal the current file position but not the complete sequence of actions. A properly designed database can retain submission, validation, query, resubmission, approval, inspection and enforcement timestamps. These event records permit calculation of processing time and identification of bottlenecks without assuming that every delay reflects officer performance. Some applications may be incomplete, contested or dependent on external clearances. A fair performance system should therefore separate time under agency review from time awaiting applicant action and should document reasons for suspension or refusal.

The public-facing dimension of GIS requires caution. Online maps can improve transparency by showing permitted land uses, application status and service locations, but unrestricted publication of personal or security-sensitive information may be inappropriate. A layered access model is preferable. Applicants may view their own files; professional users may submit plans and respond to queries; inspectors may update field records; managers may access performance dashboards; and the public may see generalised planning information. Role-based access, authentication, backups and an audit log are necessary if the platform is to become an administrative record rather than an informal visualisation tool. Capacity development should be tied to work tasks rather than limited to general software training. Officers who validate applications need competence in parcel search, document linkage and basic geometry checks. Field inspectors need mobile data capture, photograph management and location verification. Database administrators need schema maintenance, backup and quality-control skills. Managers need dashboard interpretation and change-management capacity. This task-based model is more sustainable than training all staff in every GIS function. It also makes evaluation possible because competence can be assessed through completion of defined planning operations rather than self-reported familiarity alone.

Theoretical and conceptual framework

The article adopts a socio-technical systems perspective. Planning performance is treated as the product of interaction among technology, data, people, procedures and institutional authority. GIS is the technical component, but its usefulness depends on data quality, user competence, organisational coordination and the legitimacy of decisions made from the database. Failure in any one component can constrain the entire system. For example, accurate parcel geometry cannot prevent delay if approval files still move through undocumented channels.

The conceptual pathway begins with data acquisition and standardisation. Parcel boundaries, building lines, setback areas, roads and control points are represented as spatial features. Application and inspection records are linked through a unique identifier. These inputs support plan assessment, site verification, monitoring and management reporting. Outputs include maps of pending applications, parcels with approval conditions, inspection schedules and areas of repeated deviation. Feedback from these outputs should then improve data and procedures.

This framework also separates readiness from impact. The survey measures staff knowledge, access and perceptions; it does not demonstrate that GIS has already improved planning outcomes. The prototype demonstrates technical plausibility; it does not establish cost-effectiveness or causal impact. A full impact evaluation would require implementation over time, pre-defined performance indicators and comparison of approval duration, inspection coverage, error rates and user experience before and after deployment.

Methodology

The source research used a pragmatic mixed-method design in Calabar Municipality and Calabar South Local Government Areas. Quantitative evidence was obtained from staff questionnaires and administrative records. Qualitative evidence came from observation, professional consultation and examination of existing planning processes. The design was cross-sectional for the institutional survey, while the permit registry supplied a retrospective annual series for 2013–2018.

Seven organisations with direct or related responsibilities for planning, surveying, utilities and urban management were selected: the Office of the Surveyor General, Department of Town Planning Services, Cross River Geographic Information Agency, Water Board, Ministry of Environment, State Electrification Agency and Calabar Urban Development Authority. The sampling frame contained 480 staff. Ninety-five questionnaires were distributed purposively to personnel whose functions were relevant to urban planning, management, monitoring or geospatial work. Eighty-seven usable questionnaires were returned, giving a response rate of 91.6%.

The questionnaire covered institutional role, respondent function, policy for geospatial data, operation of geospatial databases, GIS knowledge, access to GIS and computer-aided design software, areas of application, perceived indispensability of GIS, approval time, process constraints, monitoring constraints and readiness to adopt GIS. Responses were analysed using frequencies and percentages. Where the archived tables contained typographical inconsistencies, calculations were checked against row-level values rather than repeating an inconsistent total.

Development-permit records were extracted for six years. The record comprised annual applications, approvals and unapproved cases. Recalculation was necessary because the published total row reported 1,439 approvals, whereas summing the six annual approval values gives 1,485. The annual application values sum to 2,206 and unapproved values to 721; these totals reconcile exactly. This article therefore reports the reproducible row-summed values and discloses the discrepancy instead of silently adopting the incorrect total.

The prototype database was created in ArcMap 10.0 using the Government Mixed-Use Development Layout, Parcel E1, Ikot Effanga Mkpa, as the base. Existing layout information was converted and organised into feature classes. Polygon features represented layout parcels, developable areas and setback areas; line features represented building lines; and point features represented beacons. Attribute fields were designed to hold parcel and development-control information.

A reproducible workflow would proceed as follows. First, scan and georeference the approved layout using known control points. Second, digitise parcel boundaries and validate topology so that polygons do not overlap or contain unintended gaps. Third, generate or digitise building lines and setback zones according to the applicable standards. Fourth, assign a unique parcel identifier and link it to application, applicant, proposed use and approval attributes. Fifth, record site-inspection dates and observations. Sixth, compare the proposed footprint with the developable polygon and produce a documented decision.

Descriptive statistics were used because the survey was designed to profile readiness and constraints rather than estimate causal relationships. The permit trend was interpreted as an administrative workload series. No claim is made that changes in applications were caused by GIS availability, political conditions or any single institutional factor. Likewise, staff perceptions of corruption or political will are reported as perceived constraints, not verified findings about individual conduct.

The study's limitations include purposive sampling, reliance on self-report, absence of time-to-decision records for individual files and lack of a post-implementation evaluation. The prototype was not deployed as a live multi-user system. Nevertheless, triangulating staff responses, registry records and a working spatial schema provides a defensible basis for proposing phased implementation.

For reproducibility, the permit reconciliation followed a transparent arithmetic procedure. Annual approved and unapproved counts were treated as primary row-level aggregates, and each annual application total was checked as approved plus unapproved. The six annual application totals were then summed to obtain 2,206 applications; the corresponding decision categories produced 1,485 approved and 721 unapproved records. The approval rate was calculated as approved applications divided by all applications for each year and for the complete period. This approach does not resolve why a record was unapproved, whether it was pending, rejected or withdrawn, because the archived table did not preserve those distinctions. The term unapproved is therefore retained as the broadest supportable category.

The prototype database was interpreted as a proof of concept rather than as evidence of operational impact. Its reproducible logic consisted of four linked components: a georeferenced parcel layer; attributes describing applicant, proposal and planning standards; document references for drawings and supporting material; and inspection fields for observed condition and decision status. Setback or building-line checks were represented by comparing proposed geometry with encoded control lines. The source study demonstrated that these components could be assembled in ArcMap 10.0, but it did not conduct a controlled before-and-after evaluation of processing time, error rate or compliance. Accordingly, effectiveness claims are framed as expected functions requiring subsequent testing.

Survey percentages were recomputed against the reported 87 usable questionnaires where the original categories allowed direct verification. Because responses concerned staff knowledge, availability and perception, they are described as respondent reports rather than objective audits of each agency. The institutional results were triangulated with the prototype and permit records, but the sources answer different questions. The survey describes readiness and perceived constraints, the permit table describes administrative workload, and the prototype demonstrates a possible data structure. Agreement among these sources strengthens practical relevance, yet it does not convert perceptions into measured causal effects.

Results and discussion

The 87 respondents represented agencies whose combined functions covered planning, environmental management, utility provision, infrastructure monitoring and geospatial data. More than half stated that their organisations combined urban planning, management and monitoring responsibilities. Compliance monitoring and geospatial data gathering were the two most frequently reported functions, each accounting for 23.0% of responses. The profile indicates that the survey reached personnel positioned to comment on spatial information needs.

Table 1. Study design, institutional coverage and response profile

Component	Value	Analytical purpose
Planning-related organisations	7	Institutional coverage across planning, surveying, utilities and urban management
Sampling frame	480 staff	Reference population reported by participating organisations
Questionnaires distributed	95	Purposive sample of relevant personnel
Usable responses	87	91.6% response rate
Permit-record period	2013–2018	Administrative workload and outcomes
Prototype platform	ArcMap 10.0	Parcel-based development-control database

Institutional policy and database capacity were uneven. Approximately one-third reported an existing policy for geospatial data collection, half reported no policy and the remainder had no clear knowledge. A similar distribution applied to operation of a geospatial database. These responses suggest that some technical activity existed, but it had not yet become a consistent enterprise-wide practice. Uncertainty among staff is itself important because a policy that is not known by relevant users cannot reliably guide data collection or sharing.

Knowledge was more favourable than institutionalisation. Forty-nine per cent reported good GIS knowledge and 17.2% fair knowledge, while one-third reported no knowledge. Software access also showed partial readiness: 39.1% reported both GIS and CAD, 25.3% CAD only and 9.2% GIS only. However, 26.4% reported neither. The resulting pattern is a mixed-capability environment in which some staff could support a pilot, but wider implementation would require tiered training and shared infrastructure.

Table 2. Digital-policy, knowledge and software indicators

Indicator	Category	n	%
Geospatial-data policy	Yes	29	33.3
Geospatial-data policy	No	43.5	50.0
Geospatial-data policy	No idea	14.5	16.7
GIS knowledge	Good	43	49.4
GIS knowledge	Fair	15	17.2
GIS knowledge	None	29	33.3
Software availability	GIS and CAD	34	39.1
Software availability	CAD only	22	25.3
Software availability	GIS only	8	9.2
Software availability	Neither	23	26.4

Existing applications were concentrated in cadastral and mapping tasks. Cadastre or layout preparation accounted for 25.3%, survey-plan charting and map production 12.6%, land-use conformity or site suitability 10.4%, and utility location 11.5%. Only 4.6% identified development control or plan approval as an area of GIS use, while 35.6% reported no application. This is a critical finding: the technology was present in some form, but its use had not penetrated the core workflow examined by the research.

Perceived value was high. Ninety-one per cent described GIS as indispensable to varying degrees, and all respondents agreed or strongly agreed that GIS should be deployed as a solution for urban planning, management and monitoring. Such support reduces one adoption barrier, but enthusiasm should not be confused with operational readiness. The simultaneous presence of high perceived value and weak development-control use indicates an implementation gap rather than a lack of interest.

Table 3. Existing GIS application and perceived readiness

Indicator	Response	n	%
GIS application	Cadastre/layout preparation	22	25.3
GIS application	Survey charting/map production	11	12.6
GIS application	Land-use conformity/site suitability	9	10.4
GIS application	Development control/plan approval	4	4.6
GIS application	Utility/infrastructure location	10	11.5
GIS application	None	31	35.6
Perceived indispensability	Very indispensable	44	50.0
Perceived indispensability	Fairly indispensable	22	25.0

Perceived indispensability	Indispensable	15	16.7
Need for GIS deployment	Strongly agree/agree	87	100.0

Approval procedures were affected by several reported bottlenecks. Delays in communication, movement of files and processing by allied professionals each accounted for 17.24% of responses. Site visitation and report preparation accounted for 13.79%, while document validation and inadequate staff each accounted for 10.34%. These categories describe a workflow in which an application can stall at multiple hand-offs. A geospatial system can provide status visibility and shared access, but process redesign is required to prevent the digital platform from merely recording existing delay.

Monitoring constraints were also institutional. Lack of political will was reported by 29.03%, perceived human factors or corruption by 25.81%, lack of funds by 19.35%, inadequate trained personnel and technology by 16.13%, and weak legal or policy framework by 9.68%. These are respondent perceptions, but they reveal the breadth of conditions that a technology project must address. Procurement of software alone would not resolve funding continuity, legal authority or accountability.

Table 4. Reported approval-process and monitoring constraints

Constraint domain	Reported constraint	n	%
Approval process	Communication delay	15	17.24
Approval process	File-movement delay	15	17.24
Approval process	Delay by allied professionals	15	17.24
Approval process	Site visit/report delay	12	13.79
Approval process	Document-validation delay	9	10.34
Approval process	Inadequate planning staff	9	10.34
Monitoring	Limited political commitment	25	29.03
Monitoring	Perceived human factors/corruption	22	25.81
Monitoring	Funding constraint	17	19.35
Monitoring	Inadequate trained personnel/technology	14	16.13
Monitoring	Weak legal/policy framework	8	9.68

The permit registry documented 2,206 applications from 2013 to 2018. Row-level recalculation showed that 1,485 applications were approved and 721 remained unapproved, equivalent to 67.3% and 32.7%, respectively. Applications rose from 192 in 2013 to 608 in 2017 before falling to 247 in 2018. The series could reflect development cycles, administrative capture or other unmeasured influences; it should not be interpreted as a direct measure of construction activity.

Annual approval proportions varied substantially. Approximately 83.9% of applications were approved in 2013, compared with 34.8% in 2014, 70.8% in 2015, 71.8% in 2016, 75.8% in 2017 and 54.3% in 2018. Without file-level reasons, these variations cannot be attributed to applicant quality, staffing or policy change. They do, however, demonstrate why a digital registry should capture dates, reasons for return, missing documents and final disposition.

Table 5. Reconciled development-permit records, 2013–2018

Year	Applications	Approved	Unapproved	Approval rate (%)
2013	192	161	31	83.9
2014	267	93	174	34.8
2015	421	298	123	70.8
2016	471	338	133	71.8
2017	608	461	147	75.8
2018	247	134	113	54.3
Total	2,206	1,485	721	67.3

The prototype schema provides a practical response to the identified gap. Parcel polygons establish the spatial unit of regulation. Building lines and setbacks convert standards into visible geometry. Beacons preserve survey control, while attribute records connect the parcel to the administrative file. A planner can therefore evaluate whether a proposed footprint lies within the developable area and can later compare inspection evidence with the approved representation.

The figure brings the two evidence streams together. The left panel shows a substantial and variable permit workload. The right panel shows that staff knowledge and access were materially higher than actual use of GIS for development control. This mismatch supports a phased programme in which existing technical capacity is redirected towards a specific, high-value workflow rather than a broad and poorly defined digital transformation.

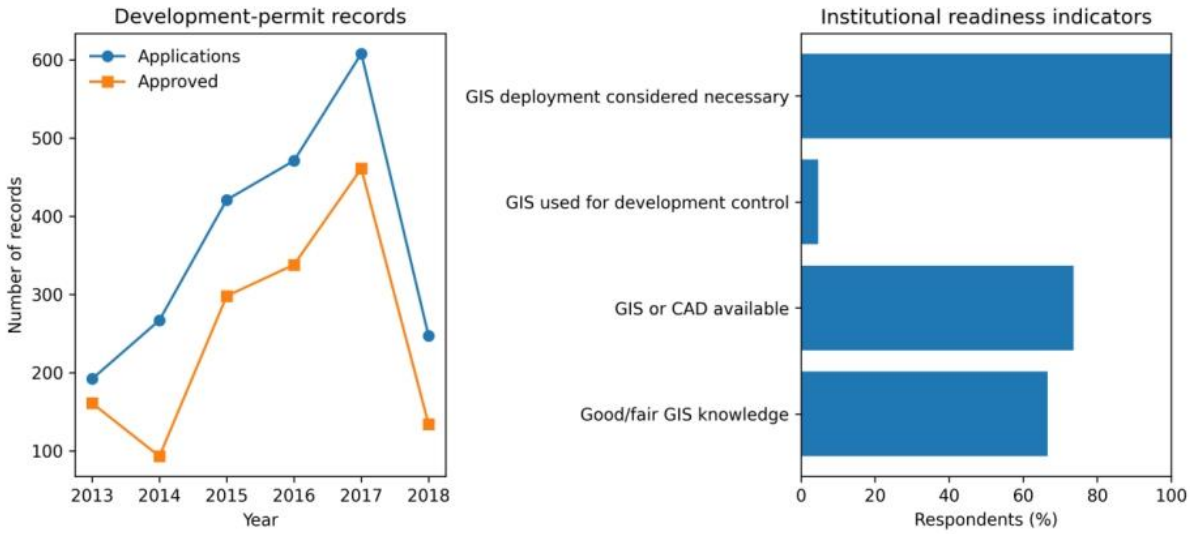

Figure 1. Development-permit workload and selected GIS-readiness indicators.
Source: Author's analysis of the archived survey and permit records.

The results are consistent with the literature on socio-technical adoption. GIS is useful when it becomes part of routine decision-making, not when it remains confined to map production. The Calabar evidence suggests that a successful programme should begin with a minimum viable database, standardise identifiers, make status visible and define responsibility for updating. Expansion to web portals, mobile inspection or public dashboards should follow only after the core data are reliable. The study also has a governance implication. A transparent database can reduce opportunities for files to disappear and can expose inconsistent treatment, but it does not eliminate discretion. Approval standards must be clear, reasons must be recorded and access rights must be controlled. Audit logs, supervisory review and data-protection procedures are therefore integral to the system design rather than optional additions.

The readiness profile indicates a consequential gap between general awareness and routine regulatory use. Two-thirds of respondents reporting good or fair knowledge suggests that GIS was not wholly unfamiliar, and the reported presence of GIS or CAD in several agencies indicates some technical base. Nevertheless, only a small share identified development control as an existing application. This pattern is more accurately described as partial institutional capacity than as either complete absence or successful adoption. It implies that skills and software may have been concentrated in mapping, survey or design tasks without being embedded in the permit and inspection workflow that generates daily planning decisions. The unanimous view that GIS deployment was necessary should not be read as proof that staff agreed on implementation details. Support for a broad technological objective can coexist with concerns about workload, job roles, data ownership and accountability. Implementation should therefore begin with process mapping and user consultation. Officers should identify which information is repeatedly requested, where duplicate entry occurs, which approvals depend on external agencies and which field observations need structured capture. Such consultation can transform general support into explicit operating rules and can reveal where digitisation would otherwise add a second workflow rather than replace an inefficient one.

The permit series further demonstrates why a tracking system is needed. Annual application volume varied substantially, and the overall approval rate of 67.3% concealed marked year-to-year differences. The low rate in 2014 cannot be attributed to a single administrative failure from the available table; it may reflect incomplete submissions, backlogs, policy change or data-entry practice. A geospatial database would not by itself explain the variation, but it could preserve the status history needed for later analysis. The defensible inference is that aggregate annual totals are insufficient for performance diagnosis and should be supplemented with dated status categories and reasons for non-approval.

Reported monitoring constraints also point to the limits of a desktop-only solution. Limited political commitment, perceived human factors, funding and shortages of trained personnel affect whether information is acted upon. If site inspections cannot be financed or enforcement decisions are inconsistently authorised, a map may display contraventions without producing corrective action. GIS should therefore be paired with inspection schedules, escalation rules and management review. The platform can improve visibility and traceability, but legal authority and organisational follow-through remain necessary conditions for regulatory effect.

Policy implications

The first priority is a parcel-based digital permit register. Every application should receive a unique identifier linked to the parcel, applicant, proposed use, submission date, required documents, assessment stages, inspection records and decision. This register should be designed before a public portal because internal data discipline is a prerequisite for reliable external service.

Second, implementation should be phased. A pilot can begin within one well-mapped layout, using a small team of planning, surveying and information-technology staff. Performance indicators should include completeness of parcel linkage, time spent locating files, percentage of applications with documented status, inspection coverage and frequency of data errors. Lessons from the pilot should inform scale-up across the metropolis.

Third, training should be role-specific. Not every officer requires advanced spatial analysis. Front-desk staff need data-entry and document-tracking skills; planners need parcel and setback assessment; surveyors need coordinate and topology validation; managers need reporting and audit functions; and system administrators need backup, security and user-management competence. This division reduces unnecessary training costs and clarifies responsibility.

Fourth, inter-agency governance should be formalised through data standards and agreements. The surveyor-general's office, planning department, GIS agency, environmental bodies and utility providers should use consistent parcel identifiers and coordinate systems. Data sharing should specify ownership, update frequency, access level and correction procedures. A steering committee should not replace operational responsibility; each dataset requires a named steward.

Finally, digitalisation should support inclusion. Applicants should be able to obtain clear checklists, predictable fees and status information without requiring specialist knowledge. Assisted service points are necessary for users with limited digital access. Public reporting can present aggregate processing times and outcomes without disclosing personal information. In this way, GIS becomes a tool for accountable service rather than an additional barrier.

A phased implementation sequence would reduce technical and organisational risk. The first phase should establish a minimum viable register of parcels, applications and status events for one planning district. The second should add geometry-based checks for setbacks, road reservations and land-use compatibility. The third should integrate mobile inspection and document exchange with related agencies. Expansion should occur only after data-quality and user-acceptance reviews. This sequencing permits correction of identifiers and procedures before errors are multiplied across the metropolis.

Performance indicators should be designed with safeguards against perverse incentives. Useful measures include median validation time, share of applications returned for missing documents, time awaiting external clearance, inspection completion rate and proportion of records with complete parcel geometry. A simple target to maximise approvals or minimise total processing days could encourage rushed decisions or unfair rejection of complex cases. Indicators should therefore be interpreted with application complexity and applicant-response time, and periodic file audits should verify that faster processing has not reduced planning scrutiny.

Long-term sustainability requires a recurrent budget for imagery, equipment, connectivity, backups and staff retention. Project-funded hardware without maintenance arrangements can quickly become unusable. Procurement should favour open data standards and exportable formats so that records are not locked into one vendor. The authority should also adopt retention, disaster-recovery and version-control procedures. These measures may appear less visible than a public dashboard, but they determine whether the system remains reliable after initial implementation.

Conclusion

The evidence shows a credible institutional basis for GIS-supported development control in Calabar Metropolis, but not a completed digital transformation. Staff knowledge and software exposure were substantial, and respondents overwhelmingly recognised the value of GIS. At the same time, development-control use remained rare, geospatial policies and databases were uneven, and approval and monitoring were affected by administrative and governance constraints.

The permit records demonstrate a sizeable and variable workload. Recalculation of annual values produced 2,206 applications, 1,485 approvals and 721 unapproved cases. These data support the need for an auditable register, but they do not establish why approval proportions changed. The prototype layout database demonstrates how parcels, setbacks, building lines and administrative attributes can be integrated, while the absence of a live deployment limits claims about performance impact.

A defensible policy response is therefore phased and socio-technical. Calabar should begin with standard identifiers, reliable parcel geometry, structured application records, role-specific training and transparent status tracking. Evaluation should precede expansion. GIS can improve urban planning and monitoring when it is embedded in clear procedures and accountable institutions; it cannot compensate for weak data or unclear authority on its own.

The evidence also clarifies what a successful digital transition should mean. Success is not the number of computers installed or maps produced, but the proportion of planning decisions supported by complete, traceable and spatially consistent records. A mature system should make it possible to identify who changed a status, what evidence informed the decision, where the affected parcel is located and whether required inspections occurred. These outcomes can be evaluated after implementation through file audits and processing-time studies. Until such evaluation is undertaken, the prototype should be understood as a feasible institutional design supported by staff readiness evidence, not as proof of realised efficiency gains.

Calabar's practical opportunity lies in converting existing technical familiarity into a shared regulatory workflow. The survey, permit series and prototype together support investment in a parcel-centred register, but they also show that technology must be accompanied by staffing, funding, leadership and rules for inter-agency cooperation. A cautious pilot with independent review would provide stronger evidence than immediate city-wide deployment and would allow the authority to correct data and process weaknesses before scaling.

Declarations

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Conflict of interest

The author declares no known financial or personal conflict of interest relating to this manuscript.

Author contribution

All authors contributed to the Conceptualisation, methodology, investigation, data curation, analysis, visualisation, original drafting and revision.

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