Towards Improved Land Administration Services: A Model To Support Cadastral Data Interoperability Among Land Agencies In Accra, Ghana

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Keywords: Land Services, Cadastral Data Interoperability, Land Agencies.

SUMMARY

Although a finite natural resource, land is crucial to society's well-being and advancement. Vis-à-vis the significance of land, its provision is at the end of a complex interplay of government, agencies, and private entities on different facets of society, all of which establish people-to-land relationships. In pursuing improved land services, this research explored cadastral data interoperability among land agencies at the heart of land service provision in Accra, Ghana.

The "as-is" use cases of three key services: land title registration, and building permit acquisition were assessed and revealed suboptimal provision of land services across various defined indicators. The analysis of agency(s) operations and interactions uncovered challenges including semantic heterogeneities of data, a lack of metadata, inconsistent use of data standards, the absence of an Integrated Web-based Platform, and a culture of resistance to data sharing. Building upon this baseline, our proposed model for cadastral data interoperability, inspired by global standards and principles, consisted of five key components, which are: interoperability governance guidelines; an inter-agency relationship structure; cadastral data standardization using LADM; a metadata technical specifications guide; and cadastral data dissemination mechanisms.

The study concludes that the proposed model offers a promising framework for enhanced coordination among land agencies, facilitating cadastral data interoperability and sustainable land management in Accra, Ghana. To seamlessly integrate the model into land agency operations, we recommend building consensus for change, providing technical training, securing financial support, adopting an incremental implementation approach, and instituting continuous monitoring and evaluation. We see the significance of this study strongly where the development of this model and its potential implementation set the tone for facilitating emerging advancements such as 3D cadastres using artificial intelligence (AI), especially in the presence of interoperable data and agencies.

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1. INTRODUCTION

There is a broad consensus that land is a vital resource that sustains peoples' livelihoods worldwide. Nevertheless, this finite natural resource contends with an increasing population with growing economic, social, and environmental demands. It is on this background that efficient land administration and management are imperative.

Within the domain of Land Administration, and more so this research, “services” are defined as how the operational aspect of land administration, primarily land information, is provided to beneficiaries within a land market. Vis-à-vis the significance of land services, its provision, like any public service, is challenging since it is the product of a complex interaction between the government, agencies, and private entities on different facets of society. Reconciling this challenge over the years, global policy actions, initiatives, and international development agendas have prioritised discussions to amplify the chorus of improving the provision of land services. Commensurate with one such is the United Nations Sustainable Development Goal (SDG) 16, which aims to "*build effective, accountable and inclusive institutions at all levels*", with targets 10 and 6 emphasising “*citizen-centric, responsive and inclusive public service provision*” (United Nations, 2016). According to (GLTN, 2021; UN-Habitat, 2016), integrated and interoperable land agency collaboration and shared information infrastructure are essential to provide land administration services at both the central and local levels.

The paper is organised into five main sections. Section one sets the scene with the background of the research. Section two captures the problem we tackle. Section three delves into the summary of the methods and methodology employed for the research. Section four presents the results of the research. Section five concludes with the summary and significance of the paper.

2. GHANA’S LAND SERVICE AND CADASTRAL DATA INTEROPERABILITY CHALLENGES

Under the 2020 Ease of Doing Business report, Ghana ranked 118 out of some 190 countries scoring an index of 60.0, which was 26.8 shy of the highest index- 86.8 of New Zealand (World Bank, 2020). Also, interestingly Ghana records an approximately 33-day turnaround time for land registration in Ghana and ranks 14th in Africa on the Registering Property Index behind countries like Rwanda. While these statistics go a long way to substantiate Ghana's unsatisfactory land administration system and ineffective land service provision, beneficiaries' dissatisfaction over the years proves the same. According to Abubakari et al. (2018), these are tied to inconsistencies deriving from legal pluralism, data redundancies (due to the disintegration of information systems and agencies) and out-of-date information. These are

compounded by the economic, social, environmental and political exigencies, such as organisational culture and leadership, that influence how stakeholders, such as the government and land agencies, perceive land administration in the country.

The World Bank (2018) states that making spatial data interoperable among land agencies to support business processes in Ghana has been challenging. In Ghana's decentralised land management system, a considerable amount of valuable geospatial data has been gathered by government ministries and land agencies. This independent agency operation with heterogeneous datasets reveals the non-existence of interoperability. One issue is the unawareness of the existence of such valuable resources in repository land agencies. Another is that where such spatial data are known to exist, they are poorly stored, without description or outdated. Thus, in a practical business sense, a situation where there is limited standard terminology, description (meta-data), procedures or practices laid down to integrate various systems for land administration.

Consequently, there is a prevalence of a "silo mentality" where many agencies work autonomously and independently. This is the case even when there is a great demand for services jointly supplied by such agencies as the Land Use and Spatial Planning Authority (LUPSA) and Survey and Mapping Division (SMD) of the Lands Commission (LC). What is of significant concern is that this challenge will gradually become pertinent as more land agencies adopt agency-specific LIS to collect and manage spatial data for their functions. However, from a positive standpoint, the early stage of Ghana's NSDI development is advantageous since relatively less investment is required to rectify bottlenecks, such as integrating multiple LIS holding spatial data, compared to countries with multiple LIS designated for land administration. With this understanding comes the foundation of this paper, developing a cadastral data interoperability model that would improve the provision of land administration services.

3. METHODOLOGY

While there is no universally accepted framework or model for assessing land administration services due to country variations, be it social, economic, political or cultural, four conceptually and thematically conforming frameworks were reviewed and used to design a country-specific assessment framework (Steudler, 2004; FIG, 2008; World Bank, 2011; UN & World Bank, 2019). The frameworks and justifications for the selected land administration service assessment indicators are comprehensively provided in the paper- https://essay.utwente.nl/96366/ which is a detailed copy of the authors' M.Sc. research published officially in the Faculty of Geoinformation Science and Earth Observation library.

The research focused on accessing land services provided after implementing the Land Administration Project (LAP 2) in Accra. This is because the advent of LAP 2 spearheaded major institutional reforms, including the consolidation of the LC and the establishment of the CLS, among other prominent business process changes (Deane et al., 2017), which have influenced the provision of land administration services. The focus on Accra was based on the reason that although just one region, the mandates, processes and aims of the in-focus agencies

are representative of the same within other regions. Moreover, this region is the headquarters of most of the in-focus agencies (besides the CLS, which follow somewhat different principles or processes across different areas) of this research and will hence, provide valuable data which can be used to represent the same agencies located in other regions of Ghana.

For this study, the criteria for determining land administration service providers were selected by determining whether or not they are 1) a state-regulated land agency; and 2) according to their functions, provide value in the form of service to a beneficiary, primarily a client, district assembly, the government or an investor. Drawing from these criteria, supervisory bodies, mainly ministries were excluded. Private entities providing geospatial services, including Meridia, whose business processes may be difficult to reconcile with the national agenda and goals, were excluded. The model design process also did not consider the state courts that provide conflict resolution services but are not inherently land agencies and function primarily with non-cadastral data. Given this, the land administration service providers, namely, the LC, LUSPA and CLS (subsequently referred to as "in-focus agencies"), were given attention for developing the cadastral data interoperability model. These have functions and business processes overlapping in many respects and hence not only collaborate to provide current services but also have the potential to supply new competitive ones. Figure 1 shows the study area.

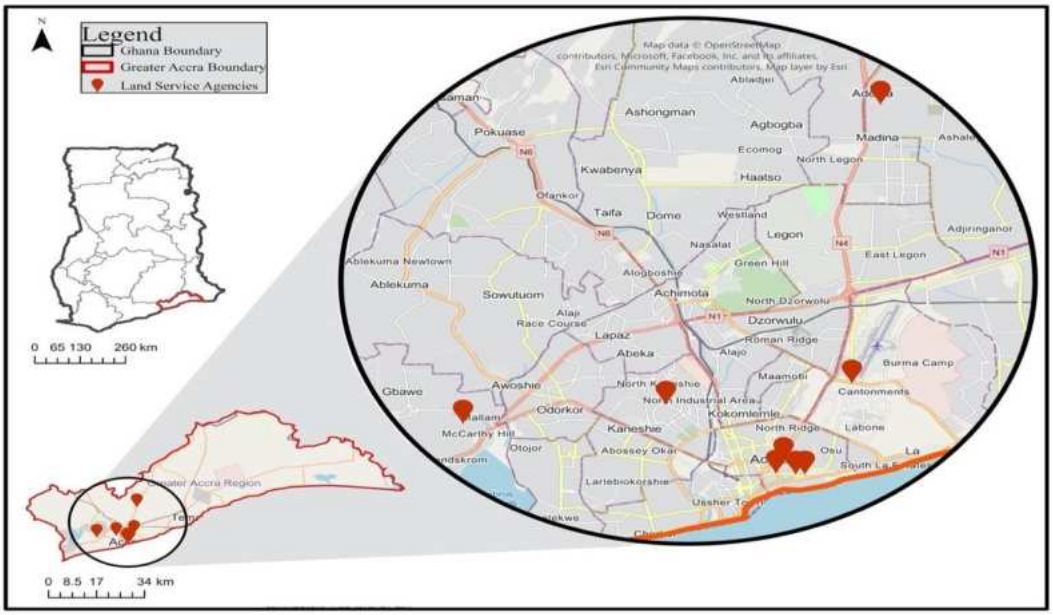

Figure 1. Study Area

During fieldwork, a literature review was supplemented with primary data from clients through questionnaires and semi-structured interviews with senior staff within the in-focus agencies. The sampling strategy employed for the survey questionnaire was convenience sampling. The purposive sampling strategy was adopted to ascertain land agencies' structure, workflow and processes for providing land services through semi-structured interviews with senior staff. Although earlier established that the model is developed based on the in-focus agencies,

supplementary information was solicited from the MLNR, the Adentan Municipal Assembly and OASL. The assessment was limited to core services most requested in these agencies. These

Respondents	Sample number	Land Agency/Division
Director/ IT engineer	2	Land Use and Spatial Planning Authority
Director/ IT engineer	3	Survey and Mapping Division
Director/ Senior Staff	3	Public and Vested Land Management Division
Director/ IT engineer	4	Land Title Registration division
Regional Director	1	Office of the Administrator of Stool Lands
Director/ Senior Staff	2	Customary Lands Secretariat
Director/ Senior Staff	1	Municipal Assembly(Zoning and Planning Department)
Director	1	Ministry of Lands and Natural Resources
Total	17	

Table 1. Interview respondents

are acquiring building/development permits, certification of plans, conflict resolution, consolidated search reports, land title registration, parcel plan preparation (survey), and registration of customary interests. Table 1 shows the semi-structured respondents' (senior staff) distribution within the in-focus agencies.

4. RESULTS OF LAND SERVICE ASSESSMENT

This section presents the gaps hindering cadastral data interoperability among land agencies in Accra, Ghana. The gaps hindering cadastral data interoperability were identified based on observation of current working systems distributed across the three in-focus agencies, results and analysis of the land service assessment. Commensurate with these gaps, the model to support cadastral data interoperability among the in-focus land agencies was designed.

4.1 . Semantic Heterogeneities

After observing the datasets of the in-focus agencies, they essentially had varying management protocols and systems. There were also differences in attribute definitions, terminology, classification, vocabularies and associations between spatial elements among them. For instance, it was observed that the title division (LTRD) of the Lands Commission has specific terminology to describe land tenure categories, such as freehold, leasehold, customary tenure, encumbered tenure and statutory tenure. On the other hand, these tenure categories were recognized differently in the LUSPA. According to a staff of the LTRD, "*freehold'' is recognized as the category that means absolute ownership of interests in a spatial unit". At the same time, an interview with one technical officer of the LUSPA revealed that "freehold is referred to as "private ownership" acknowledging unrestricted use, transfer, and disposal of interests on a spatial unit for a stipulated period under certain rights, restrictions and restrictions"*. In the same way, "leasehold" tenure recognized by the LTRD as land held by a lessee for a specific period is designated as temporary land rights granted through a lease agreement and written as "Leasehold Tenure" and defined slightly differently by the LUSPA.

With each in-focus agency handling different aspects of land administration, the divergent interpretation of data was revealed as a prevailing issue among other challenges along the same line.

4.2 . The Lack of Metadata

Another significant gap determined from fieldwork through systems observations was the non-existence of a metadata structure for cadastral data among land agencies in Accra. There was inconsistent metadata creation/documentation and management across all land service agencies, posing the predicament of understanding the characteristics, uses, quality and deficiencies of datasets collected over the years, whether analogue or digital. In the case of the Lands Commission, where there has been a concerted effort to establish this, especially with the use of the ELIS, it is not comprehensive and entirely based on international standards like the [ISO 19115], [ISO 19119], [ISO 19139] and [ISO 15836] which are abstract standards providing technical specifications specifying the content of metadata elements and their encodings (ISO/TC, 2019). The same can be said for the CLS, which operates primarily manually and has few to no written descriptions of documented data due to the less formal mode of operation.

4.3 . Differences in Standards Models and Formats for Managing Spatial Data

The fieldwork revealed that each agency uses different file formats and data structures, making exchanging and integrating spatial data difficult. Interviews from the LUSPA and SMD revealed some of such inconsistent standards: an interview with a staff of the LUSPA revealed "*The SMD insists on being the sole provider of the base map according to the mandates of the constitution; however, they have not met the LUSPA's demand for auto-rectified aerial maps for planning purposes but only provide vector maps due to financial constraints. As a result, the LUSPA has maps under the Universal Transverse Mercator (UTM) 30-31, while the SMD uses the Ghana WAR-OFFICE coordinate reference system*''. What makes this worrying is that both agencies primarily have maps at the core of their functions and, according to their mandates at specific points in the provision of services, need to share the maps they produce.

4.4 . The lack of an Integrated Web-based Platform

Another gap hindering cadastral data interoperability is the full adoption of an Integrated Web-based Platform among all in-focus land agencies, which we identified as an essential interoperability component (Berre et al. 2007; European Commission 2017). While progress has been seen in digitisation and digitalisation within land agencies, the slow adoption of the Enterprise Land Information System (ELIS), for example, by the CLS and LUSPA, is evidence of the prevailing analogue systems or incompatible digital systems to support seamless data sharing. Interviews from senior staff of the PVLMD revealed that "*less than 20% of analogue data has been migrated into the Lands Commission's ELIS, and while it is already a challenge to harmonise digital and analogue data, there are new systems, such as the OASL REV app, being designed to be used by the OASL and CLS, which is another barrier"*. The existence of silo systems introduces another layer of technical complexity for seamless sharing of data. Another challenging aspect is the capacity and skills to operate new and independent systems.

4.5 . The Culture of Resistance to Data Sharing

Another organisational gap was also identified in this regard, which is crucial for interoperability and developing an NSDI. Agencies are reluctant to share data over data ownership, control and competition concerns. Data is valuable to each agency since each agency runs on internally generated funds. As a result, agencies are hesitant to share without clear benefits or assurances of how the data will be used for their direct or indirect financial gain. Additionally, there are concerns or uncertainties about the integrity of their data. Hence, there is an unwillingness to share, due to the consequent accountability they may need to provide for their datasets. Another indirect cause is limited financial resources to invest in modern technology like ELIS country-wide and across all agencies.

5. MODEL COMPONENTS FOR CADASTRAL DATA INTEROPERABILITY

The proposed components of our model leverage the guidelines, elements, and principles of standards such as the LADM, ISO, EIF, AIF and INSPIRE. Following these standards, the model to support cadastral data interoperability comprises five components. The components are both organizational and technical descriptions. These components are Interoperability Governance Guidelines, Inter-Agency Relationships, Spatial Data Standardization using LADM, Metadata Technical Specifications Guide, and Spatial Data Dissemination Mechanisms. Each component teams to form a comprehensive model that addresses all identified gaps hindering cadastral data interoperability among the in-focus land agencies. The model is presented such that the components address cadastral data interoperability from high to low level or, more specifically, from an organisational level to a practical level. By this, the organisational level provides the high-level structure from which the practical components (technical descriptions) can be applied to enable cadastral data interoperability. The organisational level consists of the Interoperability Governance Guidelines and the Inter-Agency Relationships. Practically, the spatial data standardisation with LADM and metadata components can be found within each agency and deal directly with the internal operations within each in-focus agency. The Spatial Data Dissemination Mechanisms component can be found in the connections between the in-focus agencies and acts as a facilitator to ensure that the cadastral data stored according to the proposed standards are interoperable. Figure 2 illustrates the components of the cadastral data interoperability model at a high level.

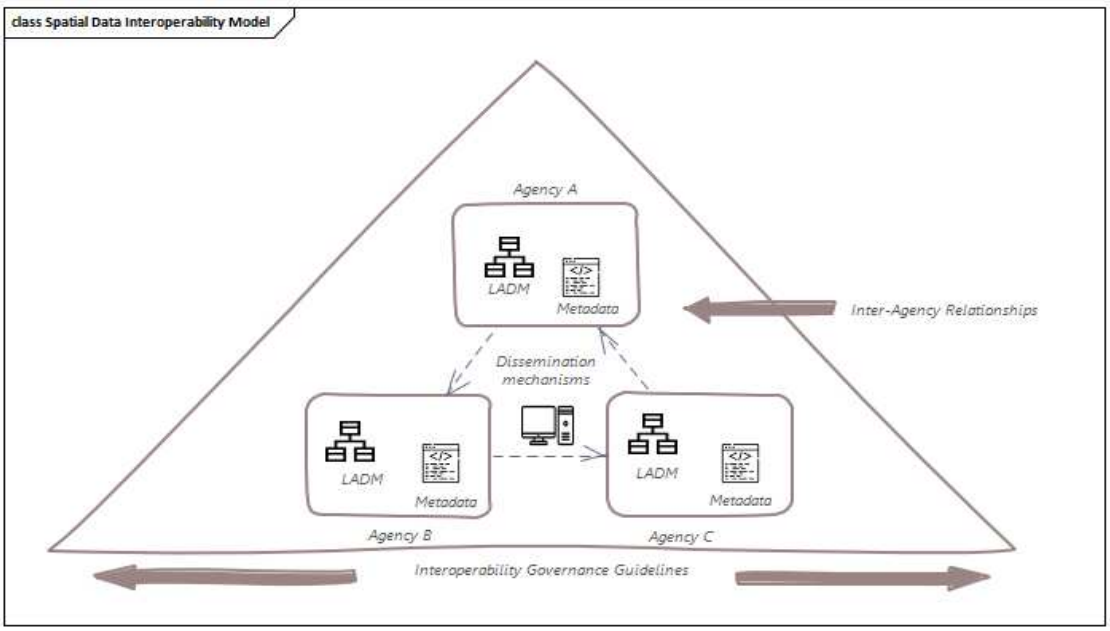

Figure 2. Cadastral Data Interoperability Components

5.1 Interoperability Governance Guidelines

We propose interoperability governance guidelines as the first high-level component imperative for cadastral data interoperability. This component specifies the underlying principles and strategies necessary to achieve the expectations of the in-focus land agencies in line with land service provision as inspired by the EIF of the European Commission (European Commission, 2017). Despite each in-focus agency's varying mandates and objectives, these principles and strategies would provide grounds where all agencies can establish integrated and complementary business processes. These principles and strategies would also form the foundation for implementing the lower-level (technical) model components. The principles and strategies outlined are carefully selected, especially considering the current modus operandi of the in-focus agencies and should be followed because they are globally accepted and suited to the context of agencies within Accra, Ghana. A detailed description of these principles and strategies is provided in Chapter 5.2.1 of the paper- https://essay.utwente.nl/96366/.

5.2 Inter-agency Relationships

According to the ATHENA cross-organisational business process (Berre et al. 2007) and the organisational interoperability recommendations of the European Union (2017), different agencies need to align their existing business processes or define and build new ones to operate effectively both internally and with other agencies to supply land services. Aligning business processes entails documenting agency mandates in an agreed-upon manner using commonly accepted modelling techniques so that the entire ecosystem of land agency providers involved in the provision of services can understand the overall (end-to-end) business relationships and their respective roles and dependencies.

In this model component, we promote operational simplicity, transparency, and reusability as drivers for interoperability, recognising that the in-focus land agencies in Accra should collaborate and reuse existing spatial data available from various sources inside or beyond their agency boundaries. Given this, this component proposes suggested interactions, roles, and responsibilities between the in-focus land agencies (and beyond them) in providing the selected services. Here, agencies and their interdependencies primarily they being (producers/collectors, users, or viewers) of spatial data are outlined. With this unified conceptual relationship, the collection, management and use of cadastral data will be done efficiently to ensure the reuse of spatial data, prevent duplication of effort and enhance the dissemination of the collected data since there is a distinction of roles. Taking this the relevant actors (agencies) we propose are the CSAU, LTRD, PVLMD, SMD, LVD, LUSPA, CLS, and GRA. All roles, responsibilities and dependencies of the in-focus agencies and added agencies are detailed in Figure 3.

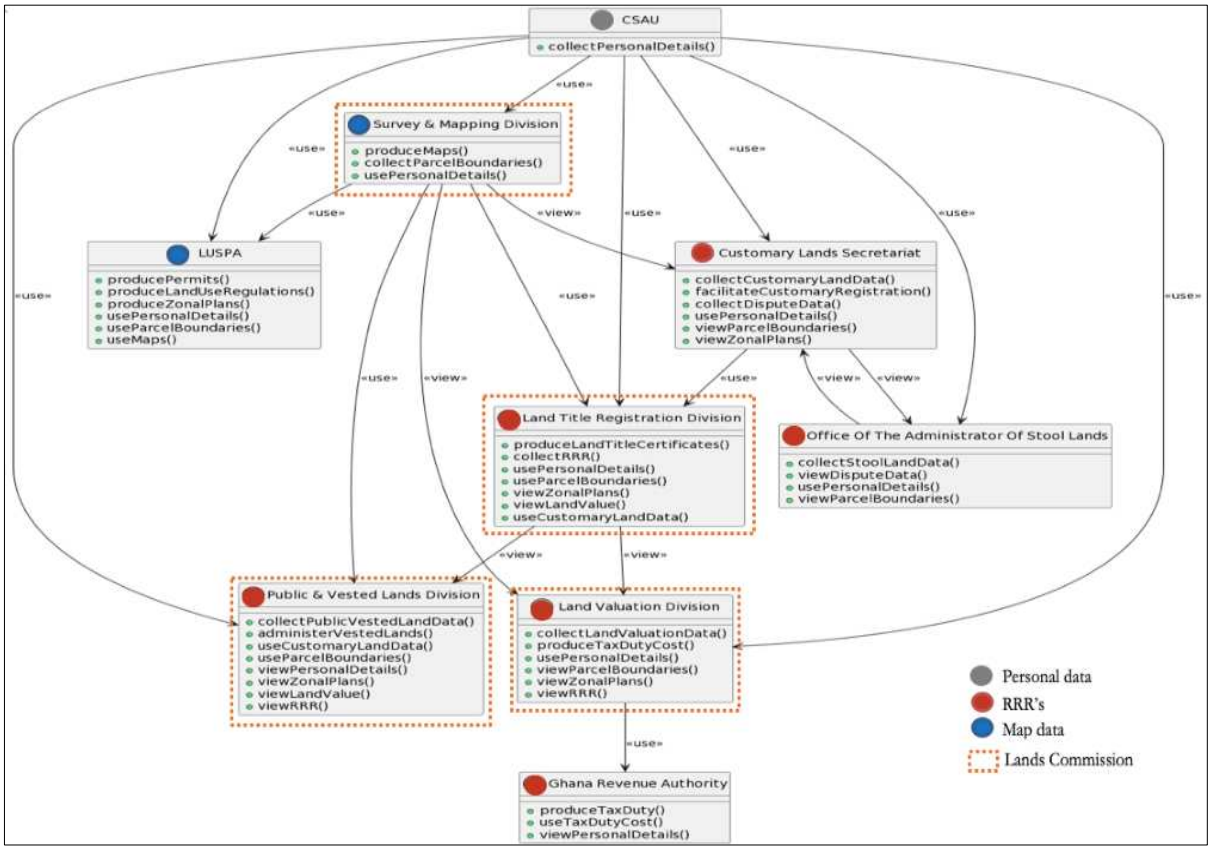

Figure 3. High Level Inter-Agency Relationships

5.3 Spatial Data Standardization with the LADM

The fieldwork revealed that spatial data is collected and used heterogeneously within each agency. To ensure the semantic homogeneity of the spatial data collected and used by the in-

focus agencies, the LADM is used as a reference model to standardize this data. Establishing sector-specific data structures and elements within the land administration space is critical to achieving semantic interoperability. After defining these resources, the in-focus agencies should agree on the meaning of the data structures and elements to be exchanged. We propose using standardized classes, data attributes, associations, multiplicities and generalizations between packages suited to Ghana's context. On reviewing the Requirements of the selected services, the three core packages of the LADM are deduced by categorizing/transforming the elements found within the service Use Cases described in Chapter 4.1. of the paper https://essay.utwente.nl/96366/. While this component does not detail every element of the LADM as is done in the case of a classic LADM country profile (see Ghana's country profile designed by Okyere, (2021), the essential aspects of it are concisely and adequately alluded to. This component ensures consistency and compatibility of spatial data since it defines a standard nomenclature for the attributes, classes, code lists, and associations to be used by all agencies.

5.4 Metadata Technical Specifications Guide

Cadastral data interoperability is achieved when access and use of these data and datasets are automated and retrievable by both humans and machines. Achieving cadastral data interoperability requires establishing standardised metadata structures and protocols to ensure consistent documentation and management of metadata for datasets across the in-focus land agencies in interoperable formats. The inter-agency relationships will also be technically implemented when a metadata specifications guide is in place.

The model stresses the significance of systematic records management and the need for in-focus agencies to develop procedures and controls to govern electronic and manual records, as motivated by the Technical Guidance for the implementation of INSPIRE dataset and service metadata based on ISO/TS 19139:2007 (INSPIRE MIG, 2022). Electronic records should be indexed to facilitate their organization, retrieval, and long-term preservation and accessibility, considering technological obsolescence and evolving formats. In the context of metadata for cadastral data and Spatial Data Services, the standards [ISO 19115], [ISO 19119], [ISO 19139] and [ISO 15836] are the key schemas from which the technical specifications in this model are sourced (ISO, 2016, 2017, 2019). The model proposes ISO 19115 and ISO 19119 as structural models to specify the content of metadata elements used. In contrast, ISO 19139 should be used to specify the encoding of ISO 19115 elements. XML namespaces and prefixes from these schemas can uniquely identify and differentiate elements or attributes in the metadata descriptions provided. To ensure that the spatial data infrastructures of the in-focus agencies are compatible and usable in a sub-national and national context, the metadata component, including general requirements and identification information, is provided in the paper-https://essay.utwente.nl/96366/.

5.5 Spatial Data Dissemination Mechanisms

A crucial component/mechanism to support the implementation of the model for cadastral data interoperability among land agencies is the establishment of a robust technical infrastructure and dedicated electronic platforms or portals. The model proposes using the appropriate technical infrastructure to facilitate the effective exchange and use of spatial data, streamline processes, promote informed decision making and accelerate seamless integration across the in-focus land agencies. A robust infrastructure for the in-focus agencies should include web services, shared data repositories/catalogues, and enterprise land information systems. In addition, electronic or virtual platforms should be used as centralized hubs for data exchange and collaboration while facilitating active cooperation among agencies and clients. These electronic platforms should have functionalities such as data validation tools, metadata repositories and catalogues, payment gateway integration and secure access controls. Table 2 shows the technical infrastructure and electronic platform functionalities essential for spatial data dissemination among land agencies.

Technical infrastructure	*Description and Functionalities*
Web services	*Agencies should exhibit their spatial data through web services, allowing other agencies to access and integrate it into their systems. Web services, such as Web*

	Feature Services (WFS) and Web Map Services (WMS), should be used to provide interfaces for querying, retrieving, and visualizing spatial data over a shared platform or application. Payment Gateway integration which uses APIs, should be used to secure payment transactions and facilitate funds transfer between clients and agencies.
Shared Data Repositories	*Shared data repositories should be used to provide a centralized storage hub for all spatial datasets, promoting easy access by authorized users across the in-focus land agencies. These repositories should use consistent data models, schemas, and coding systems to ensure compatibility of the shared data. They should also support version control and data versioning to audit changes across these agencies.*
Enterprise Information Systems	*Interoperable systems, including GIS and LIS, provide the means to access, use and analyse datasets among land agencies. These systems should have data conversion, integration, and synchronization capabilities to address syntactic and semantic heterogeneities among the unresolved datasets at the data production/collection stage.*
Electronic Platforms or Portals	*Description and Functionalities*
Data Validation Tools	*Data validation tools should be used to ensure quality assurance by running automated checks on spatial data, ensuring adherence to predefined standards such as the (LADM and OGC). This will enforce the reliability of data shared among the in-focus agencies.*
Metadata Repositories and catalogues	*Metadata repositories should be used as centralized repositories for storing and managing descriptive information about spatial datasets, such as date or creation, language, and resolution (refer to Appendix 16 for more specifications)*
Secure Access Controls	*Secure access controls should be used to control user access to sensitive spatial data, ensuring their availability, use and modification to only authorized land agency staff to reduce data manipulation.*

Table 2. Spatial data dissemination mechanisms

In summary, the model proposes that service provision will be improved when all of these components are in place. As mentioned earlier, each component, from the high to low level, should be put in place one after the other as this enforces the viability of the model.

5.6 Suggested Use Case of Acquisition of Permits After All Model Components Are Followed

To run through all aspects of the proposed model, the suggested Use Case for acquiring permits is presented as one of the three selected services. For the scope of this research, we decided to present this Use Case because it depicts the most significant changes compared to its as-is situation. Figure 4 shows the suggested Use Case for the acquisition of a building permit after all model components such as the ELIS (data dissemination and metadata), new actors under the component of inter-agency relationships and interoperability governance guidelines such as the principle of reusability are in place.

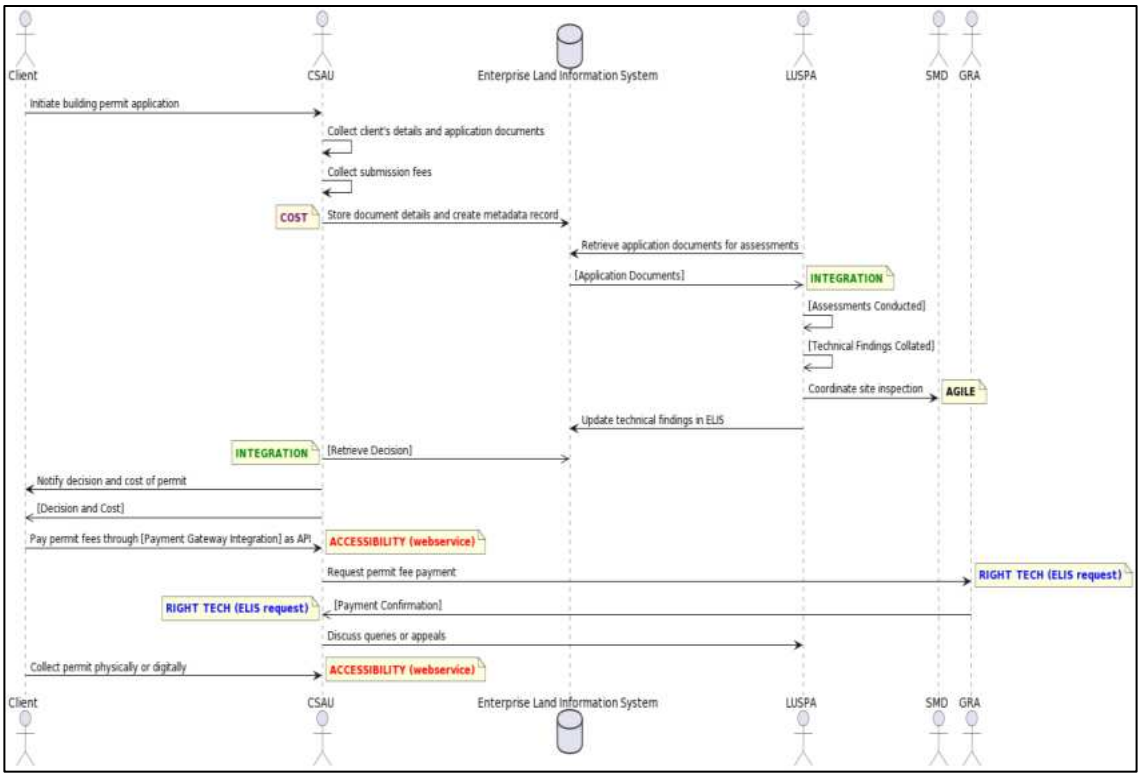

Figure 4. The suggested Use Case for the acquisition of a building permit after all model components are in place

6. CONCLUDING REMARKS

The identified gaps in cadastral data interoperability result in duplicated efforts in data collection, incomplete and inaccurate data, rigid workflows, increased service provision costs, untimely service provision, and hindered inter-agency integration. From the lenses of global standards and frameworks such as the EIF and AIF, these gaps are common denominators of the five layers of interoperability.

Addressing these gaps through our proposed model components offers potential benefits for improved land service provision. Hence, implementation of this model is recommended for Ghana's land administration. We emphasize building awareness among relevant stakeholders on the existence of the model and encouraging a consensus for its use; training to boost the technical capacity of all staff; iterative adoption/implementation of each model component; continuous monitoring and evaluation of the staff's effectiveness and the model's viability for the current land administration system.

Further research is recommended to validate the proposed model's applicability across all regions in Ghana, involving a comprehensive evaluation of land service requirements among various agencies. Additionally, exploring the integration of emerging technologies like artificial intelligence and blockchain to enhance cadastral data interoperability among Ghana's land agencies.

REFERENCES

Abubakari, Z., Richter, C., & Zevenbergen, J. (2018). Exploring the "implementation gap" in land registration: How it happens that Ghana's official registry contains mainly leaseholds. *Land Use Policy*, *78*, 539–554. https://doi.org/10.1016/J.LANDUSEPOL.2018.07.011

Bakker, N. J. (2009). Key registers as the base of the Dutch SDI. *GSDI 11 World Conference*. https://icaci.org/files/documents/ICC_proceedings/ICC2011/Oral%20Presentations%20PDF/B3-Standards,%20SDI%20and%20data%20quality/CO-151.pdf

Berre, A.-J., Elvesæter, B., Figay, N., Guglielmina, C., Johnsen, S. G., Karlsen, D., Knothe, T., & Lippe, S. (2007). The ATHENA Interoperability Framework. *Enterprise Interoperability II*, 569–580. https://doi.org/10.1007/978-1-84628-858-6_62

Deane, G., Owen, R., & Quaye, B. (2017). The Ghana Enterprise Land Information System (GELIS) As a Component of National Geospatial Policy - Land Administration Project. In B. Quaye (Ed.), *World Bank Conference on Land And Poverty*. The World Bank. https://www.intelligenceairbusds.com/files/pmedia/public/r50292_9_ghana_geospatial_policy.pdf

European Commission. (2017). *New European Interoperability Framework*. https://ec.europa.eu/isa2/sites/default/files/eif_brochure_final.pdf

FIG. (2008). *Capacity Assessment in Land Administration*. International Federation of Surveyors. https://www.fig.net/resources/publications/figpub/pub41/figpub41_A4_web.pdf

GLTN. (2021). *Land Administration and Information – Global Land Tool Network*. https://gltn.net/land-administration-and-information-2/

INSPIRE Maintenance and Implementation Group (MIG) (2023). *Technical Guidance for implementing INSPIRE dataset and service metadata based on ISO/TS 19139:2007*. https://github.com/INSPIRE-MIF/technical-guidelines/blob/main/metadata/metadata-iso19139/metadata-iso19139.adoc#common-*Requirements*-for-isotc-191392007-based-inspire-metadata-records

ISO. (2016). *ISO 19119:2016 - Geographic Information — Services*. https://www.iso.org/standard/59221.html

ISO. (2017). *ISO 15836-1:2017 - Information and documentation — The Dublin Core metadata element set — Part 1: Core elements*. https://www.iso.org/standard/71339.html

ISO. (2019). *ISO/TS 19139-1:2019 - Geographic information — XML schema implementation — Part 1: Encoding rules*. https://www.iso.org/standard/67253.html

Okyere, D. B. (2021). Country Profile of The Land Administration Domain For Ghana: With The Inclusion Title, Deed, Customary And Informal Systems Of Land Registration. Faculty of Geo-Information Science and Earth Observation Library. https://essay.utwente.nl/88705/

Steudler, D. (2004). *A Framework for the Evaluation of Land Administration Systems* [The University of Melbourne]. https://eng.unimelb.edu.au/__data/assets/pdf_file/0012/3928791/danial-steudler-phd-thesis.pdf

UN, & World Bank. (2019). *Integrated Geospatial Information Framework Part 2: Implementation Guide*.

UN-Habitat. (2016). *Fit-For-Purpose Land Administration- Guiding Principles for Country Implementation*. www.unhabitat.org

World Bank. (2011). The Land Governance Assessment Framework. In *The Land Governance Assessment Framework*. The World Bank. https://doi.org/10.1596/978-0-8213-8758-0

World Bank. (2018). *Implementation completion and results report*. https://documents1.worldbank.org/curated/en/375311468326426795/pdf/Implementation-completion-and-results-report-guidelines.pdf

World Bank. (2020). *2020 Comparing Business Regulation in 190 Economies: Doing Business Report 2020*. https://doi.org/10.1596/978-1-4648-1440-2

BIBLIOGRAPHICAL NOTES

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