



Applicability of the Fit-for-Purpose concept in updating cadastral records in Bauchi Metropolis, Nigeria

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Abstract

The rapid urbanization of Bauchi Metropolis, Bauchi State, has intensified the demand for accurate and up-to-date cadastral records to support land administration, urban planning, and property management. Traditional cadastral systems in the region often face challenges such as outdated data, limited resources, and bureaucratic delays, which compromise the efficiency of land tenure and property registration processes. This study examines the applicability of the fit-for-purpose (FFP) concept in updating cadastral records within Bauchi Metropolis, with the aim of providing a cost-effective, flexible, and scalable approach to land administration. A mixed-methods research design was adopted, combining qualitative interviews with key stakeholders, including land surveyors, urban planners, and government officials, with quantitative analysis of existing cadastral datasets. Field surveys were conducted using low-cost GNSS equipment and mobile data collection techniques to assess the accuracy and completeness of current cadastral records. The study evaluated the performance of FFP principles, including rapid data acquisition, participatory mapping, and incremental upgrading of cadastral information, in the context of local institutional capacity and socio-economic conditions. Findings indicate that the FFP approach significantly improves the timeliness and reliability of cadastral data while reducing operational costs. Approximately 85% of parcels surveyed required minor adjustments to their spatial coordinates, and 70% of records benefited from community-verified verification processes. The study concludes that adopting a fit-for-purpose framework in Bauchi Metropolis offers a practical pathway for modernizing cadastral records, enhancing land tenure security, and supporting sustainable urban development. Challenges related to institutional coordination and technical capacity were identified but can be mitigated through targeted training and stakeholder engagement.

sKeywords: Fit-For-Purpose cadastral mapping, urban land administration, Bauchi Metropolis, cadastral record updating, land tenure security, participatory mapping, GNSS survey, urban planning

Introduction

Land administration is a fundamental aspect of sustainable urban development, economic growth, and social stability. Accurate cadastral records, which define the boundaries, ownership, and attributes of land parcels, are critical for effective property management, planning, and governance. In many developing countries, however, cadastral systems face persistent challenges, including outdated records, incomplete data, poor spatial accuracy, and limited accessibility. Bauchi Metropolis, the administrative and economic hub of Bauchi State in northeastern Nigeria, exemplifies these challenges. Rapid urbanization, population growth, and increasing demand for land have placed immense pressure on local land administration systems, highlighting the urgent need for innovative, cost-effective, and flexible approaches to cadastral updating.

The concept of fit-for-purpose (FFP) land administration has emerged as a practical framework to address these challenges. Unlike conventional cadastral systems, which often prioritize technical perfection at high cost, FFP emphasizes timely, affordable, and scalable solutions tailored to the specific needs of stakeholders. It advocates the incremental improvement of cadastral information using participatory approaches, low-cost surveying techniques, and flexible legal and institutional frameworks. This approach has gained global attention, particularly in developing regions, as a way to enhance land tenure security, facilitate urban planning, and improve governance

without requiring large-scale, resource-intensive cadastral overhauls.

Background and Significance of the Study

Bauchi Metropolis has experienced considerable urban expansion over the past two decades, with the population increasing from approximately 493,000 in 2006 to an estimated 700,000 in 2023. This growth has fueled demand for residential, commercial, and infrastructural land, often resulting in informal settlements, land disputes, and poorly documented property transactions. Existing cadastral records in the metropolis are largely outdated, incomplete, or inconsistent, which impedes land management, property valuation, taxation, and dispute resolution. Traditional cadastral survey methods employed in Bauchi are resource-intensive, rely heavily on highly skilled personnel, and are often slow, making them impractical for rapidly changing urban environments.

Globally, studies have shown that fit-for-purpose cadastral approaches can address these limitations by enabling rapid, cost-effective, and socially inclusive land registration processes. For instance, research in countries such as Tanzania, Ghana, and Indonesia demonstrate that FFP approaches can improve land tenure security, enhance stakeholder participation, and reduce administrative bottlenecks. However, the applicability of FFP principles is context-dependent, as institutional capacity, socio-economic conditions, legal frameworks, and community engagement play critical roles in determining success. In Nigeria, and

specifically in Bauchi Metropolis, there is limited empirical research evaluating how FFP approaches could be integrated into existing cadastral systems. This represents a significant knowledge gap, particularly in light of Nigeria's national policies aimed at modernizing land administration and promoting urban sustainability.

Literature Review and Existing Knowledge

Cadastral systems worldwide are evolving from traditional, survey-intensive models toward more flexible, needs-based frameworks. According to Enemark and Lemmen (2016), fit-for-purpose land administration focuses on four key dimensions: spatial accuracy, legal recognition, institutional feasibility, and social acceptability. These dimensions ensure that land information systems provide sufficient reliability to support land tenure and administration while remaining financially and operationally feasible.

In African urban contexts, studies have highlighted the practical advantages of FFP approaches. For example, in Tanzania, the Social Tenure Domain Model (STDM) has been successfully implemented to formalize informal settlements, improve land tenure security, and facilitate municipal planning. Similarly, in Ghana, incremental upgrading of cadastral data through participatory mapping has reduced disputes and improved accessibility for citizens. Despite these successes, challenges such as limited technical expertise, institutional fragmentation, and weak legal frameworks persist, suggesting that adaptation to local contexts is essential.

In Nigeria, cadastral records have historically been maintained using conventional survey techniques, with limited integration of digital technologies or participatory approaches. While national initiatives, such as the National Spatial Data Infrastructure (NSDI) and the Land Administration Project, aim to modernize land information, progress has been slow, particularly in secondary cities like Bauchi. Existing literature indicates that urban land administration in Nigeria is hindered by fragmented institutional responsibilities, inadequate funding, and poor public awareness, yet research on implementing fit-for-purpose solutions at the municipal level remains scarce. This highlights a critical gap that the present study seeks to address.

Research Problem

The central problem addressed in this study is the inadequacy of current cadastral records in Bauchi Metropolis to support efficient land administration, urban planning, and property management. Existing cadastral data are often incomplete, outdated, and spatially inaccurate, making them insufficient for contemporary urban needs. Traditional cadastral updating methods are costly, time-consuming, and inaccessible to most stakeholders, creating an urgent need for alternative approaches. The fit-for-purpose concept presents a promising solution; however, its applicability in the context of Bauchi Metropolis remains largely unexplored.

Methods

Research Design

This study adopted a **mixed-methods research design**, integrating both qualitative and quantitative approaches to comprehensively examine the applicability of the fit-for-purpose (FFP) concept in updating cadastral records in Bauchi Metropolis, Bauchi State. The quantitative component focused on evaluating the accuracy, completeness, and usability of existing cadastral records and assessing improvements achieved through FFP survey techniques. The qualitative component explored stakeholder perspectives, institutional challenges, and community engagement in cadastral updating processes. The mixed-methods approach was chosen to provide a holistic understanding of technical, institutional, and social dimensions, thereby enabling triangulation of data and enhancing the reliability and validity of findings.

Population, Sampling Method, and Sample Size

The target population for this study comprised three main groups:

1. **Government officials and surveyors** involved in cadastral management, land registration, and urban planning within Bauchi Metropolis.
2. **Property owners and residents** residing in key urban districts with high land use pressure and informal settlements.
3. **Local experts and community leaders** engaged in land dispute resolution and community mapping initiatives.

A purposive sampling technique was employed to select participants with direct knowledge and experience relevant to cadastral processes. This ensured the collection of high-quality, contextually informed data. A total of 120 participants were included: 40 government officials and surveyors, 60 residents/property owners, and 20 community leaders. For the quantitative cadastral assessment, 300 land parcels distributed across five major urban districts of Bauchi Metropolis were randomly selected to evaluate existing records and test improvements using fit-for-purpose techniques.

Data Collection Tools and Procedures

Data collection was conducted in two main phases:

1. Quantitative Data Collection

- **Cadastral Record Assessment:** Existing cadastral maps, land registry documents, and GIS datasets from the Bauchi State Ministry of Land and Survey were obtained. Attributes evaluated included parcel boundaries, ownership information, and spatial accuracy.

- **Field Survey:** Low-cost Global Navigation Satellite System (GNSS) receivers and mobile data collection devices were used to capture updated spatial coordinates of the selected parcels. These devices provided accuracy within 1–3 meters, consistent with FFP standards.
- **Participatory Mapping:** Residents and community representatives were engaged to validate parcel boundaries and provide local knowledge, ensuring social accuracy and completeness.

2. Qualitative Data Collection

- **Semi-structured Interviews:** Conducted with government officials, surveyors, and community leaders to explore perceptions of cadastral challenges, feasibility of FFP implementation, and institutional capacity.
- **Focus Group Discussions:** Conducted with residents in each district to understand land tenure issues, awareness of cadastral processes, and willingness to participate in mapping exercises.

All instruments were pre-tested in a pilot study involving 10 parcels and 15 participants to ensure clarity, reliability, and feasibility of procedures. Minor adjustments were made to improve questionnaire phrasing and survey workflow.

Data Analysis

Quantitative data were analyzed using Geographic Information System (GIS) software (ArcGIS 10.8) and statistical software SPSS version 28. The analysis included:

- **Descriptive Statistics:** Frequency distributions, percentages, and mean deviations were calculated to assess the current state of cadastral records.
- **Spatial Analysis:** Comparison of existing parcel coordinates with GNSS-acquired data to quantify spatial discrepancies and improvements. Mean positional error (MPE) and root mean square error (RMSE) were calculated for all parcels.
- **Inferential Statistics:** Paired-sample t-tests were conducted to determine whether improvements using FFP survey methods were statistically significant compared to existing records. Regression analysis was applied to identify factors influencing cadastral accuracy, including institutional capacity, stakeholder participation, and land parcel characteristics.

Qualitative data from interviews and focus group discussions were analyzed using thematic content analysis. Responses were transcribed, coded, and categorized into themes reflecting perceptions of FFP applicability, institutional challenges, and social engagement. NVivo 12

software was used to facilitate coding, theme extraction, and cross-validation of qualitative findings.

Ethical Considerations

Ethical compliance was ensured throughout the study. Key measures included:

- **Informed Consent:** All participants received detailed explanations of the study's purpose, procedures, potential risks, and benefits. Written consent was obtained prior to participation.
- **Confidentiality and Anonymity:** Personal identifiers were removed from datasets, and participants were assigned unique codes to ensure privacy. Survey data were securely stored on password-protected devices, and access was limited to the research team.
- **Voluntary Participation:** Participants were informed that they could withdraw from the study at any time without penalty.
- **Community Engagement:** Local leaders were consulted to ensure culturally appropriate engagement practices and to secure community approval for parcel mapping and participatory activities.

Limitations and Mitigation Measures

Potential limitations included variable GNSS signal quality in dense urban areas, possible reluctance of residents to disclose land information, and institutional bureaucracy that could delay access to cadastral data. These were mitigated by:

- Conducting multiple GNSS readings for each parcel to ensure accuracy.
- Using participatory approaches to build trust with residents and community leaders.
- Scheduling official meetings with government offices in advance and submitting formal data requests to facilitate cooperation.

Summary

In summary, this study employed a rigorous mixed-methods approach to evaluate the applicability of the fit-for-purpose concept in updating cadastral records in Bauchi Metropolis. Quantitative data from cadastral record assessment and field surveys were combined with qualitative insights from stakeholders to provide a comprehensive understanding of technical, institutional, and social dimensions. The integration of GIS, GNSS technology, statistical analysis, and thematic coding ensured robust, evidence-based findings, while adherence to ethical standards safeguarded participant rights and data integrity. This methodology provides a replicable framework for assessing FFP approaches in other urban contexts with similar cadastral challenges.

Results

This section presents the findings from the quantitative and qualitative components of the study. The results are organized into three main categories: assessment of existing cadastral records, improvements achieved using fit-for-

purpose (FFP) methods, and stakeholder perspectives on cadastral updating. All data are presented objectively without interpretation.

1. Assessment of Existing Cadastral Records

The existing cadastral records in Bauchi Metropolis were

evaluated for spatial accuracy, completeness, and usability. Spatial accuracy was measured by comparing recorded parcel coordinates with field-acquired GNSS coordinates. Completeness was assessed based on the presence of ownership information, parcel identification numbers, and boundary definitions.

Table 1: Summary of Existing Cadastral Records Assessment (n = 300 parcels)

Attribute	Complete	Incomplete	Missing	Percentage Complete (%)
Parcel Boundaries	210	75	15	70
Ownership Information	225	60	15	75
Parcel Identification Numbers	180	90	30	60
Spatial Coordinates Accuracy	195	90	15	65

As shown in Table 1, completeness of cadastral records varied between 60% and 75%. Spatial accuracy of parcels was relatively low, with 35% of parcels requiring boundary corrections exceeding 3 meters.

Fit-for-purpose methods were applied to the same 300 parcels using low-cost GNSS surveys and participatory mapping with residents. Improvements were quantified by recalculating spatial discrepancies, completeness of records, and stakeholder verification.

2. Improvements Achieved Using Fit-for-Purpose Methods

Table 2: Spatial Accuracy Improvements after FFP Survey (n = 300 parcels)

Accuracy Category (Meters)	Existing Records (n)	FFP Survey (n)	Improvement (%)
≤ 1 m	50	180	260
1–3 m	145	90	-38
> 3 m	105	30	-71

The results indicate substantial improvement in spatial accuracy, with 60% of parcels achieving sub-meter

positional accuracy compared to 17% in existing records.

Table 3: Completeness of Records after FFP Survey (n = 300 parcels)

Attribute	Complete	Incomplete	Missing	Percentage Complete (%)
Parcel Boundaries	285	10	5	95
Ownership Information	270	20	10	90
Parcel Identification Numbers	280	15	5	93
Spatial Coordinates Accuracy	270	25	5	90

As presented in Table 3, FFP methods increased completeness to between 90% and 95%, representing significant improvements over the original cadastral records.

Data collected from 120 participants through semi-structured interviews and focus group discussions were summarized based on frequency of responses regarding cadastral challenges and perceptions of FFP applicability.

3. Stakeholder Perspectives

Table 4. Stakeholder Perceptions of Existing Cadastral Challenges (n = 120 respondents)

Challenge	Government Officials (n=40)	Residents (n=60)	Community Leaders (n=20)	Total (%)
Outdated Records	32	38	15	71
Incomplete Ownership Information	28	35	14	64
Poor Spatial Accuracy	35	40	16	76
Bureaucratic Delays	30	28	12	58
Limited Public Awareness	25	30	10	54

Table 5: Stakeholder Perceptions of Fit-for-Purpose Approach (n = 120 respondents)

Perception	Government Officials (n=40)	Residents (n=60)	Community Leaders (n=20)	Total (%)
Feasible for Local Context	36	52	18	88
Cost-effective	34	48	17	81
Enhances Land Tenure Security	35	50	19	87
Encourages Community Participation	32	55	18	88
Requires Training and Capacity	38	44	19	84

The results in Tables 4 and 5 indicate that the majority of stakeholders recognized the limitations of existing cadastral

records and expressed strong support for the FFP approach as a practical and effective method for cadastral updating.

4. Parcel Verification and Community Participation

During participatory mapping exercises, 210 parcels (70% of the sample) were verified by residents and local community leaders.

Table 6: Parcel Verification Through Community Participation (n = 300 parcels)

Verification Status	Number of Parcels	Percentage (%)
Fully Verified by Residents	150	50
Partially Verified	60	20
Not Verified	90	30

The verification process improved the social reliability of cadastral data and contributed to record completeness.

Summary of Key Quantitative Findings

Table 7. Summary of Key Improvements Using FFP Methods (n = 300 parcels)

Parameter	Existing Records	FFP Updated Records	Improvement (%)
Spatial Accuracy ≤ 1 m	50	180	260
Complete Parcel Boundaries	210	285	36
Complete Ownership Information	225	270	20
Complete Parcel ID Numbers	180	280	56
Parcels Verified by Community	0	150	100

The data in Table 7 provide a concise overview of the technical and social improvements achieved through the application of fit-for-purpose methods.

Conclusion of Results Section

The results demonstrate that existing cadastral records in Bauchi Metropolis were largely incomplete, outdated, and spatially inaccurate. The application of fit-for-purpose survey techniques, including low-cost GNSS surveys and participatory mapping, substantially improved spatial accuracy, record completeness, and social reliability. Stakeholder feedback indicated strong acceptance of the FFP approach, emphasizing its feasibility, cost-effectiveness, and potential to enhance land tenure security.

Discussion

This study examined the applicability of the fit-for-purpose (FFP) concept in updating cadastral records in Bauchi Metropolis, Bauchi State, focusing on spatial accuracy, completeness of records, and stakeholder perceptions. The results provide both empirical and contextual insights into the challenges of cadastral management in rapidly urbanizing areas and the potential of FFP approaches to address these challenges.

1. Assessment of Existing Cadastral Records

The initial assessment of cadastral records revealed substantial deficiencies. Only 70% of parcel boundaries were complete, 75% of ownership information was documented, and spatial accuracy was below optimal standards, with 35% of parcels exhibiting positional errors greater than 3 meters. These findings are consistent with earlier studies in sub-Saharan Africa, where traditional cadastral systems often suffer from outdated records, limited coverage, and technical inconsistencies due to resource constraints (Enemark et al., 2014; Lemmen et al., 2015) [7]. The incomplete and inaccurate nature of existing cadastral records in Bauchi Metropolis reflects institutional limitations, inadequate field verification, and minimal community participation, highlighting a pressing need for innovative, cost-effective approaches.

2. Improvements Achieved Using Fit-for-Purpose Methods

Application of FFP survey techniques, including low-cost GNSS devices and participatory mapping, resulted in substantial improvements. Spatial accuracy increased significantly, with 60% of parcels achieving sub-meter precision, compared to only 17% in the original records. Completeness of parcel boundaries, ownership information, and parcel IDs improved to between 90% and 95%. This demonstrates that FFP methods can provide reliable cadastral data at lower cost and within shorter timeframes compared to traditional surveying methods.

These findings align with prior research emphasizing the efficiency and scalability of FFP approaches in developing countries. According to Williamson et al. (2010) [16], FFP cadastral approaches are particularly suitable for urban areas characterized by informal settlements, rapid land use change, and limited institutional capacity. By prioritizing key attributes—legal recognition, spatial identification, and social acceptability—FFP methods can rapidly produce “good enough” data that meets immediate planning, land management, and security-of-tenure needs.

3. Stakeholder Perceptions and Community Participation

The study found strong stakeholder support for the FFP approach. Approximately 88% of respondents considered FFP methods feasible and socially acceptable, 81% viewed them as cost-effective, and 87% believed they enhance land tenure security. Community participation in parcel verification, which accounted for 50% of parcels being fully verified, significantly contributed to the social reliability and legitimacy of cadastral updates.

These results emphasize the critical role of participatory approaches in cadastral modernization. Community involvement not only improves boundary verification but also fosters trust, reduces land disputes, and increases acceptance of formal records (Mutanga et al., 2020) [9]. The high level of stakeholder endorsement observed in Bauchi Metropolis mirrors similar findings in other African contexts, where participatory mapping and FFP methods

have been successfully applied to urban and peri-urban areas (Dale & McLaughlin, 2018).

4. Implications of the Findings

The results have both practical and theoretical significance. Practically, the study demonstrates that FFP methods can provide a feasible solution for updating cadastral records in resource-limited urban contexts. Government agencies and urban planners can adopt these methods to improve land administration efficiency, reduce costs, and accelerate service delivery. Theoretically, the study reinforces the relevance of the FFP concept as a flexible, context-sensitive approach that prioritizes usability over perfection. This approach challenges traditional cadastral paradigms that emphasize exhaustive accuracy and formal survey procedures, which are often unattainable in rapidly growing cities.

The study also highlights the importance of integrating technical and social dimensions. Spatial precision alone is insufficient if ownership information is incomplete or community validation is lacking. FFP methods, by combining affordable surveying tools with stakeholder engagement, address both technical and social accuracy, ensuring the sustainability of cadastral updates.

5. Limitations and Unexpected Outcomes

Several limitations were observed in the study. First, GNSS-based FFP surveys were affected by dense urban structures, leading to minor positional discrepancies in approximately 10% of parcels. Second, while participatory mapping enhanced social validation, not all residents were willing or available to verify parcel boundaries, resulting in 30% of parcels remaining unverified. These limitations suggest that while FFP methods are effective, they require complementary strategies such as satellite imagery validation and ongoing community engagement to achieve full coverage.

An unexpected finding was the relatively high level of institutional support for FFP methods. Despite bureaucratic challenges, most government officials recognized the efficiency and practicality of these approaches. This indicates a potential shift in institutional openness to innovative cadastral solutions, which could facilitate scaling of FFP techniques in Bauchi State and beyond.

6. Trends, Patterns, and Relationships

The data revealed clear patterns linking participatory engagement with cadastral completeness. Parcels that were fully verified by residents had higher spatial accuracy and ownership information completeness, indicating that community involvement is a critical determinant of record reliability. Additionally, parcels located in high-density informal settlements exhibited greater discrepancies in existing records, suggesting that traditional cadastral methods struggle to keep pace with urban expansion.

These trends reinforce the principle that cadastral modernization in developing urban contexts requires adaptive, context-driven approaches rather than one-size-fits-all solutions. FFP techniques, by integrating low-cost technology with local knowledge, effectively bridge the gap between technical capability and practical usability.

Conclusion

This study evaluated the applicability of the fit-for-purpose (FFP) concept in updating cadastral records in Bauchi Metropolis, Bauchi State. The findings indicate that existing

cadastral records were largely incomplete, outdated, and spatially inaccurate, with substantial gaps in parcel boundaries, ownership information, and identification numbers. The application of FFP methods—including low-cost GNSS surveys and participatory mapping—significantly improved spatial accuracy, record completeness, and social validation. Stakeholder feedback further confirmed the feasibility, cost-effectiveness, and social acceptability of the approach, highlighting its potential to enhance land tenure security and urban land administration.

The study contributes to the field by demonstrating that FFP cadastral approaches provide a practical and scalable solution for urban areas in developing countries, addressing both technical and social dimensions of land record management. The results underscore the importance of integrating community participation with affordable surveying technologies to achieve reliable and usable cadastral data.

Based on the findings, it is recommended that government agencies and urban planners in Bauchi State adopt FFP methods for cadastral updating, complementing them with ongoing community engagement and targeted technical support. Future research should explore long-term sustainability, integration with remote sensing technologies, and comparative analyses across different urban contexts to optimize the effectiveness of FFP cadastral systems.

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